ARCHITECTURAL DRAUGHTSMAN

NSQF LEVEL - 4

1st Year

TRADE THEORY

SECTOR: CONSTRUCTION

(As per revised syllabus July 2022 - 1200 hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : **Construction**

Duration : **2 Years**

Trade : **Architectural Draughtsman - 1st Year Trade Theory- NSQF Level - 4 (Revised 2022)**

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai has now come up with instructional material to suit the revised curriculum for **Architectural Draughtsman 1st Year Trade Theory NSQF Level - 4 (Revised 2022) in Construction Sector.** The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Director General, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ATUL KUMAR TIWARI, *I.A.S*
Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

January 2024
New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi (NSQF LEVEL - 4) under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Theory)** for the trade of **Architectural Draughtsman NSQF LEVEL - 4 (Revised 2022)** under **Construction** Sector for ITIs.

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NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the course of the **Architectural Draughtsman 1st Year** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022).

Module 1 - Safety & architectural symbols and sketches

Module 2 - Plane geomentry and orthographic projection

Module 3 - Masonry construction

Module 4 - Carpentry works, lintel and arches

Module 5 - Introduction to Auto CAD and design elements

Module 6 - Model space view port and projection of solids

Module 7 - Stairs and floors

Module 8 - Introduction to Design and preliminary drawing

Module 9 - DPC, History of Architecture - I and final design in Auto CAD

Module 10 - History of Architecture - II and surface development

The skill training in the shop floor is planned through a series of practical exercises centered around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the course of the **Architectural Draughtsman 1st Year** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No.	Learning Outcome	Exercise No.
1	**Draw different types of architectural symbols following safety precautions. (NOS:HCS/N0802)**	**1.1.01 - 1.1.12**
2	**Draw different types free hand sketches and different type of letterings. (NOS:HCS/N0802)**	**1.1.01 - 1.1.12**
3	**Draw different types of plane geometry. (NOS:HCS/N0802)**	**1.2.13 - 1.2.26**
4	**Draw orthographic projections. (NOS:HCS/N0802)**	**1.2.13 - 1.2.26**
5	**Draw different sizes of Bricks and Brick Masonry. (NOS:HCS/N0802)**	**1.3.27 - 1.3.35**
6	**Draw different types of Stone Masonry. (NOS:HCS/N0802)**	**1.3.27 - 1.3.35**
7	**Draw different types of Foundation. (NOS:HCS/N0802)**	**1.3.27 - 1.3.35**
8	**Draw different Carpentry Joints. (NOS:HCS/N0802)**	**1.4.36 - 1.4.45**
9	**Draw different types of Wooden Doors and Windows. (NOS:HCS/N0802)**	**1.4.36 - 1.4.35**
10	**Draw different types of Lintels. (NOS:HCS/N0802)**	**1.4.36 - 1.4.35**
11	**Draw different types of Arches. (NOS:HCS/N0802)**	**1.4.36 - 1.4.35**
12	**Draft in CAD. (NOS:HCS/N05202)**	**1.5.46 - 1.5. 52**
13	**Draw plan, elevation and side view of Solids in inclined positions and Section of Solids. (NOS:HCS/N9401)**	**1.6.53 & 1.6.54**
14	**Draw Plan, elevation and Construction Details of different types of stairs. (NOS:HCS/N9402)**	**1.7.55 - 1.7.63**
15	**Draw different types of flooring details. (NOS:HCS/N9403)**	**1.7.55 - 1.7.63**
16	**Illustrate design procedure of Residential Building. (NOS:HCS/N9421)**	**1.8.64 - 1.8.69**
17	**Draw plan, elevation and section through toilet of the residential building and the site plan with landscape. (NOS:HCS/N9422)**	**1.8.64 - 1.8.69**
18	**Draw details of Damp proof Course (DPC) and Water Proofing Treatment at different locations. (NOS:HCS/N9423)**	**1.9.70 - 1.9.81**
19	**Draw typical vertical section of an external wall of two storied load bearing structure and RCC framed structure. (NOS:HCS/N9424)**	**1.9.70 - 1.9.81**
20	**Produce final project work applying advance CAD commands and File management. (NOS:HCS/N9425)**	**1.9.70 - 1.9.81**
21	**Surface Development of geometrical solids. (NOS:HCS/N9426)**	**1.10.82**

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 26 Hrs.; Professional Knowledge 06 Hrs.	Draw different types of architectural symbols following safety precautions. **(NOS:HCS/N0802)**	**Familiarization** 1 Importance of safety and general precautions observed in the institute and in the section. (1 hrs.) 2 Importance of the trade in the development of the country's infrastructure. (01 hrs.) 3 Recreational, medical facilities and other extracurricular activities of the institute. (01 hrs.) 4 All necessary guidance to be provided to the new comers to become familiar, with the working of training institute. (01 hrs.)	**Orientation** Familiarization with the institute Importance of trade training Introduction to the trade and professional prospects Orientation of subjects Familiarization with engineering drawing, tools and equipment. (03 hrs.)
		Architectural symbols 5 Architectural symbol for materials, doors, windows. (08 hrs.) 6 Architectural symbols for trees, plants, shrubs. (07 hrs.) 7 Architectural symbols for plumbing and electrical fittings and fixtures. (07 hrs.)	**Architectural Symbols** Architectural signs and symbols and their uses in the drawings (03 hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 06 Hrs.	Draw different types free hand sketches and different type of letterings. **(NOS:HCS/N0802)**	**Sketching** 8 Free hand sketching of trees, plants and shrubs. (05 hrs.) 9 Free hand sketching of landscape and monuments. (05 hrs.) 10 Free hand sketching of objects. (05 hrs.) 11 Lettering – types of lettering, legibility, uniformity. (08 hrs.) 12 Purpose and uses of lines, curves, line weight, types of lines. (05 hrs.)	**Sketching techniques** Elements of drafting, readability, clarity, accuracy and neatness Pencil grades Method of pencil uses Uses of different brush strokes Various types of lines used for sketching (06 hrs.)
Professional Skill 17 Hrs.; Professional Knowledge 02 Hrs.	Draw different types of plane geometry. **(NOS:HCS/N0802)**	**Plane geometry** 13 Draw a line parallel to any given point. (01 hrs.) 14 Divide a line into any number of equal parts different methods. (01 hrs.) 15 Bisect a line, arc or angle. (01 hrs.) 16 Geometrical constructions using different method – square, pentagon, triangle, hexagon, heptagon, octagon, ellipse. (06 hrs.)	**Solids** Definition of solids – cube, square prism, hexagonal prism, triangular prism, square prism, triangular pyramid, hexagonal pyramid, pentagonal pyramid, cylinder, sphere, cone. (02 hrs.)

		Dimensioning 17 Basic system of measurement, dimensional control, location, dimensioning of different objects like lines, circle, curves and angles Scale and proportion. (08 hrs.)	
Professional Skill 92 Hrs.; Professional Knowledge 10 Hrs.	Draw orthographic projections. **(NOS:HCS/N0802)**	**Introduction to orthographic projections** 18 Types of projections. (02 hrs.) 19 Projection planes. (02 hrs.) 20 First angle projection. (02 hrs.) 21 Third angle projection. (02 hrs.) 22 Method of drawing orthographic projections. (02 hrs.) Projections of lines and lamina 23 Projections of lines in simple position. (12 hrs.) 24 Projection of lamina in simple position. (12hrs.) Projection of solids in simple positions 25 Drawing plan, elevation and side elevation of simple solids like cube, pyramid, prism, cone, cylinder in first angle projection. (30 hrs.) 26 Drawing projection of solids in third angle projection in simple positions. (28 hrs.)	**Types of projections** Types of projections Projection planes First angle projection Third angle projection **Isometric view** Isometric view of geometrical solids (10 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 12 Hrs.	Draw different sizes of Bricks and Brick Masonry. **(NOS:HCS/N0802)**	**Brick masonry** 27 Sizes of brick and brick bats. (04 hrs.) 28 English and Flemish bond for one brick thick and one and half brick thick wall. (18 hrs.) 29 Different types of bonds (zig zag bond, diagonal bond, stretcher bond, header bond, monk wall bond, herring bone bond, Dutch bond, garden wall bond). Brick laying with the help of tools / infrastructure. Setting out & measurement, cutting & construction, joint finishing & presentation. (28 hrs.)	**Brick masonry** Technical terms, Sizes of brick and brick tiles, Principle of brick masonry construction, English and Flemish bond for one brick thick and one and half brick thick wall, Different types of bonds and their uses in construction, Hollow brick masonry, AAC Block, Fly-ash brick . brick laying, understanding brick laying, pattern designs. Interpretation of drawings ,setting out and measurement, construction, joint finishing & presentation. (12 hrs.)
Professional Skill 22 Hrs.; Professional Knowledge 06 Hrs.	Draw different types of Stone Masonry. **(NOS:HCS/N0802)**	**Stone masonry, tile masonry** 30 Setting and measurement Cutting, preparations, fix, cleaning 31 Coursed and uncoursed rubble masonry. (04 hrs.) 32 Random rubble masonry. (06 hrs.) 33 Ashlar masonry. (04 hrs.)	**Stone masonry, tile masonry Wall & floor filing Produce and interpret drawing, setting out & measurement, preparations ,fix** Technical terms Principles of stone masonry Rubble masonry Ashlar masonry Composite masonry (06 hrs.)

		34 Composite masonry (stone facing with brick backing, stone facing with concrete backing, stone facing with rubble backing). (08 hrs.)	
Professional Skill 22 Hrs.; Professional Knowledge 10 Hrs.	Draw different types of Foundation. **(NOS:HCS/N0802)**	**Foundation with column** 35 Types of foundation – spread foundation, grillage foundation, pile foundation, raft or mat foundation. (22 hrs.)	**Foundation with column** Purpose of foundation Causes of failure of foundation Types of foundation – spread foundation, grillage foundation, pile foundation, raft or mat foundation (10 hrs.)
Professional Skill 22 Hrs.; Professional Knowledge 06 Hrs.	Draw different Carpentry Joints. **(NOS:HCS/N0802)**	**Carpentry Joints** 36 Lengthening spliced or longitudinal joints. (03hrs.) 37 Bearing joints. (03 hrs.) 38 Framing joints. (04hrs.) 39 Angle or corner joints. (04 hrs.) 40 Widening or side joints. (04 hrs.) 41 Oblique-shouldered joints. (04 hrs.)	**Carpentry Joints** Technical terms Lengthening joints and their uses Bearing joints and their uses Framing joints and their uses Angle or corner joints and their uses Widening or side joints and their uses Oblique-shouldered joints and their uses (06 hrs.)
Professional Skill 48 Hrs.; Professional Knowledge 12 Hrs.	Draw different types of Wooden Doors and Windows. **(NOS:HCS/N0802)**	**Doors** 42 Details of paneled door, flush door, batten and ledged door. (24 hrs.) **Windows** 43 Details of casement window, louvered window, ventilator. (24 hrs.)	**Doors** Standard Sizes of doors Types of doors - paneled door, flush door, batten and ledged door **Windows** Standard Sizes of windows Details of casement window, louvered window, ventilator Fixtures and fasteners Types of joints (used in doors and windows) (12 hrs.)
Professional Skill 10 Hrs.; Professional Knowledge 02 Hrs.	Draw different types of Lintels. **(NOS:HCS/N0802)**	**Lintels/slab lintels** 44 Details of Wooden lintel, stone lintel, brick lintel, steel lintel, RCC lintel, Chajjas. (10 hrs.)	**Lintels/ slab lintels** Purpose of lintel Types and uses of lintels – wooden lintel, stone lintel, brick lintel, steel lintel, RCC lintel, Chajjas (02 hrs.)
Professional Skill 17 Hrs.; Professional Knowledge 06 Hrs.	Draw different types of Arches. **(NOS:HCS/N0802)**	**Arches** 45 Details of semicircular arch, flat arch, segmental arch, pointed arch, two centered arch. (17 hrs.)	**Arches** Technical terms Materials used for construction of arches Types of arches and their uses – flat arch, semicircular arch, segmental arch, semi elliptical arch, two centered arch, three centered arch. (06 hrs.)
Professional Skill 84 Hrs.; Professional Knowledge 21 Hrs.	Draft in CAD. **(NOS:HCS/N05202)**	**CAD** 46 Introduction to CAD. (03hrs.) 47 Starting procedures of CAD – screen appearance, tool bar, menu bar, quick access tool bar, command tool bar, units, settings, dimensioning. (04 hrs.)	**Commands. (22hrsFactors considered in architectural design Introduction to CAD** Understanding the basic elements of design like point, line, plane, figure, form and space, light and color, texture. (21 hrs.)

		48 Basic CAD drafting commands - 1 – line, circle, arc, ellipse, copy, move, rotate, erase, undo, mirror, offset, fillet, polygon, trim, extend, explode. (05 hrs.) 49 Basic CAD commands 2 – rectangle, array, scale, stretch, break, join, chamfer, spline, colors, line type, line weight, properties, match properties, hatch. (05 hrs.) 50 Draft a plan and elevation of a sofa set, bed, chair, table, dining, TV unit etc using basic CAD Commands (30hrs) 51 Draft door/windows and ventilators in detailed section (frame panel fixing etc) (15 hrs) 52 Draft interiors of bed room/living room using basic CAD commands. (22 hrs)	
Professional Skill 46 Hrs.; Professional Knowledge 08 Hrs.	Draw plan, elevation and side view of Solids in inclined positions and Section of Solids. **(NOS:HCS/N9401)**	**Projection of Solids in inclined positions in AutoCAD** 53 Drawing plan, elevation and side elevation of inclined solids like cube, pyramid, prism, cone, cylinder in first angle projections. (18 hrs.) **Section of solids** 54 Drawing projection of solids in different section plane. (28 hrs.)	Introduction to model space view port in auto CAD (08 hrs)
Professional Skill 84 Hrs.; Professional Knowledge 18 Hrs.	Draw Plan, elevation and Construction Details of different types of stairs. **(NOS:HCS/N9402)**	**Stairs** 55 Plan and elevation of different types of stairs – straight stairs, quarter turn stairs, open well stairs, bifurcated stairs, circular stairs. (26 hrs.) 56 Construction Details of dog-legged stairs, baluster details, railing, nosing, tread and riser calculation. (26 hrs.) 57 Details of wooden stairs. (16 hrs.) 58 Details of MS spiral stairs. (16 hrs.)	**Stairs** Technical terms General dimensions and arrangements Requirements of good stairs Ashlar masonry Classification of stairs – straight flight stairs, dog legged stairs, newel stairs, open well stairs, geometrical stairs, circular stairs, bifurcated stairs, spiral stairs, stairs of different materials – wooden stairs, stone stairs, metal stairs, reinforced concrete stairs (18 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 08Hrs.	Draw different types of flooring details. **(NOS:HCS/N9403)**	**Floors and flooring** 59 Components of ground floor. (5 hrs.) 60 Details of cement flooring. (5 hrs.) 61 Details of stone / tile flooring. (5hrs.) 62 Details of wooden suspended flooring. (5 hrs.) 63 Details of wooden double floor. (5 hrs.)	**Floors and flooring** Components of floor – sub floor, floor covering, construction of ground floor, selection of floorings Suspended floors Floor coverings Ground and basement floor (08 hrs.)
Professional Skill (44 Hrs)	Illustrate design procedure of Residential Building. **(NOS:HCS/N9421)**	**Introduction to design** 64 Design topic – Residential. (18 hrs.) 65 Concept and visualization of design. (Students should be able to	Design principles – balance, proportion, perspective, movement, rhythm, harmony, unity, symmetry and contrast (06 hrs.)

Professional Knowledge (06 Hrs.)		understand the process of designing and the design project will go throughout the year) Initial sketches/ preliminary drawings manually. Sketches of the plan. (26 hrs.)	
Professional Skill 40 Hrs.; Professional Knowledge 12 Hrs.	Draw plan, elevation and section through toilet of the residential building and the site plan with landscape. **(NOS:HCS/N9422)**	**Preliminary drawing** 66 Drawing to be prepared by trainees in AUTOCAD based on single floor residential building after analyzing the requirement and area analysis. (12 hrs.) 67 Front elevation and one side elevation. (06 hrs.) 68 Section through staircase or toilet. (16 hrs.) 69 Site plan with landscaping. (06 hrs.)	Conceptual design ideas – site analysis, site planning, requirements, space designation, proportionately defined rooms, single line diagram, floor plan analysis, functional planning. (12 hrs.)
Professional Skill 34 Hrs.; Professional Knowledge 18 Hrs	Draw details of Damp proof Course (DPC) and Water Proofing Treatment at different locations. **(NOS:HCS/N9423)**	**Damp proof Course (DPC)** 70 Details at plinth level. (10 hrs.) 71 Details at terrace level (Water Proofing Treatment). (10 hrs.) 72 Details at basement level. (10hrs.) 73 Details of cavity wall. (04 hrs.)	**Damp proof Course (DPC)** Definition Sources of dampness Prevention methods of dampness – integral treatment, surface treatment, membrane damp proofing, cavity wall construction Materials used in DPC – mastic asphalt, hot laid bitumen, metal sheets, PCC etc. (06 hrs.) **Anti-termite treatment** Types of Anti termite treatment a)Treatment to basement in ordinary soil (06 hrs.) b)Treatment to basement in damp soil (06 hrs.)
Professional Skill 08 Hrs.; Professional Knowledge 02 Hrs.	Draw typical vertical section of an external wall of two storied load bearing structure and RCC framed structure. **(NOS:HCS/N9424)**	Draft in AutoCAD 74 Load bearing wall. (04hrs.) 75 RCC framed structure. (04hrs.)	Pre-fabricated panels RCC, GI Powder coated steel panels. (02 hrs.)
Professional Skill 111 Hrs.; Professional Knowledge 15 Hrs.	Produce final project work applying advance CAD commands and File management. **(NOS:HCS/N9425)**	**CAD** 76 Advance CAD commands – layers, block, insert, group, divide, measure, design center, text gradient, dimension style, leader, layouts, model space view ports, File management. (15 hrs.) **Final design** 77 Final floor plans showing living room, kitchen, bedrooms, toilet, logical order from the main entrance, basic area with furniture, garage and driveway, pedestrian ways, levels, north line, section line, scale, dwv schedule, statement of area etc. (30 hrs.) 78 Front elevation with all heights and levels mentioned. (17 hrs.)	**Indian architecture** Stupas and its characteristic features and typical examples Typical Buddhist column or order Northern Indian style elements and characteristic features (lingaraja temple at Orissa, sun temple at konark, temple of khajuraho (15 hrs.) **History of architecture (HOA) Egyptian architecture** Characteristic features of Egyptian architecture Tombs mastaba pyramid – the great pyramid at cheops at giza the great sphinx of chephren

		79 One side elevation with all heights and levels mentioned(17 Hrs.) 80 Detailed section through staircase/ toilet with all heights and levels mentioned. (All presentation drawing to be submitted as project spiral binding). (17 hrs.) 81 Final site plan with landscape elements. (15 hrs.) **Note**: design elements to keep in consideration while designing the elevations	**Greek architecture** Greek columns like doric order, ionic order, corianthan order Characteristic features of the temple of Parthenon at Athens, Olympia stadium at athens.
Professional Skill 10 Hrs.; Professional Knowledge 14 Hrs.	Surface Development of geometrical solids. **(NOS:HCS/N9426)**	**Surface Development** 82 Developing surface Development of solids. (10 hrs.) **Note**: subject of drawing, scale, date, job no, address, ph.no, north – south direction, sheet no. to be mentioned in all the sheets. Drawing produced should be well readable and self-explanatory.	**Roman architecture** Characteristic features of the temples of Saturn at rome, the pantheon at Athens, basilica of Trajan at rome. **Indian architecture** Stupas and its characteristic features and typical examples Typical Buddhist column or order Northern Indian style elements and characteristic features (Lingaraja temple at Orissa, sun temple at Konark, temple of Khajuraho) Central Hindu style elements and characteristic features (rock cut temples at Badami and Humpi, Hoysaleswar temple at halebid) South Hindu or Dravidian style elements and characteristic features (shore temple at Mahabalipuram, Brihadesvar temple at Tanjavur, temple of Madurai) (14 hrs.)

Familiarization with the institute and trade

Objectives: At the end of this lesson you shall be able to
- **state the general training system**
- **state the information about the trade**
- **state the importance of trade training.**

Training system

General

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers range of vocational training courses catering to the need of different sectors of economy labour market. The vocational training programmes are delivered under aegis of National Council of Vocational Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship. Training Scheme (ATS) are two pioneer programmes of NCVT for propagating vocational training.

Candidates broadly need to demonstrate that they are able to:

- Read & interpret technical parameters/documentation, plan and organize work process, identify necessary materials and tools.
- Perform work with due consideration to safety rules, Govt. Bye laws and environmental protection stipulations.
- Apply professional knowledge, core skills & employability skills while performing the work.
- Check the work as per sketches and rectify errors.
- Document the technical parameters related to the work undertaken.

About the trade

What do Architectural draughtsman do?

Architectural draughtsman, also called as drafters, who perform some of the tasks as civil draughtsman and often work with civil engineers and architects. Architectural draughtsman are like civil Draughtsman who prepare not only CAD drawings but also, prepare architectural 3D models, interior and exterior designs.

However, drafting can be applied to several other areas, besides architecture drafting and construction work. Drafting can be done to create drawings of circuitry or mechanical designs. An Architectural Draughtsman's CAD drawings include specifications such as specifications and procedures in addition to using CAD. Draftsman's also use calculaters, tables and technical hand books related to Architectural drawings.

The type of work of an Architectural draughtsman does depends on his or her area of expertise. For example, drafters produce drawings for construction projects. They may specialized in Architectural design in residential or commercial buildings. Architectural draughtsman prepare drawings in Arhitectectural culture projects and rendering

of residential and commercial buildings.

Architectural draughtsman use hand drawing and computer aided drafting methods to generate precise drawings that meet given specifications and one used by manufactures, builders and engineers.

They also and organize assigned work and detect & resolve issues during execution. Demonstrate possible solutions and agree tasks with in the team, communicate with required clarity and understand technical English, Sensitive to environment , self-learning and productivity.

Introduction to the trade and professional prospects

Objectives: At the end of this lesson you shall be able to
- **state the duties and task for "Architectural Draughtsman".**

Job duties and tasks for Architectural Draughtsman

- Produce drawings using computer aided drafting system (CAD) or drafting mechanics or by hand using compass, dividers, protectors, triangles and others drafting devices,
- Draw plans and detailed drawing of residential buildings and commercial buildings with Architecture aspects.
- Draw maps diagram and profiles.

Options for employment are

Employment opportunities for trainee from this trade as Architectural draftsman shall be available in Central & State Governmnet Departments.

Private sector opportunities shall be as Draftsman, Construction Supervisor with Architect, Civil Engineer, and Civil Contractor, Builders.

Options for Self- Employment are

The Trainee shall be able to independently undertake planning, drawing and supervision of civil construction work. He can set up his own office for above work and also to supply Civil Construction materials.

Rules and regulation of the institute and trade

- The trainees who are all got admission in I.T.I has to follow same general rules stiuplated by the institution, and those are given below
- He/she should try to earn good name from the institution
- The trainees should attend the institution at the correct time so punctuality should be maintained.
- He/she should be very sincere and faithfull not only to their instructor but also other instructors and staff of the institute.
- He/she should attend with proper formal uniform as specified by the institute.
- He/she should not wear loose clothes and this may be the cause for accident while crossing in shops floor.
- He/she should have good attitude and behave with good manner to all the staff members his/her fellow students and to his/her senior students.
- He/she should participate in the activities of the institute.
- He/she should maintain discipline of the class room and the institution.
- He/she should not spoil the environment of institute.

Note: The above rules and regulation are also compulsory for the women trainees to adhere

Leave facility

Thetrainees should attend the institute 80% of attendance. Casual leave is eligible for 12 days per year and medical leave is eligible for 20 days per year.

Orientation of Subjects and subjects to be taught for each semester

Objectives: At the end of this lesson you shall be able to
- **over view of the subjects**
- **subject to be taught in each year.**

Overview of the subject to be taught for each semester: During the two years' duration, a candidate is trained on subject viz. Professional Skill, Professional Knowledge, Workshop Calculation & Science and Employability Skills. In addition to this, a candidate is entrusted to undertake project work and Extra Curricular Activities to build up confidence. (On job Training) The practical skills are imparted in simple to complex manner & simultaneously theory subject is taught in the same fashion to apply cognitive knowledge while executing tasks. The practical part starts with simple drawings of symbols, and finally ends with final plan of Residential / Public building; drawing of 3D models, walk through and animations at the end of the course.

The broad components covered under Professional Skill subject are as below.

Environment of I.T.I is differing from the school's education. In I.T.I we concentrate more time in practical training i.e he/she has to obtain good skill in the trade in which they trained. Hence we can say I.T.I.s are institutions which lay the carpet for self-job opportunity and different job opportunity in public sector and private sector.

There are so many departments in public sector and private sector which provides the job opportunity for the trade of Architectural Draughtsman.

The name of some public sectors are given below

- Central / State public works department
- Central architect department
- Military Engineering service
- National Highways department
- Railways
- Nagar palkas (Municipalities)
- Private building construction & interior design companies

Now Government of India passed an order in parliament those are all trained in particular group of trades such as Architectural Draughtsman, D'man Civil, D'man Mechanic and Mechanic shop group of trades, they can join in 2nd year of diploma courses in the respective states.

Subject to be taught in the trade of Architectural Draughtsman for each year.

1st Year

- Orientation of subjects
- Famililiarization with institute. Importatance of trade training and professional prospects
- Familiarization with engineering drawing tools and equipments.
- Architectural symbols and their uses in the drawings.
- Elements of drafting, freehand sketching
- Pencil grades
- Various types of lines used for sketching
- Solid-definition of solids - cube - square – prism - hexogonal prism etc.,
- Types of projection - Projection plane - First angle projection - 3rd Angle projection.
- Isometric view - Views of isometric solids
- Bricks masonry and its types
- stone masonry and its types
- Foundation - And its details - Types
- Carpentry joints
- Doors - And their types - Windows and their types
- Lintels
- Arches
- CAD Introduction
- Factors considered in architectural design
- Damp proof course (DPC) definition. Sources of dampness - prevention etc.
- Anti - Termite treatment types
- Design principle and concepts of visualization
- Concept of design ideas - Site analysis - Site planning etc.,
- Prefabricated panels RCC
- Stairs - Types
- Floors and flooring
- History of Architecture
- Egyptian Architecture
- Roman Architecture
- Indian Architecture

- Central hindu styles and elements - Characteristic features
- Projection of solids
- Preliminary and final design in CAD.
- Surface development of solids

2nd Year

- Introduction to design concept and visualization of design.
- Factors considered in architectural design.
- Environmental factors in architectural design.
- Reading and interpretation of structural drawing.
- Draft sanction drawing in Auto CAD.
- Introduction tp 3D modeling software - sketch up.
- Special doors and windows.
- Roof and roof coverings.
- Draft working drawings in Auto CAD.
- Anthropometry and ergonomics of commercial buildings.
- Case study of complete project report.
- Climate responsive design.
- Draw joints in structures.
- Prepare 3D model and BOQ using BIM software.
- Project presentation, Rendering
- Green architecture/ sustainable architecture.
- Prepare layout of working drawings

Familiarization with engineering drawing tools and equipments

Objectives: At the end of this lesson you shall be able to
- **state the importance of engineering drawing**
- **state the areas of Architectural Draughtsman engineering drawing.**

Introduction

The communication of ideas through the graphical language is probably the oldest form of communication among human. Engineering graphics is the study that required special equipment to form the images.

Engineering Drawing

Drawing drawn by a person, having knowledge about engineering aspect for the engineering purpose is an engineering drawing. It is the universal graphic language of engineers, spoken, read and written in its own way. Every language has its own rules of grammer.

Engineering drawing also has its grammer in the theory of projections, its idioms in conventional practice, its punctuations in the types of lines, its abbreviations, symbols and its descriptions in the constructions. The shape of objects are established by different lines and size description are by symbols lettering and dimensioning.

In Civil Engineering, this is concerned with structural works. It is very broad with many subspecialties, including structural, geotechnical, water resource and transportation engineering. Structural engineers are concerned with the safe design and construction of structures.

These can range from small warehouses to skyscrapers and from highway overpasses to large bridges and can include dams of all sizes. Geotechnical and soil mechanics engineers evaluate the capacity of rocks and soils to bear heavy structures.

Water resource engineers handle water collection, distribution, and purification, including the building of dams, flood control, and irrigation. Transportation engineers design highway and public transportation systems.

Geometrical Drawing

It is the foundation of all engineering drawing. It is the art of representation of geometrical objects on a drawing sheet, which is difficult to learn or teach without the good aids. Accuracy, neatness and legibility are of great importance in engineering drawing.

Plane geometrical Drawing

It is the art of representation of objects having two dimensions, i.e. length and breadth such as, square, rectangle, etc. on a drawing sheet.

Solid Geometrical Drawing

It is the art of representation of objects having three dimensions, i.e. length and breadth and height such as, cube, cylinder, etc. on a drawing sheet.

The learning process is accomplished through traditional construction methods, may then only easily accomplished by the use of computer.

The skill of manual drafting is still in great demand and will continue to be, however, because computer drafting is not suitable for all phases of design.

For example, for designing certain types of custom-made architecture and in remodeling one-of-a-kind developments manual draughtsman are still in demand for their abilities and extensive experience.

List of drawing instruments, equipments and materials to be used during training

Objectives: At the end of this lesson you shall be able to
- **state instruments, equipments and materials**
- **list out instrument, equipments and materials**
- **state the standard as per 962-1987**
- **to use different drawing instruments, equipments and materials**
- **follow Precautions in the use of instruments, equipments and materials.**

Introduction

Engineering Drawing is the language of engineers, the accuracy and neatness of the engineering Drawing depends on the quality of the instruments, equipments and material used. Hence, preference should be given to standard instruments and equipments and draughtsman should be able to use different drawing instruments.

List of instruments

- Drawing board

- Tee-square or Mini Drafter
- Set-square
- Scale
- Protractor
- French curves
- Stencil
- Drawing instruments box

List of equipments

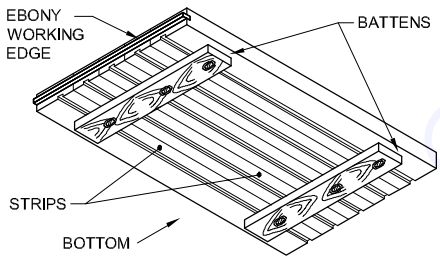
- Drafting machine
- Computer for Auto CAD. (Monitor UPS, CPU, key board, mouse, etc.)
- Plotter/Printer

List of materials

- Drawing papers
- Drawing pencils
- Rubber/ Eraser
- Drawing papers fasteners (Drawing pins, Cello tape)
- Tracing paper or tracing film

Drawing board (Fig 1)

Fig 1



DRAWING BOARD

The standard size should be as per IS: 1444-1963/1977 of Bureau of Indian Standards.

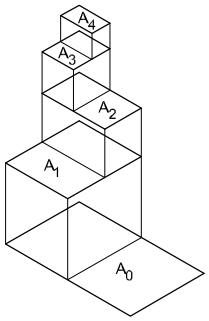
Sl. No.	Designation	Drawing Boards Sizes in mm (L x W x T)	Drawing sheets to be used with designation
1	B0	1500 x 1000 x 25	A0
2	B1	1000 x 700 x 25	A1
3	B2	700 x 500 x 15	A2
4	B3	500 x 350 x 15	A3

The following precaution may be taken in handling the drawing boards:

- Always keep an extra sheet on the top surface of the drawing board.
- Do not keep anything on the top flat surface of the drawing board.
- Take sufficient care in up keeping the straightness of the ebony edge.

Drawing papers (Fig 2)

Fig 2



HALVING AND DOUBLING

The standard size as per Bureau of Indian standard (B.I.S)

Designation	Trimmed size (mm)	Untrimmed size (mm)
A0	841 x 1189	880 x 1230
A1	594 x 841	625 x 880
A2	420 x 594	450 x 625
A3	297 x 420	330 x 450
A4	210 x 297	240 x 330
A5	148 x 210	165 x 240

1 The size of the drawing sheets to be used depends on the size of the object to be drawn and the scale to be used.

2 The length of the drawing sheet can be horizontal or vertical while drawing.

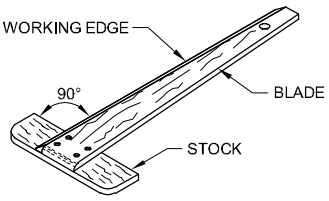
3 A2 size of drawing sheet is most convenient for drawing purposes in the class room.

4 The width to length ratio of drawing sheet is

5 Area of A0 drawing sheet is 1.00 square meter.

T-square (Fig 3)

Fig 3



T-SQUARE

It consists of two parts, a long strip called blade and a short strip called head or stock. The blade is fitted with an ebony or plastic piece on its upper edge to form a working edge.

The following precautions may be taken in handling the T-square (Fig 4)

1 When not in use, T-square should be left flat on the drawing board or suspended from the hole at the end of the blade.

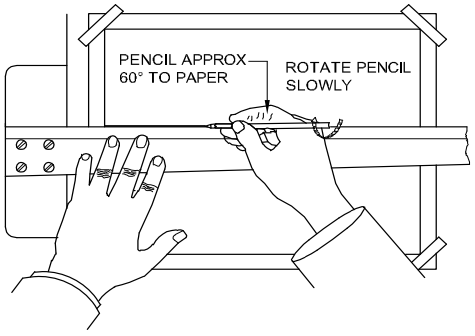
2 Clean the blade with moist cloth to remove lead particles.

3 Do not use T-square as a hammer to drive in the drawing pins etc.

4 Do not use the ebony edge as a straight edge for cutting paper with knife.

5 Ensure that the screw heads are tight.

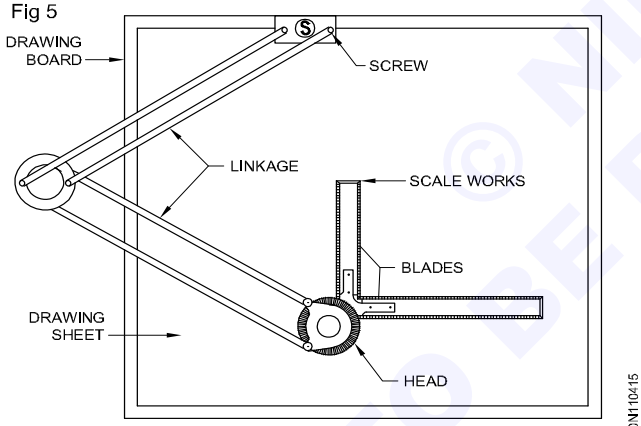
Fig 4



T-square is used to draw only horizontal lines. Do not use lower edge of the T-square to draw horizontal lines. While drawing horizontal lines, the pencil should be slightly inclined towards the right. Vertical and inclined lines are drawn with the help of set squares.

Mini drafter (Fig 5)

Fig 5

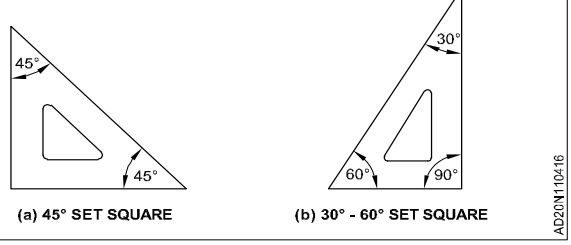


MINI DRAFTER

It is a simple and small shaped instrument of the drafting machine. Now-a-days these are mostly used by the engineering students. All the working functions of T-Square, Set-Square, Protractor, Scales and their merits are co-ordinated in a Mini-Drafter.

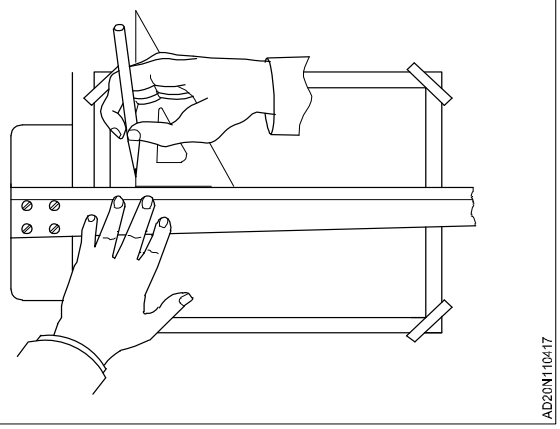
Set-square (Figs 6 & 7): It is made of transparent celluloid plastic in triangular shape They are available in two types, 30°-60° and 45°-45°.

Fig 6



(a) 45° SET SQUARE (b) 30° - 60° SET SQUARE

Fig 7



Engineer's scales (Table)

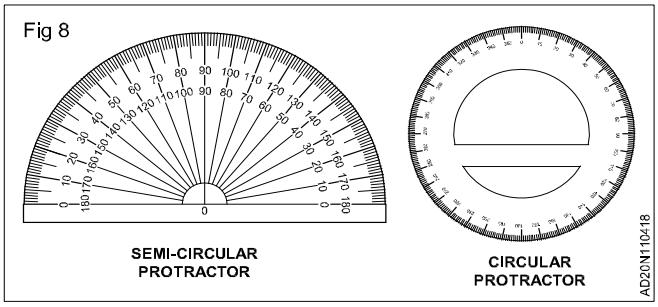
It is used to make full size, reduced size or enlarged size drawings conveniently, depending upon the size of the object and that of the drawing sheet. They are made of cardboard, plastic and as recommended by Bureau of Indian Standards, are available in set of eight scales. They are designated from M1 to M8.

Table

Designation	Description	Scales
M1	Full size	1:1
	50 cm to a meter	1:2
M2	40 cm to a meter	1:2.5
	20 cm to a meter	1:5
M3	10 cm to a meter	1:10
	05 cm to a meter	1:20
M4	02 cm to a meter	1:50
	01 cm to a meter	1:100
M5	5 mm to a meter	1:200
	2 mm to a meter	1:500
M6	3.3 mm to a meter	1:300
	1.66 mm to a meter	1:600
M7	2.5 mm to a meter	1:400
	1.25 mm to a meter	1:800
M8	1 mm to a meter	1:1000
	1.5 mm to a meter	1:2000

Protractor (Fig 8)

Fig 8



SEMI-CIRCULAR PROTRACTOR CIRCULAR PROTRACTOR

It is made of transparent celluloid plastic, available in semi circle or circle.

Compass (Fig 9)

It is used for drawing circles both in pencil and in ink. It consists of two legs hinged at one end. One leg is attached with a steel needle by means of a screw while the other leg is provided with a socket to accommodate interchangeable attachments.

Dividers (Fig 10)

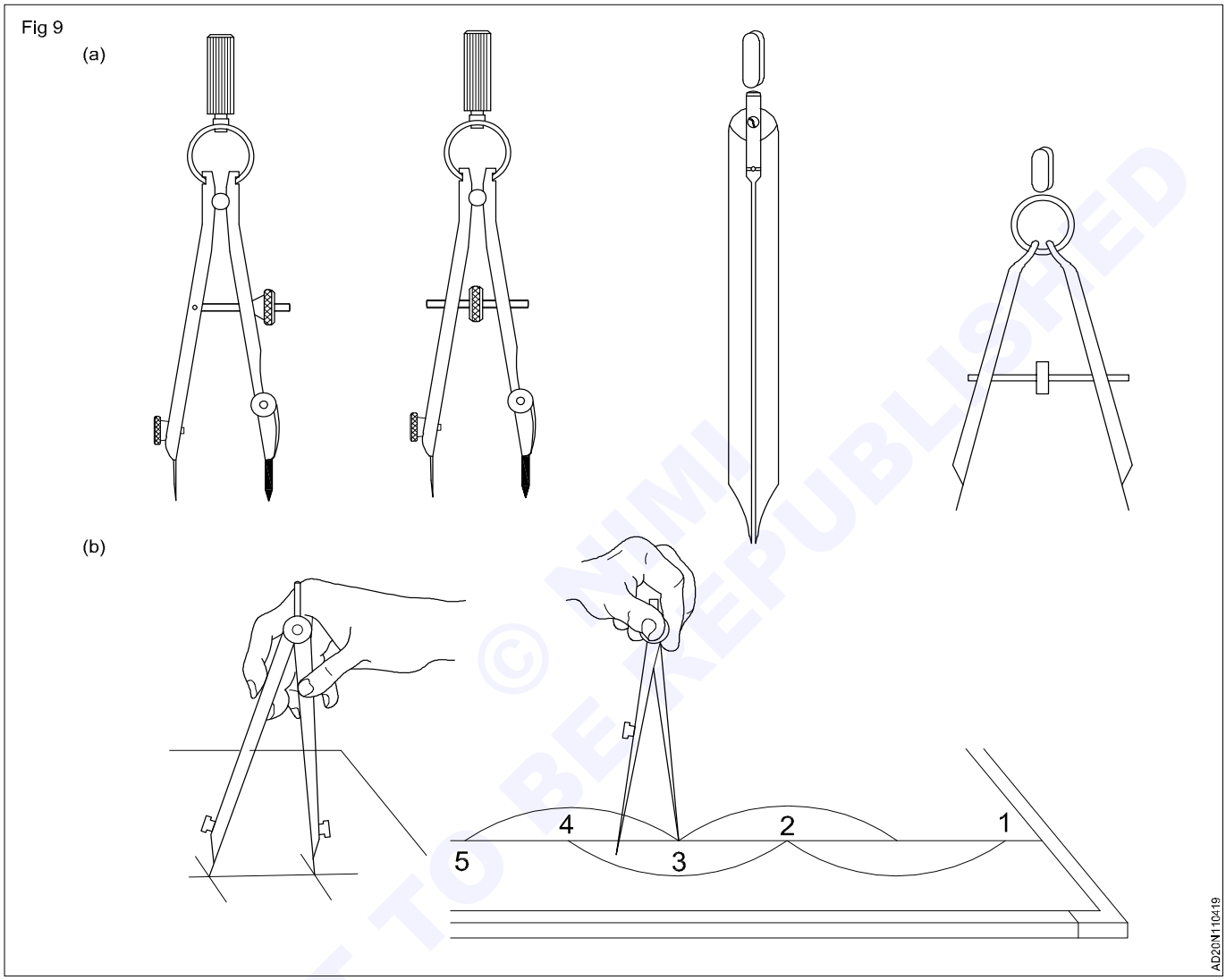
Dividers are similar to the compass and are made in square, flat and round forms. They are used for:

1 Dividing curved or straight lines into any number of equal parts.

2 Transferring dimensions from one part of the drawing to another part.

3 Setting dimensions form the scale to the drawings

Fig 9



Drawing pencils (Fig 11)

These are in many grades. The grade HB denotes medium soft. The grade H denotes the degree of hardness in an increasing order. Similarly, grade B indicates the degree of softness in an increasing order.

The lead of the wood pencil may be sharpened in the following ways

1 Cylindrical

2 Conical

3 Wedge (Chisel edge)

4 Bevel

Mechanical clutch pencil is very common in use. This is very simple, easy to use, requires no sharpening time and even cheaper in long run. Hence, this type of pencil is preferred by professional draughtsman. Students using these types of pencils will save a lot of time.

1 Only a sharp pencil can make quality drawing and hence, sharpen the pencil as and when it is necessary.

2 Sharpen the pencil only where there is no grade mark.

3 In a compass H pencil sharpened to bevel point, having its wedge shaped side slopping outside, is used.

4 As a general guide, use:

Fig 10

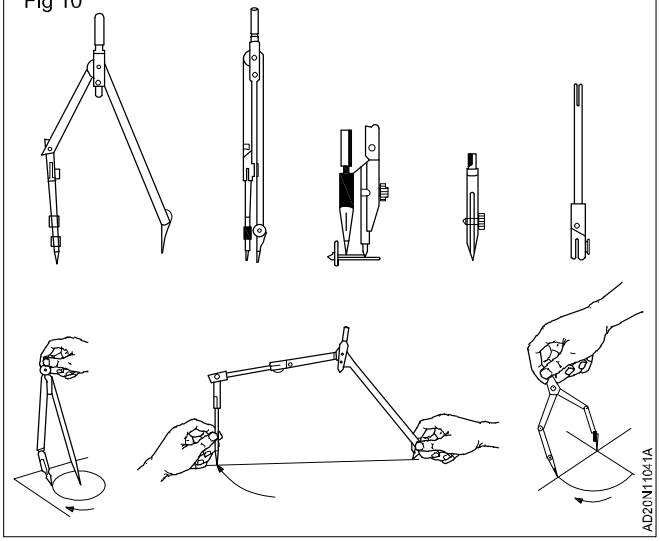
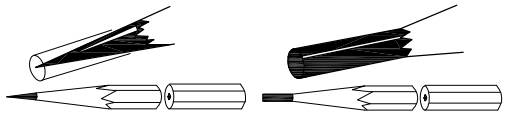


Fig 11



I HB pencil for sketching free hand sketches

II H for outlines, visible lines, finishing, dimensioning, lettering, arrows etc.

III 2H for construction lines, dimension lines, center lines, section lines etc.

IV 3H,4H for drawing minute details

V B for shading.

Eraser

Soft pencil erasers are ideal for erasing pencil marks. This eraser will not destroy the surface of the paper and hence drawing can be re-penciled.

Fastener: (Fig 12)

Following materials are used to fix the drawing sheet on the drawing board.

- Thumb pins
- Cello tapes
- Fold back gap spring clips.

Template: Templates are available for drawing circles, arcs, ellipses, triangles, squares and other polygons. Also, symbols used by various engineering faculties, such as architectural, mechanical, electrical, chemical etc. are now available in the form of templates.

Stencils

Stencil is a thin flat piece of celluloid used to write letters and numerals. This helps the draftsmen to write neatly and uniformly and at a faster rate.

French curves (Fig 13): A French curve is a curved ruler used for drawing irregular curves that are neither circles nor circular arcs. It is made of wood, plastic or transparent celluloid. There are different forms and sizes of French curves.

Fig 12

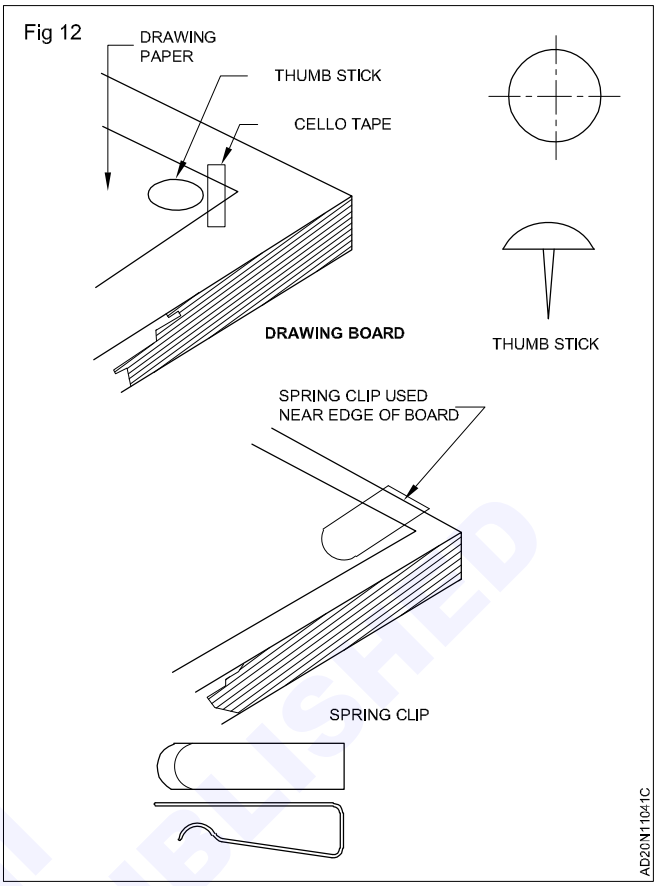
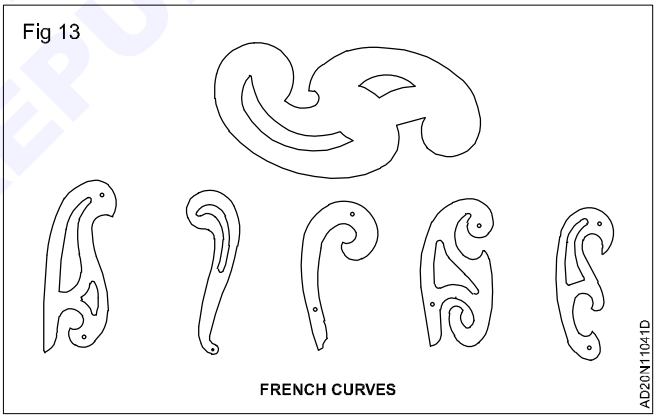


Fig 13



Flexible curve

Flexible curve is made out of materials having flexibility. It is made of lead bar enclosed in rubber and can be bent into any shape to form a curve. It helps to draw smooth curve passing through any given points. Flexible curves of various sizes are now available in the market.

Precautions in the use of instruments:

Following precautions should be taken while doing the drawing works,

1 The lower edge opposite to the working edge of the Tee-Square should not be used for drawing horizontal lines.

2 T- Square should not be used as hammer to drive to drawing board pins.

3 Measuring scales should not be used as hammer to drive to drawing pins.

4 Drawing sheets should never be cut by blade or knife with the T-Square blade as the guide.

5 All the instruments and drawing sheet etc. Should be thoroughly dusted off and cleaned before starting the work.

6 No end of the pencil should be kept in mouth.

7 No oiling should be done to the joints of the instruments; otherwise, oil will give stains or spots on the drawing sheets.

8 Only required instruments should be kept on the drawing board. All extra instruments should be kept away in drawer.

9 Divider should not be used as pincer.

10 Soaking paper should not be used for drying the ink.

11 After completing the work all the instruments should be properly cleaned.

Conclusion

One should practice handling and using drawing instruments before attempting complex drawing problems. Developing correct drawing habits will enable to make continuous improvement in the quality of drawings. Each drawing will offer an opportunity for practice. Later on, good form in the use of instruments will become a natural habit.

Symbols for architectural & building drawings (IS 962 - 1989)

Objectives: At the end of this lesson you shall be able to
- **identify the symbols for building plan- bath, kitchen and symbols of plants, trees & shrubs.**

Architectural signs and symbols and there was in drawings

It has been found desirable to codify the numerous architectural and building drawing office practices followed in the various architectural and civil engineering departments, so that the drawings prepared in any office can be read without fear of misinterpretation.

The purpose of studying signs and symbols is to establish certain conventions, in order to avoid confusion, increase speed and achieve quick identification wherever possible.

IS 962:1989 is the code of practice for Architectural and building drawings. It lays down the recommendations for sizes, layout, reproduction, folding of drawings, scales, projection, line work, lettering and dimensioning, graphical symbols etc.

Symbols are in constant use on small scale drawings and it is considered that time would be saved and confusion avoided if a standard range of symbols is extensively used.

Careful attention shall be given to the size of these symbols, having due regard to the scale of the drawing. some symbols may have to be slightly enlarged for the purpose of clean indication.

How to use appliances symbols for building plan (Figs 1&2)

Home plan - used for kitchen and bathroom design, architectural and construction documents, space plans, remodeling and planning additions.

Floor plan - used for commercial building design, space plans, architectural layout, construction documents, structural diagrams and facility planning.

Fig 1

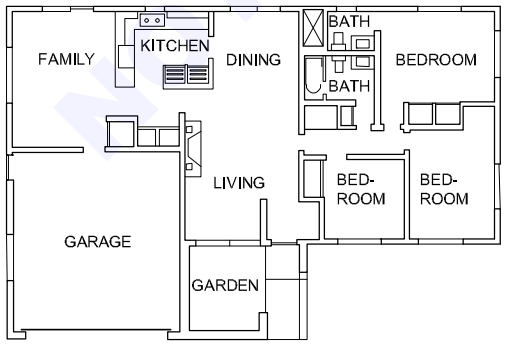
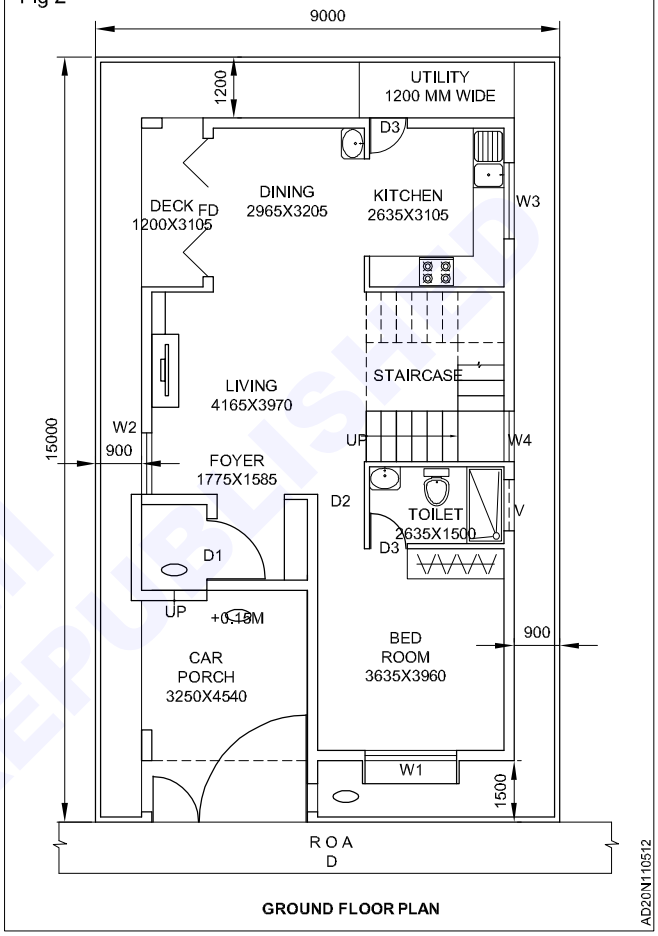


Fig 2



GROUND FLOOR PLAN

Kitchen and bath symbols (Fig 3 to 5)

Fig 3

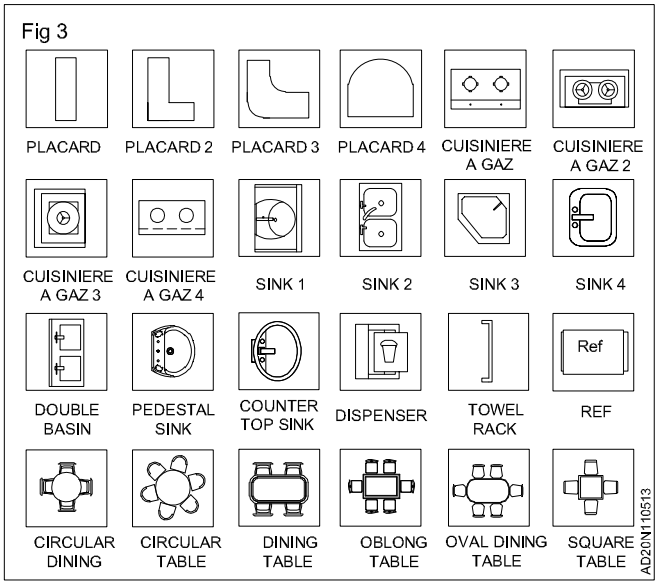


Fig 4

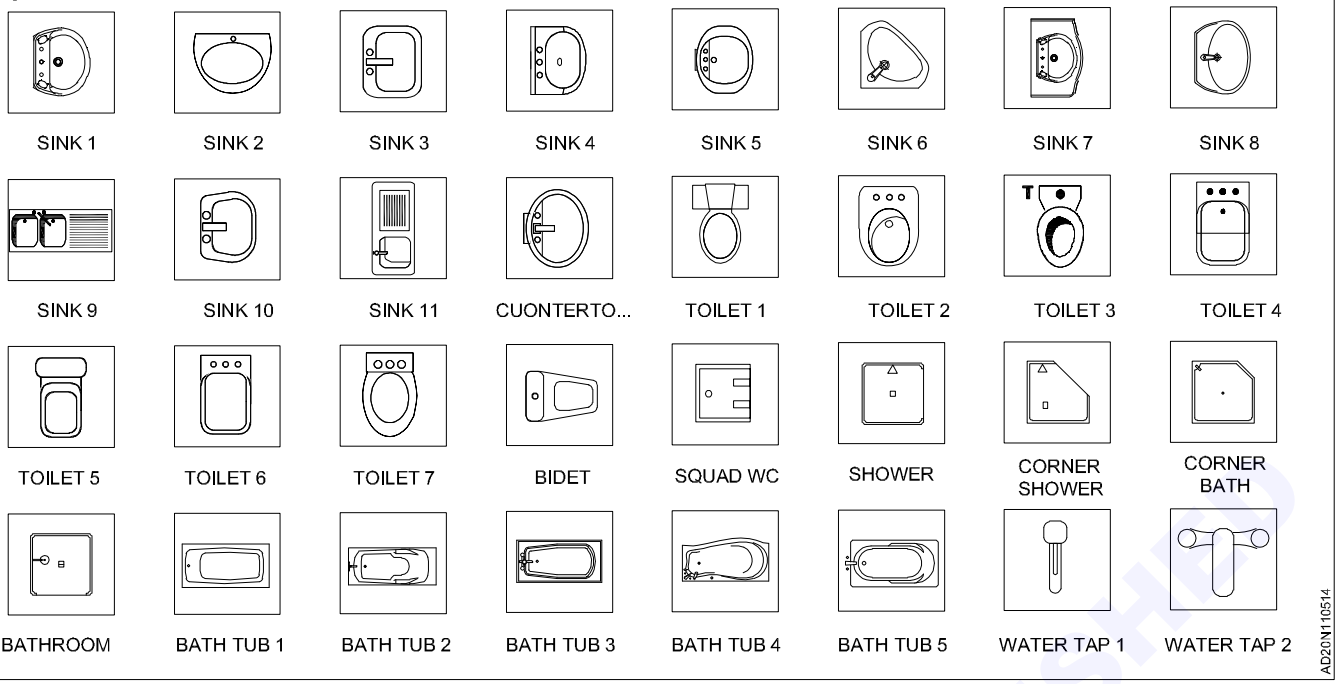
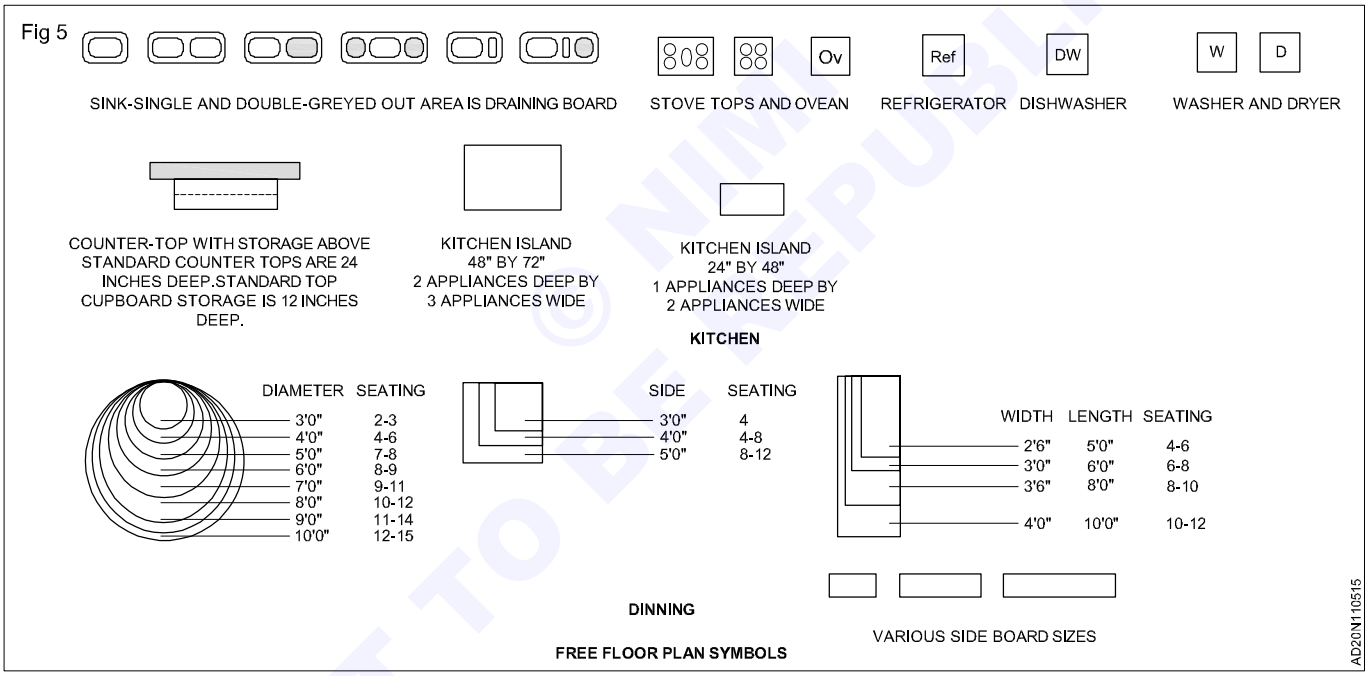


Fig 5



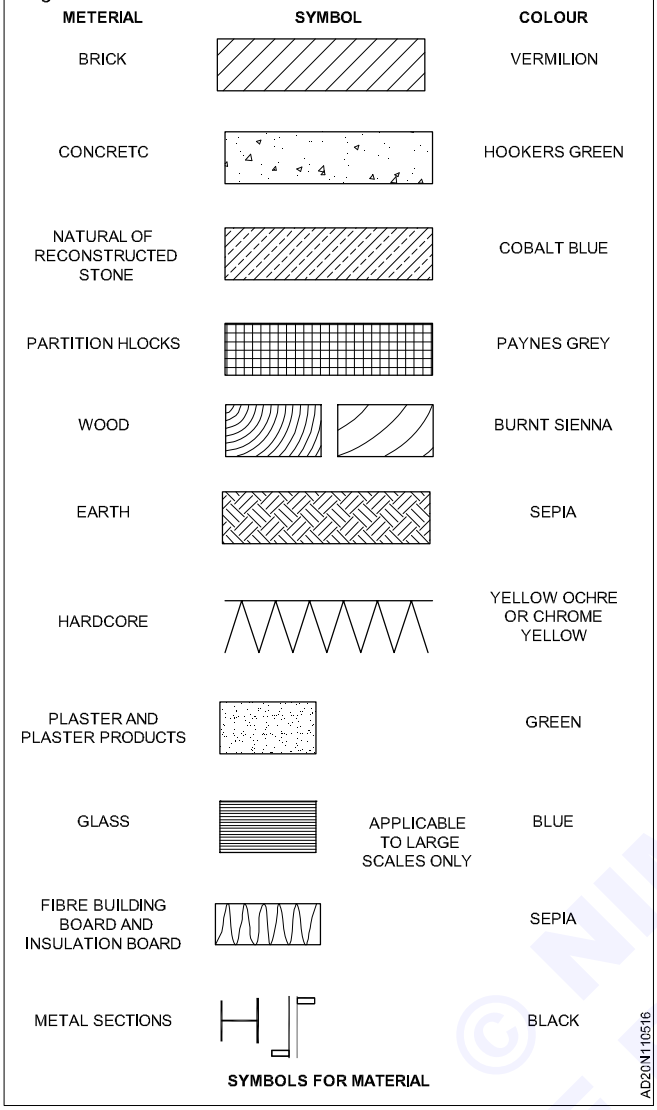
The new version of symbols includes more kitchen and bathroom symbols for drawing floor plans.

One of the obligatory documents that is included to design project of home, apartment, office center, or any other premise is the plan of arrangement of different appliances and home appliances. Creation the plan of such kind lets you to preplan the location of appliances, to make sure in convenience of their location and to envisage all nuances. Well though-out plan helps to avoid mistakes and future reworks, especially in relation to be location of major and large appliances. Ready-made symbols of appliances included to the appliances library are ideal and even indispensible for designing professional building plans and appliance layouts for homes, commercial and office premises.

Symbols for materials (Fig 6)

Hatching pattern can be used as a means to broadly indicate the material of the part /object to differentiate difference material is sectional views BIS laid out standards ((IS 11663-1986) on conventional representations of the materials and the some are given below.

Fig 6



SYMBOLS FOR MATERIAL

Symbols for Doors and windows

Generally, window openings shall be defined in elevation and doors, screens and sliding windows on the plan

symbols for windows shown in Fig 7 the point or apex of two lines crossing the ventilator or casement indicates the hinged side.

These symbols indicate what and where things need to be built and installed. By identifying the shape of a door symbol, we can easily understand its type.

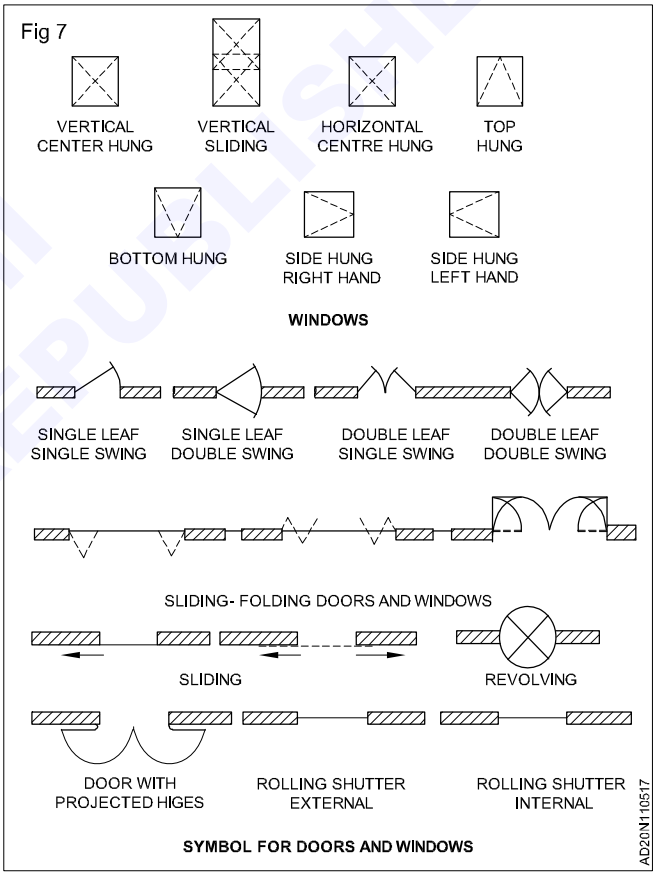
Anyone who needs the drawing can observe signs of sinks stars and tubs that looks like the accurate top view of the actual item. there symbols are like a standardized language that every architects and engineers can understand worldwide.

Symbols convey specific geometry and other details about pieces of equipment's. It's used to limit errors caused by personal interpretation

There Symbols helps to work faster, Symbols are great for creating reusable elements in the drawing Symbols give a lot of information's in a limited space. It explains the type of material by introducing patterns, colours and textures. Symbols drawn in computer aided drafting can be broadly reusable and it saves lot of time.

In hand drawing we can use furniture templates on the proper scale to draw faster.

Fig 7



SYMBOL FOR DOORS AND WINDOWS

Symbols for electrical

NAME	SYMBOL	NAME	SYMBOL
RELAY (AT 'N', INSERT THE NUMBER OF WAYS)		AERIAL	
SYNCHRONOUS CLOCK OUTLET		CEILING FAN	
IMPULSE CLOCK OUTLET		BRACKET FAN	
MASTER CLOCK		EXHAUST FAN	
FIRE ALARM PUSH		FAN REGULATOR	
AUTOMATIC CONTACT		COOKER CONTROL UNIT	
BELL CONNECTED TO FIRE ALARM		EARTH POINT	
FIRE ALARM INDICATOR (AT 'N' INSERT NUMBER OF WAYS)		SURGE DIVERTER	
AMPLIFIER		PILOT OR CORRIDOR LAMP	
CONTROL BOARD		INDICATOR (BUZZER MAY BE ADDED, IF REQUIRED)	N
MICROPHONE OUTLET		RELAY	
LOUDSPEAKER OUTLET		RESET POSITION	
RECEIVER OUTLET		HORN OR HOOTER	
		SIREN	

THIS GENERAL SYMBOL IS APPLICABLE TO ANY SYSTEM BY THE ADDITION OFAN IDENTIFYING SYMBOL (APPROPRIATE TO A PARTICULAR SYSTEM) IN THE UPPER HALF.FOR EXAMPLE,BELL SYSTEM RELAY.

WHERE ITEMS OF OPERATIONS ARE COMBINED, THE SYMBOLS MAY BE COMBINED, FOR EXAMPLE,INDICATOR AND BELL.

AD20N110518

NAME	**SYMBOL**
SELF-CONTAINED ELECTRIC WATER HEATER	
HUMIDISTAT	H
BELL PUSH	
BELL	
BUZZER	
INDICATOR (AT 'N' INSCRT NUMBER OF WAYS)	
TELEPHONE INSTRUMENT POINT PUBLIC SERVICE	
TELEPHONE INSTRUMENT POINT INTERNAL	
TELEPHONE CABLE DISTRIBUTION BOARD PUBLIC SERVICE	
TELEPHONE CABLE DISTRIBUTION BOARD INTERNAL	
TELEPHONE PRIVATE EXCHANGE PUBLIC SERVICE	
TELEPHONE PRIVATE EXCHANGE OR INTERNAL	

AD20N110519

NAME	SYMBOL	NAME	SYMBOL
BATH		SHOWER TRAY	
BIDET		WASH BASIN	

SYMBOLS FOR SANITARY INSTALLATIONS-CONTD

NAME	SYMBOL	NAME	SYMBOL
CORNER LAVATORY BASIN	LB	CLEANER'S SINK	
TROUGH LAVATORY, WALL TYPE	TL	LAUNDRY SINK	
TROUGH LAVATORY, ISLAND TYPE	TL	WC	
CIROULAR WASHING FOUNTAIN		URINAL BOWL	
SINGLE SINK, LEFT HAND DRAINER		URINALSTALLS	
DOUBLE SINK, LEFT HAND DRAINER		INDUSTRIAL WASHING TROUGH	
SINGLE SINK, WITH DOUBLE DRAIN BOARD		PEDESTAL DRINKING FOUNTAIN	DF
DOUBLE SINK, WITH DOUBLE DRAIN BOARD		DRINKING FOUNTAIN, WALL TYPE	DF
		FLOOR TRAP	FT

SYMBOLS FOR SANITARY INSTALLATIONS

AD20N11051A

NAME	SYMBOL	NAME	SYMBOL
MANHOLE OR INSPECTION CHAMBER	MH OR IC	STAIR	UP
COLD WATER CISTERN	C W C	COOKER	C
INTERCEPTING TRAP AND FRESH AIR INLET	MH NO, F A I	REFRIGERATOR	R
VENT INLET		WASH BOILER, 'G'GAS,'B'ELECTRIC	W B C
VENT OUTLET		WASHING MACHINE, WRINGE TYPE	WM
RAIN-WATER OUTLET	R W O	WASHING MACHINE, AUTOMATIC	AW
RADIATOR		CENTRIFUGAL DRYER	D
UNIT HEATER		CABINET DRYER	D
CONVECTOR		RACK DRYER	D
SURFACE PANEL, WALL TYPE		LAUNDRY TRAY, SINGLE	LT
SURFACE PANEL, WALL TYPE		LAUNDRY TRAY, DOUBLE	L T
EMBEDDED PANEL IN CAST-IN CEILING		IRONING MACHINE	I M
EMBEDDED PANEL IN SUSPENDED CEILING		BUILT-IN IRONING BOARD	
EMBEDDED PANEL IN CAST-IN FLOOR		SURFACING IRONING BOARD	
UNIT HEATER		BED	
TOWEL RAIL			

FITMENT SYMBOLS

AD20N11051A

SYMBOLS FOR CIVIL ENGINEERING

SL. NO.	OBJECT	CONVENTIONAL SIGN	COLOUR
1.	CHAIN LINE		CRIMSON LAKE
2.	TRIANGULATION STATION	A	CRIMSON LAKE
3.	TRAVERSE STATION	A	CRIMSON LAKE
4.	BENCH MARK	OR B.M. 10.000	CRIMSON LAKE
5.	BUILDING (PUCCA)		CRIMSON LAKE
6.	BUILDING (KATCHA)		BURNT UMBER
7.	TEMPLE, CHURCH, MOSQUE		CRIMSON LAKE
8.	WALL & GATE		CRIMSON LAKE
9.	BOUNDARY WITH PILLARS		CRIMSON LAKE
10.	DAM		CRIMSON LAKE
11.	CITY OR TOWN		BUILDINGS - CRIMSON LAKE ROADS - BURNT SIENNA
12.	CEMETRY		BLACK
13.	RIVER		PRUSSIAN BLUE
14.	CANAL OR STREAM (PERENNIAL)		PRUSSIAN BLUE
15.	CANAL OR STREAM (NON-PERENNIAL)		EDGES - BLACK
16.	CANAL WITH LOCK		PRUSSIAN BLUE
17.	LAKE OR POND		PRUSSIAN BLUE
18.	WELL		PRUSSIAN BLUE
19.	DRAIN (KATCHA)		PRUSSIAN BLUE
20.	DRAIN (PUCCA)		DRAIN - PRUSSIAN BLUE DIRECTION - CRIMSON LAKE
21.	WIRE FENCING		BLACK
22.	WOOD FENCING		YELLOW
23.	PIPE RAILING		BLACK
24.	BOUNDARIES		BLACK
25.	HEDGE		HEDGE GREEN
26.	TREE	OR	HEDGE GREEN

SL. NO.	OBJECT	CONVENTIONAL SIGN	COLOUR
27.	JUNGLE		HEDGE GREEN
28.	ORCHARD		HEDGE GREEN
29.	CULTIVATED LAND		DRAINS - PRUSSIAN BLUE CULTIVATION - GREEN
30.	BARREN LAND		BLACK
31.	ROUGH PASTURE		BLACK
32.	MARSH OR SWAMP		BLACK
33.	SAND HILL		BLACK
34.	EMBANKMENT		BLACK
35.	CUTTING		BLACK
36.	FOOTH-PATH		BURNT UMBER
37.	VILLAGE CART-TRACK		BURNT UMBER
38.	UNMETALLED ROAD		BURNT SIENNA
39.	METALLED ROAD		BURNT SIENNA
40.	RAILWAY SINGLE LINE	OR	BLACK
41.	RAILWAY DOUBLE LINE		BLACK
42.	ROAD BRIDGE		BURNT SIENNA
43.	RAILWAY BRIDGE		BLACK
44.	ROAD & RAIL LEVEL CROSSING		RAIL - BLACK ROAD - BURNT SIENNA
45.	TELEPHONE OR TELEGRAPH LINE		BLACK
46.	ELECTRIC LINE		BLACK
47.	NORTH DIRECTION	N	BLACK
48.	DEMARCATED PROPERTY BOUNDARY		
49.	UNDEMARCATED PROPERTY BOUNDARY		
50.	CULVERT		
51.	ELECTRIC LINE		

AD20N110511B

Symbols of plants, trees and shrubs

Objectives: At the end of this lesson you shall be able to

- **identify the symbol of different plants, trees and shrubs.**

Design elements - Trees and plants (Fig 1, 2, 3)

The design elements library of trees and plants contains various symbols of trees, hedges, ground covers, greenery and shrubbery: “Landscape design is an independent profession and a design and art tradition, practiced by landscape designers, combining nature and culture. In contemporary practice landscape design bridges between landscape architecture and garden design. Landscape design focuses on both the integrated master landscape planning of a property and the specific garden design of landscape elements and plants within it. Use the vector stencils library trees and plants to draw the plans of landscape architecture, lawns, gardens, yards, parks planning, grounds keeping landscape design and arboretums.

Fig 1

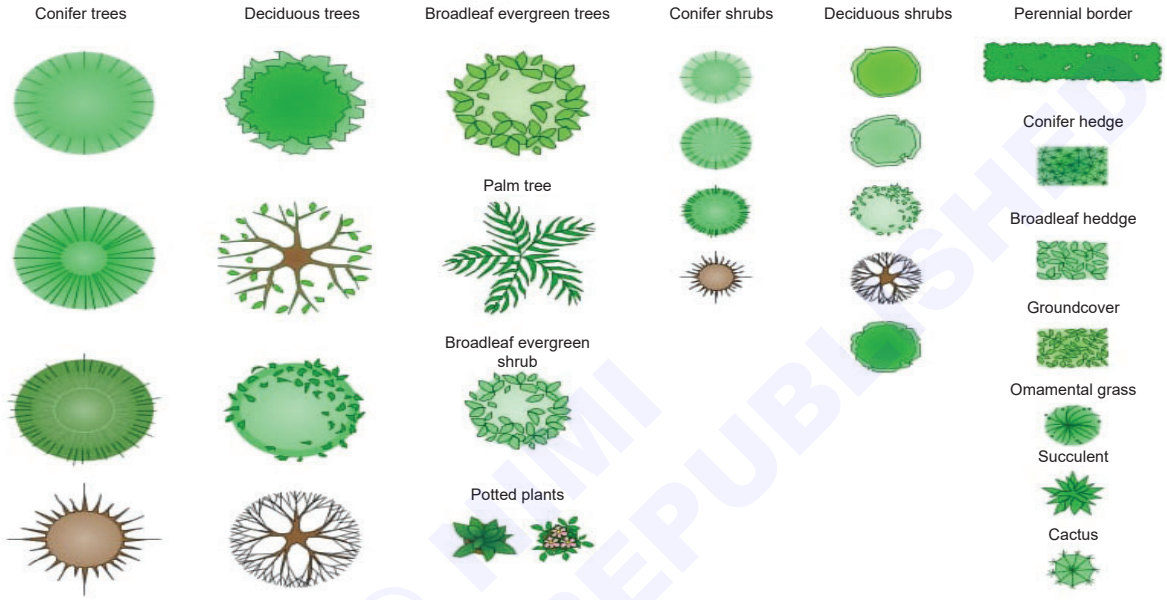


Fig 2

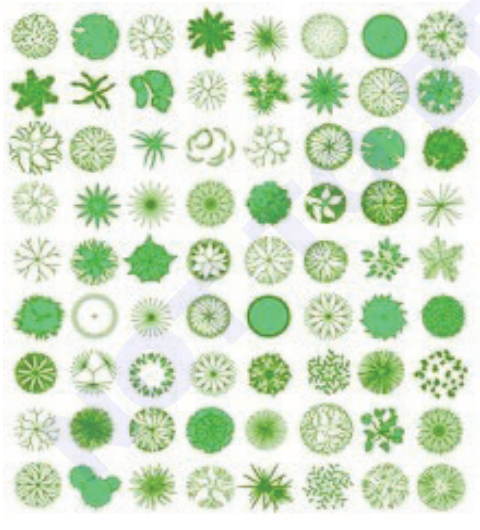
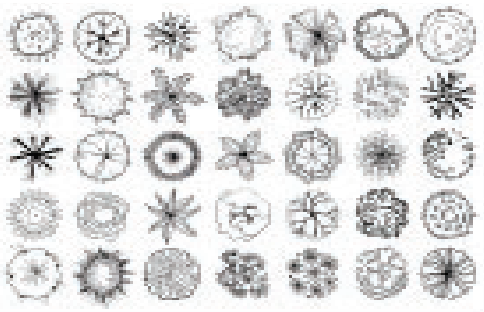


Fig 3



Coniferous trees or plants has small needle line leaves and has conical shapes

Ex: Pine, cedar, evergreen trees etc.

Deciduous trees are broad leave which increase large surface area

Ex: banyan tree, ashoka tree etc.

Free hand sketching

Objectives: At the end of this lesson you shall be able to
- **state the need for free hand sketching**
- **state the method of pencil uses**

Need for free hand sketching

Primary duty of draughtsman is to prepare drawings which are required for various purposes. Although several Instruments/equipment are available at the disposal of the draughtsman to make perfect scaled drawings. Very often he will also be required to make drawing "free hand" using just a pencil and an eraser."

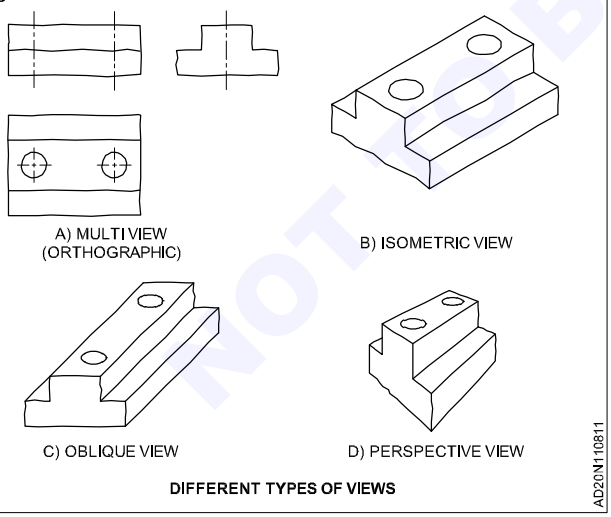
Here are a few examples of situation wherein free hand sketches will have to be necessarily made.

- On the site sketching for production/maintenance.
- Recording of initial idea of a design.
- For quick exchange of ideas among designer, draughtsman.
- Urgency (free hand sketching takes less time)

To make free hand drawings/sketches for the draughtsman has to acquire new skills and one has to have considerable practice to be able to make good free hand sketches. Ability to make good free hand sketches is an asset to any draughtsman.

Free hand sketches are not usually made to scale. However, they should be as nearly to the proportions as possible. (See Fig 1 for example of free hand sketching)

Fig 1



DIFFERENT TYPES OF VIEWS

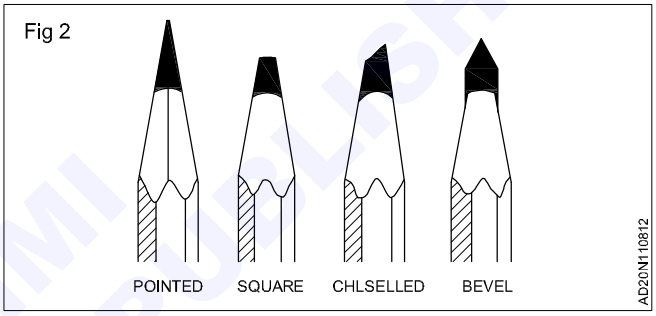
Materials for free hand stitching: A4 size sheet preferably a pad instead of loose papers) pencils of soft grade. Example H, HB, F and a good quality eraser are the only materials required. For drawing different darkness, the pencil points should be sharpened to conical shape.

Methods of pencil use

Remember these points regarding the use of pencils

1 The point of a pencil can be sharpened in different shapes. For general purposes drawing, the point should be long and round. Square points are better for drawing thick lines and lettering or filling masses. Chiselled points are required for shading. Bevelled point is suitable for drawing strips and lettering (Fig 2).

Fig 2



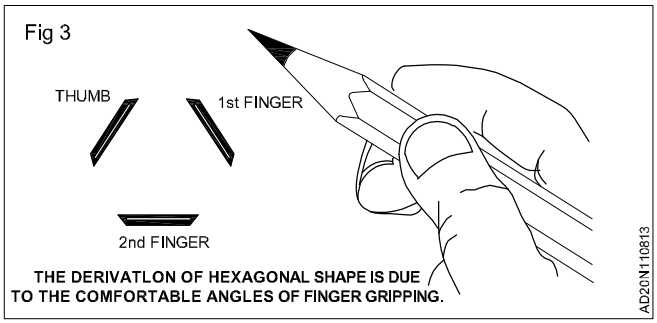
2 Pencil should be held between thumb and first two fingers. The thumb and index finger grip while the middle finger supports it. It should be held a bit above from where it gets tapering. If it is held too close, the hand movement will not be free and in large sweep.

3 The angle of pencil to the drawing surface should be between 30 and 45. This is to ensure easy and convenient movement of pencil.

4 The pressure exerted on pencil should be slight and even.

5 The pencil should be rotated slowly while drawing to keep the point round longer and to delineate a line of even thickness (Fig 3).

Fig 3



THE DERIVATLON OF HEXAGONAL SHAPE IS DUE TO THE COMFORTABLE ANGLES OF FINGER GRIPPING.

Pencil techniques

Horizontal lines, for instance, are drawn from left to right Horizontal lines are lines parallel to the lower edge of the drawing paper Vertical lines are sketched from the top downward, and inclined lines are also generally sketched from left to right. Short lines are drawn with finger movement while long lines are made arm movement. Parallel lines are lines which never meet even if they are prolonged or extended to any desired length. Parallel lines may be vertical, horizontal or inclined.

Lines may be drawn in various thicknesses or weights with a soft pencil. This is done by varying the pressure of the pencil against the drawing paper. It is this feeling of pressure exerted by the fingers on the pencil that must be developed in order to acquire the "feel" of the pencil. These varying kinds of line can also be drawn by using different grades of drawing pencil. "Curved lines, or curves, are regular or irregular. A regular curve is either a circle, an arc (part of the circumference of a circle), or an ellipse. Irregular curves are those which have no definite direction." In sketching circles, the radii and the two-stroke method are often used. For an ellipse, the beginners should use the parallelogram method. The other two methods of sketching an ellipse should be attempted only after one has acquired the "feel" of the drawing pencil.

Pencil grades

Pencil lead is made of graphite and clay. The graphite is the part that makes the dark mark on the paper. The clay is there because graphite is far too soft and crumbly to write or draw. The grade of a pencil depends on proportions of graphite and clay (or polymer/resin) More graphite makes for a softer lead, and more clay makes for hander lead.

Architects and drafters often use a range of different pencils for a single drawing switching to harden lead when they want light/sharp lines and a softer lead for darker shades.

Handen leads has H rating (H, 2H, 4H etc.) and softer leads gets B ratings (B, 2B, 4B etc.) while HB pencil lead is in the middle ground for general purposes.

There is an extra grade between HB and H – an F grade means F for fine / firm line.

Sketching Techniques

Objectives: At the end of this lesson you shall be able to
- **explain the various types of lines used for sketching**
- **explain the different shading techniques**
- **explain the various types of colouring media.**

Various types of lines used for sketching

1 Flat lines (Fig 1 & 2)

Fig 1

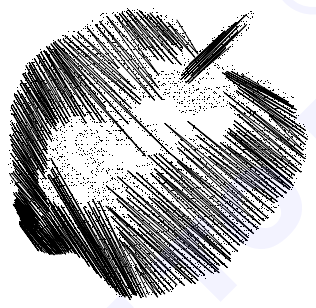
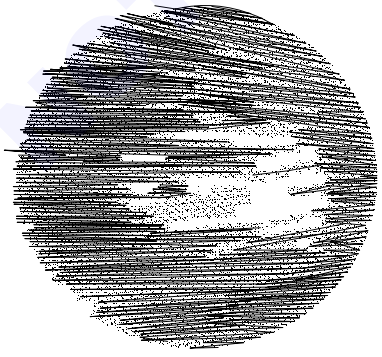


Fig 2



Flat lines also known as the straight lines, are helpful in expressing emotional and evoking emotional responses and providing illusion on the viewer's eyes.

You can start on a horizontal direction, a vertical direction or a diagonal direction depending on how you want your image to look like.

2 Contour lines (Fig 3)

One of the striking characteristics of contour lines is the purity of the line, which even without the use of colour, distinctively display shape and beauty of the image. In outlining and in sketching, what you follow is only the important edges, outlines and contours of the object you want to draw.

3 Scumble/ Scribbling (Fig 4)

Scribbling or scumble drawing is a drawing merely composed of abstract and random lines.

4 Cross hatch line (Fig 5 & 6)

Without cross hatching, interlacing or interweaving parallel lines often in different densities is able to create the effects of light and shadows in their drawings thereby creating shading on the images.

5 Pointillism (Fig 7 & 8)

Pointillism is a technique of grouping together dots to create an image or filling an image using dots. Pointillism is a very slow form of art because technically speaking, filling an image with the use of dots is a very monotonous process.

Fig 3

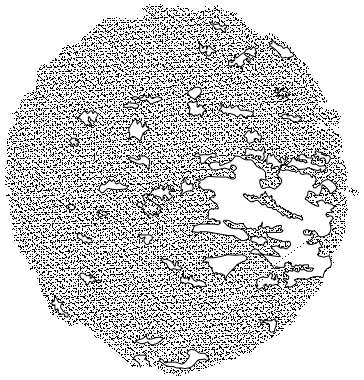


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Fig 4

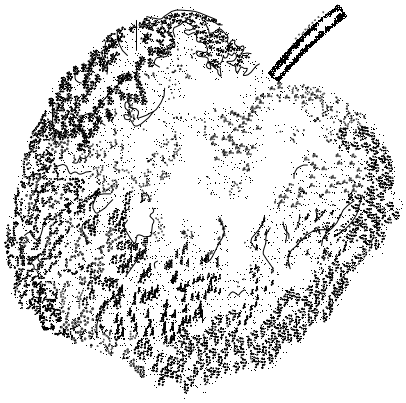

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Fig 5

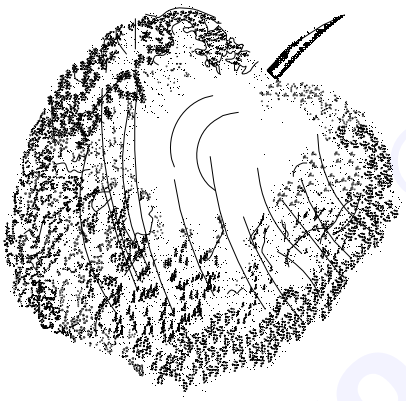

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Fig 6

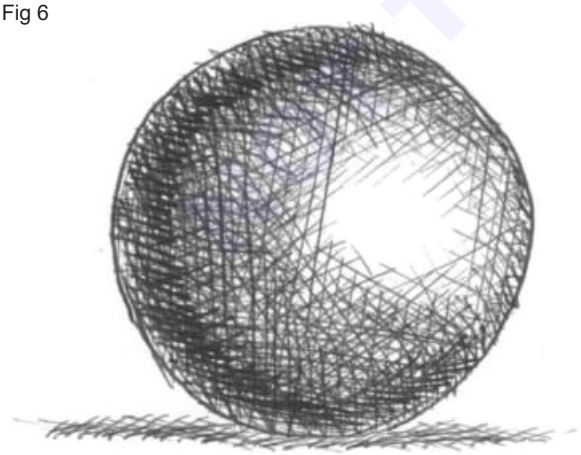

Fig 7

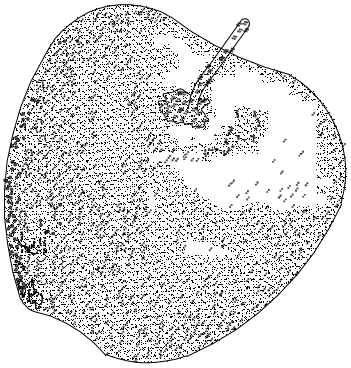

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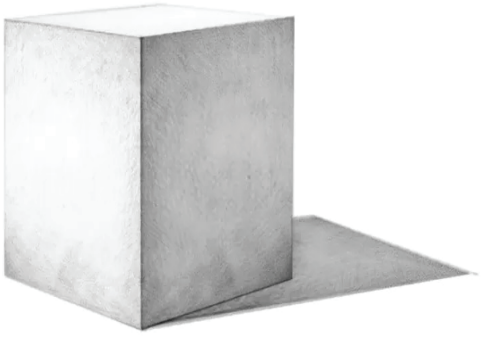
Fig 8

Different shading techniques

1 Regular shading (Fig 9)

Moving the pencil from left to right or top to bottom produces this shading technique.

Fig 9



2 Irregular shading (Fig 10)

As opposed to the regular shading, the pencil's direction in irregular shading changes at intervals.

3 Circular shading (Fig 11)

Instead of making straight lines or making irregular strokes, a circular motion is used.

4 Directional shading (Fig 12)

Two directions are used in shading, although, they should not overlap each other.

Fig 10

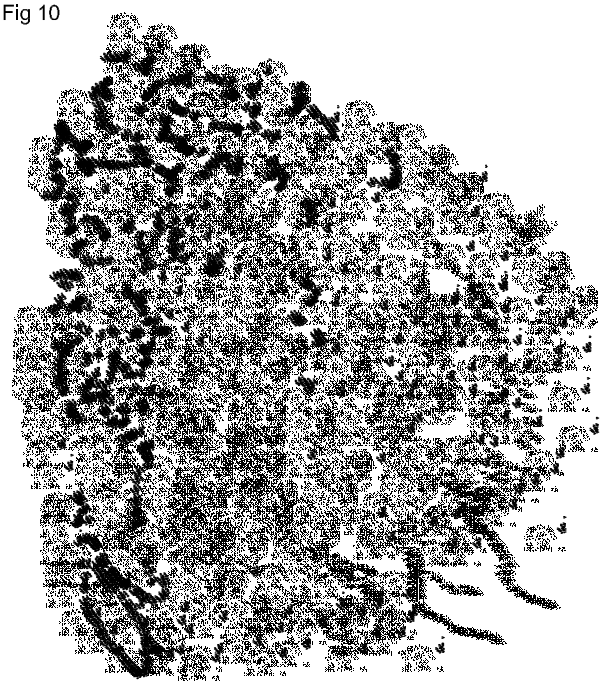


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Fig 11

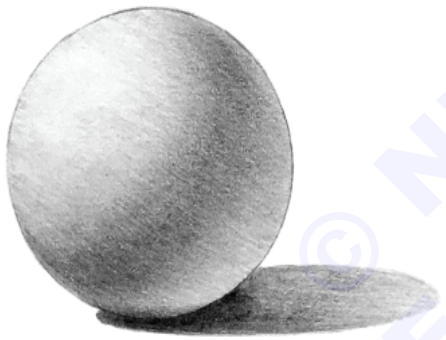
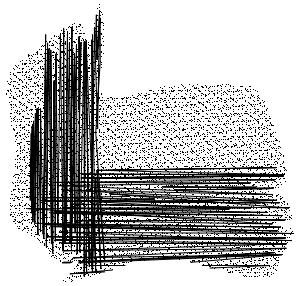


Fig 12



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Types of colouring media

These are different methods of colouring

1 Colour pencils

Effective on textured drawing paper.

2 Felt pens

Effective on cartridge and tracing paper

3 Crayons

Very effective on rendered perspective made on tracing paper but should be used from rear side with drawing paper backing.

4 Water colour

Can be used on cartridge or handmade paper and is more effective on textured cartridge paper.

5 Poster colour

Perspective made in pencil, on textured or cartridges paper and coloured by poster colour is not very effective as the variation in shades is difficult to achieve.

6 Photo colour

Photo colour is available in paper and liquid forms. This is the best medium of colouring on drawing paper. You can prepare your special shades by mixing these colours and keeping in bottles permanently so as to save time in mixing the colours.

Use different brush strokes

Objectives: At the end of this lesson you shall be able to

- **state brief description of type of brush strokes**
- **state dry brush technique**
- **double and triple load techniques**
- **cross hatching**
- **paint splatter**
- **strokes with a fan brush.**

Different brush strokes

Mastering basic brush strokes and painting techniques are a pre-requisite before you embark on an artistic journey to the colourful world of paints. Brushes are tools that let you shape your imagination.

You must be familiar with all the painting techniques that let you actually transfer your imagination to the spans of your canvas.

If you are a beginner and are just getting started with the fine art of painting, you must first know how to use a water brush and handle any given paintbrush. Meanwhile, you can also take a look at some paintings at any online painting gallery to get some inspiration.

There are basically five kinds of basic brush strokes. Using one or any combination of these primary strokes, you can draw any shape, form, and composition.

The five strokes- Gradient Blending, Wet into Wet, Optical Mixing, Stumbling, and Smudging,

The first thing you need to learn is how to give a proper basecoat or wash. Separate basecoat brushes are available in the market and can be used for painting the entire canvas with gesso or varnish, or a very faint neutral colour, depending on your medium.

Artists brushes are usually given numbered sizes. The number on the side of the brush refers to the thickness, length or width of the brush hair. This number system vary between different manufactures for different brush types (Fig 1)

Fig 1

1 Dry Brush Technique

This is a technique used by artists to make the paint have a specific texture and to make the stroke appear "feathery". Any brush can be used for this technique depending on your subject. (Fig 2)

Fig 2

You can use acrylic colours for this technique because the colours may appear bold and thick.

Remember to use a clean (and dry!) brush for this technique. Dry it with a paper towel if necessary.

Cover only the tip with very little paint. If you load it too much then it defeats the purpose.

After that lightly apply the colour on the canvas. Keep the strokes brisk but firm. The strokes have a translucent quality and you can notice the texture of the canvas underneath.

A few examples of where the dry brush technique can be used are grass, wood, bushes, or clouds.

2 Double load and triple load techniques

You can double load a brush, by adding two different colours, on the brush, without them mixing together.

You need a flat brush for this technique. First, cover a corner of the brush with one colour. Then cover the other side in a different colour.

When you apply your stroke, the two colours will blend together without completely mixing.

Similarly, for a triple load dip the whole brush in one colour and then follow the double load technique.

Use these techniques to paint sunsets, dark skies, and oceans. use flat brush for better easy strokes

3 Cross-Hatching

When Cross-hatching, simply apply strokes in an overlapping fashion from different directions.

Vertical and horizontal cross-hatching is a style you could utilize to add texture to your strokes.

And for X Cross-hatching, apply the paint in "X" strokes that overlap each other depending on the texture you would like.

You can use a single colour or multiple colours for cross-hatching. In walls or dry surface this technique helps to avoid multiple coating. In angle strokes of coating the colour may look very dull after drying. Adopting cross hatching stroke helps to maintain the colour intensity even after drying. (Fig 2)

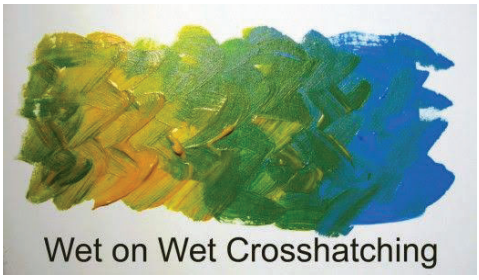
You can also utilize wet on wet, wet on dry techniques for different effects.

4 Paint Splatter

This is a technique everyone loves! Sure things can get messy but it is also a lot of fun! You can use any thick brush you like for this method, but the best option is probably a toothbrush.

Slightly wet the brush before you apply the paint so that the splatter looks effortless. Depending on the brush you use the range of the splatter will vary.(Fig 3)

Fig 3



5 Strokes with a Fan Brush

A fan brush can be utilized to generate a lot of different patterns. You can create coniferous trees and bushes or even patches of grass! Using a dry brush technique for this you can create a patchy effect and give a rugged look like sand or mountains.

These were preferred brush strokes but you can also utilize these basic brush strokes along with these brushing techinques. Mastering these techniques will take time and then you can figure out what different combinations to use accordingly. (Fig 4)

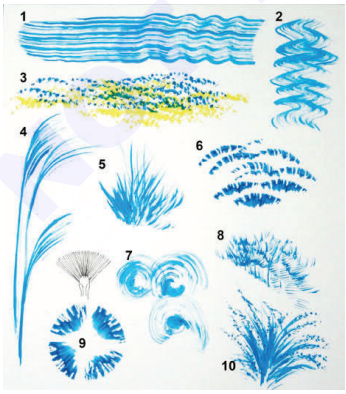
Fig 4

Gradient Blending

Gradient blending is a blending two or more colours to get a gradient, bent outwards or inwards effect in your artwork. The gradient helps your artwork acquire a real, three-dimensional look. The transition from one colour to the next is always smooth and the colour tones must undergo a subtle change in every stroke to gradually produce an overall change of colour.

Almost any brush can be used to practice this stroke, but since this stroke mostly finds its use in painting large patches like skies and greens, a flat, fan bristle brush would be a suitable option. (Fig 5)

Fig 5



Wet into Wet

This brush stroke acquires its name from its implementation. The base colour is painted on a sheet of paper and while the paint is still wet, another coloured paint can be used to draw uniform patters on it. The two colours merge at the boundary where the two colours meet. You can also create a gradient with the second colour, varying the tone and intensity of the colour across the span of a stroke.

The colour tone can be deeper at the top while gradually fading to let the base colour dominate towards the end of the stroke. Random but similar patterns can be painted throughout the base using this technique to create an effect.

Scumbling

This technique is the most simple of all. And all you need to do is dip your brush in the paint bottle, strain it on your canvas so that the bristles begin to splay and then rotate the brush slightly to create a mottled or blotched effect. You can use more than one colour to create more interesting patterns. While using different colours you should let the colours shift tone gradually, making the transition from one colour to another smooth.

Suppose you use red and yellow, so keep a deep shade of red at the top while scumbling and then use a shade of yellow halfway down red so the pattern is orange in between while changing to yellow at the bottom. You could use a flat or round bristle for these kinds of strokes.

Optical Colour Mixing

In this technique, artists opt for a combination of two or more contrasting colours to draw similar patterns on canvas. All the patterns must be the same just different in colours. These similar shaped but differently coloured patterns create a very effective visual effect in a painting.

Moreover, you need round bristled brush for optical colour mixing technique.

Smudging

This type of brush stroke involves blotting a piece of paper with some colour and then smudging it with a round brush. This process of smudging creates a clouded effect in the painting. In this technique, users blend more than two colours to produce a more appealing effect. The two colours must not be contrasting however and must blend properly to give a neat-smudge.

Use a Waterbrush

A water brush is not like other brushes. Apart from the similar factor of bristles, there is nothing common in either their look or methods.

Instead of dipping the brush in water, water is filled inside a small container in the back of the brush itself. This means that the bristles always remain moist; you can control the amount of water by pressing on the container. The more you press. The more water will come out.

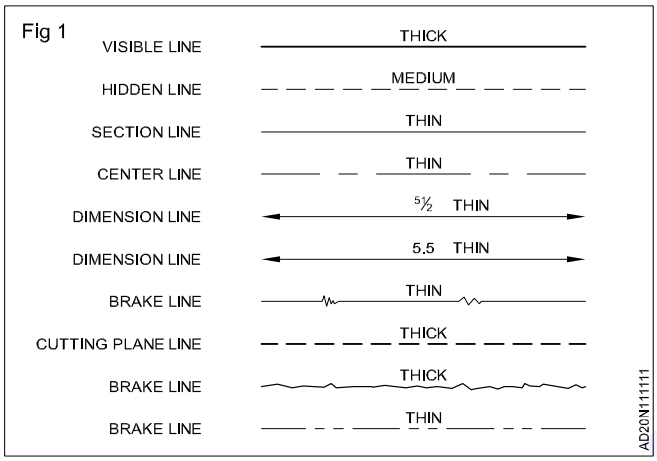
You can not only use the brush with watercolours, but you can use it to blend soft pastels and colour pencils too!

Lines and lettering

Objectives: At the end of this lesson you shall be able to
- **state the uses of types of lines**
- **state the different types of lettering.**

Lines (Fig 1): Architectural drawing is a systematic combination of different types of lines. Each type serves a specific function. Whatever may be the type of line, its thickness should be uniform throughout. The thickness of the line varies depending upon the type of line. The brief description of each type of line is given below.

Fig 1



1 **Outlines:** These lines are drawn to represent visible edges and surface boundaries of the objects. They represent the final shape of the objects, on the drawing. They are also known as principal lines or object lines. They are continuous thick lines.

2 **Dimension lines:** They are thin continuous lines. They terminate in 'arrow head' where they touch outlines, extension lines, or center lines.

3 **Extension lines:** These are continuous lines used in dimensioning an object. A gap of about 2mm should be left between these lines and the outlines of an object and should extend about 3mm beyond the dimension lines.

4 **Dashed lines:** They are also known as dotted lines. They are represented by short dashes of equal lengths of about 2mm spaced at equal distances of about 1mm. They are used to show the invisible or hidden parts of drawings. The dashes are of medium thickness.

5 **Centre lines:** These lines are drawn to indicate the axis of cylinder, cone etc. They are represented by long and short dashes in a proportion ranging from 6:1 to 4:1. They should be closely and evenly spaced in any one drawing. The following should be taken care of while drawing center lines.

   a The center lines cross, the short dashes should intersect symmetrically.

   b The center lines should extend about 3mm to 10mm beyond the outline of the object.

   c When a center line coincides with either a visible or a hidden line, it should not be continued into such lines.

   d The center lines should not be used as extension lines or as dimension lines as far as possible.

   e In case of very small circles, the breaks can be omitted while drawing center lines.

6 **Construction lines:** These are thin continuous lines, used for construction drawings.

7 **Projection lines:** These are also thin continuous lines, used for drawing the projectors.

8 **Section or hatching lines:** They are continuous thin line generally inclined at 45 to the horizontal. They are uniformly spaced about 1mm to 1.5mm apart. These lines are used for sectioning an object.

9 **Pointer or leader lines:** These lines are continuous thin lines and used to connect a note with the feature to which it applies.

Lettering: The writing of alphabets and numerals on the drawing paper is known as lettering. It is an important part of a drawing. Lettering is used to write titles, dimensions, and to impart all other necessary information required for completely describing any object on the drawing. It explains that part of the drawing which cannot be shown by lines. The title tells the name of the object shown on the drawing, the dimensions give the size, and notes explain how the object is made. However accurate and neat a drawing may be, it does not look good if lettering is poor. The lettering should be plain, simple, legible and uniform so that it could be executed with ease and rapidly by free hand. The efficiency in lettering can be achieved by continuous careful practice.

Lettering is a form of free hand drawing and its attractiveness enhances the entire graphic presentation on the drawing sheet.

Proportion of letters : It means the relationship between height and width of each letter. Although there is no fixed standard for the proportion of each letter, yet all letters in a given type of alphabets have a general relationship to each other whose allows only small variation.

The letters whose which width is about 2/3 of the height are known as normal letters. The letters narrower than the normal letters but having same height are known as compressed or condensed letters. The letter wider than the normal letters but having same heights are known as extended letters.

The general proportions of letters may be 5:4, 6:5, and 7:4, 6:5 proportions being the most prevalent. The size of any capital letter is reflected by its height.

Uniformity of letters : The uniformity of lettering means keeping the height, slope, spacing, size and strength of the lines of all the letters same. Uniformity in height can be obtained by drawing guide lines. Slope of letters is maintained by drawing slope lines. Strength of the line can be achieved by proper pressure on the pencil point. Spacing is maintained by providing equal area between consecutive letters. Guidelines should be drawn so lightly that they do not require erasing. The reasonable ratio of 1:4 of the spacing been letters is generally provided in double stroke or block printing. The ration 1:4 means that 1 unit is to be left after covering 4 units' space by letter.

Type of Lettering (Fig 2) : The three basic styles of lettering are gothic, roman and text. Gothic letters may be either single stroke gothic or commercial gothic. Roman letters may be either single stroke gothic or commerical gothic. Roman letters are not used in architectural drawing. They are mostly adopted by artists. The lettering style in which all the alphabets are made of uniform thickness is known as gothic lettering style. Gothic lettering is in single stroke and commercial letterings is thicker variety of letters, otherwise both types are same.

Fig 2

Following are the types of gothic lettering

1 Vertical gothic lettering

2 Inclined, sloped or italic gothic lettering

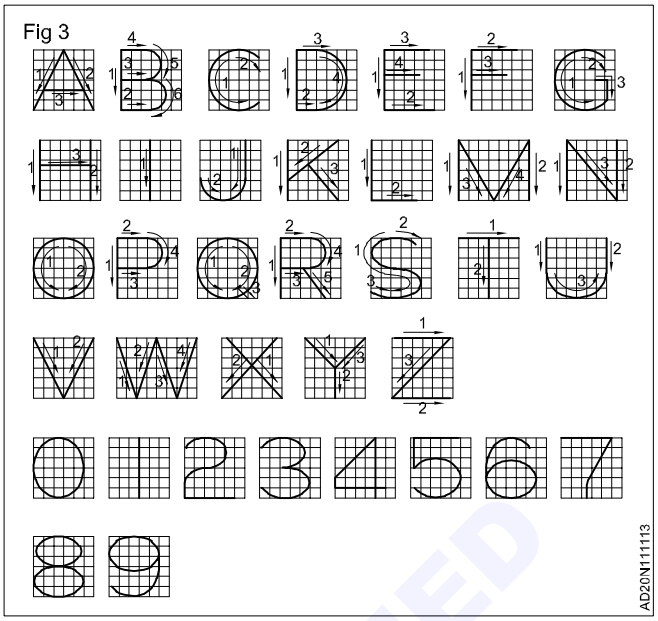
Each type may further be sub divided into three categories, namely single stroke lettering, double stroke lettering, or instrumental block lettering and lower case lettering.

Single stroke lettering (Fig 3) : Single stroke lettering means that the thickness of straight or curved lines of alphabets is same throughtout and is equal to a single stroke of pen or pencil. When single stroke letters are written at a slope varying from 65 to 75 leaning towards right, they are known as slant or sloped or italic single stroke letters. Size of letters is represented by its height. The usual ratio of height to width of letters is 6:5.

Double stroke lettering (Fig 4)

In this case thickness of straight and curved parts of letters is increased to 1/5 height or width. They area just like single stroke lettering except that thickness is more in this case. They can also be vertical as well as italic.

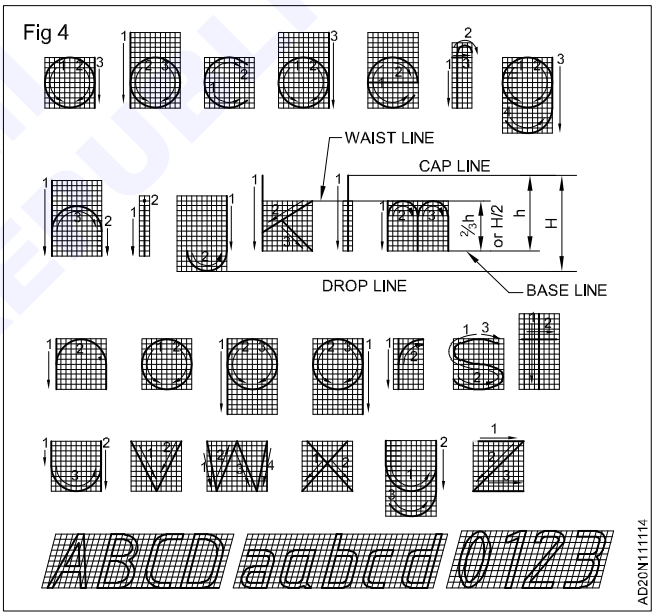
Fig 3



Lower case lettering (Fig 4)

This type lettering is used in maps or architectural drawings.

Fig 4



ISI size lettering

The standard sizes of the alphabets as recommended by the Indian Standards Institution are as follows.

S.No.	Description	size of alphabets
1	main title and drawing	6,8,10,12mm
2	Sub titles and helping	3,4,5 and 6mm
3	Notes such as legends schedules materials & dimensions	2,3,4,5mm

Architectural lettering : The Practice of creating visually appealing and precise letterforms for architectural drawings, design and presentations. It serves both functional and aesthetic purposes, enhancing the clarity and visual appeal of the design documentation.

Plane geometry

Objectives: At the end of this lesson you shall be able to
- **define various geometrical solids**
- **define solids of revolutions**
- **state the method of drawing the three views of solids in different position**
- **auxiliary view**
- **sectional views.**

Solids: Solids are the objects which have definite shape, size and occupies certain space. They have three dimensions viz., length, breadth or width and height. According to their shapes. They are classified into two groups.

– Polyhedra

– Solid of revolution

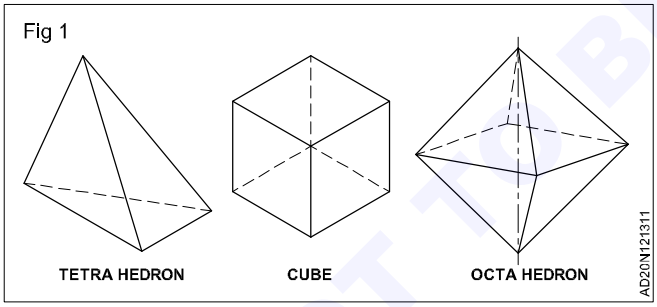
Polyhedra: Polyhedra are solids having (poly-many) more than the flat surfaces called faces. The ends of surfaces meeting with each other are called edges. When the faces are identical to each other, they are called `Regular Polyhedra'. Depending on the number and shape of faces regular polyhedrons are named. Of the many regular polyhedrons three are defined below:

Tetrahedron: A solid having four equilateral triangular faces solid having least number of flat surfaces.

Cube or Hexahedron: A solid having six regular square faces.

Octahedron: A solid having eight equilateral triangular faces. (see Fig 1)

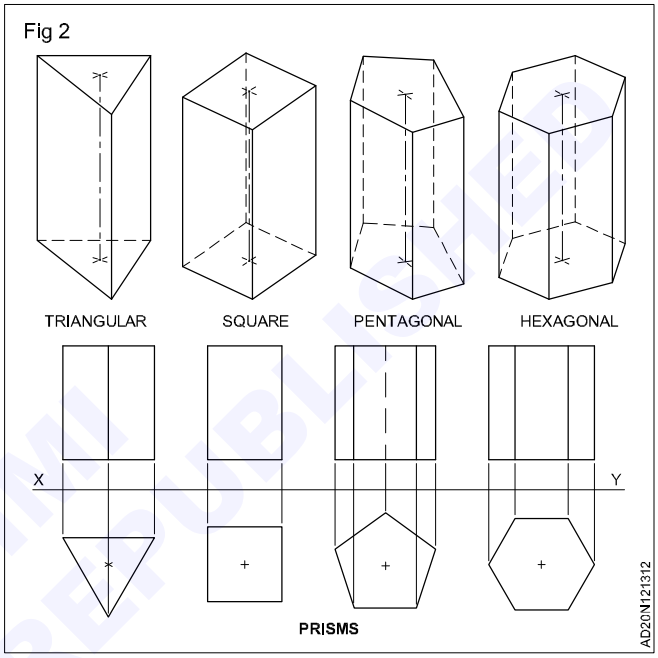
Fig 1



When solids are not composed of identical surfaces, such polyhedrons are either Prisms or Pyramids.

Prism: Prism is `Polyhedron' having two identical end faces. The top and bottom base surfaces are joined by parallelograms or rectangular surfaces. Imaginary line joining the center of the end faces is called the axis. The axis is right angles to the end faces. Prisms are in general designated according to the shape of the end faces. Eg. Square, rectangular, triangular, hexagonal, pentagonal, octoganal (Prisms) etc. Prisms are right or oblique, the axis of regular prisms is at right angles to the face. Whereas in oblique prisms the axis is inclined to the end face. (Fig 2)

Fig 2



Pyramids: Pyramids are polyhedra solids having a base surface whose shape may be triangular, square or polygon and as many slant triangular faces as there are sides in the base. All the slant triangular faces join at a common point called APEX.

Similar to prisms, pyramids also are known by the shape of their base viz triangular, square, rectangular, pentagonal, hexagonal etc. The imaginary line joining the center of the base to the apex is called the AXIS.

Fig 3 shows some pyramids and their views.

Solids of revolution: When a plane figure revolves about an axis a solid is generated.

Example

The solid shown in the Fig 4 is formed by the revolution is formed by the revolution of the plane (Fig 4A) ABC about the axis AB.

Geometrical solids like cylinder, cone and sphere are solids of revolutions.

Cylinder: When a rectangle rotates about one of its sides a cylinder is generated.

Cylinder has two flat circular faces and a curved surface. (Fig 4B)

Cone: When a right angled triangle revolves about one of its side forming the right angle, a cone is generated. Cone forming has a circular face and a slant curve surface. (Fig 4C)

Sphere: When a semi-circle revolves about its diameter a sphere is generated. A sphere has no flat surface. (Fig 4D)

Fig 3

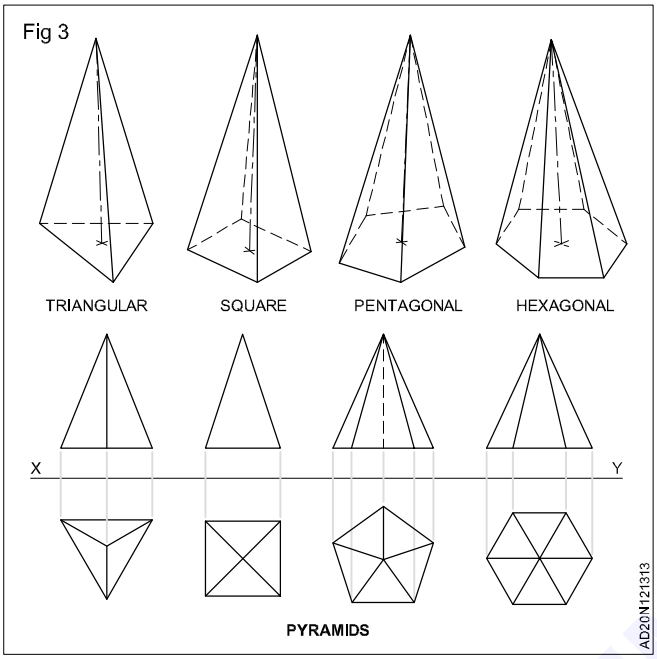
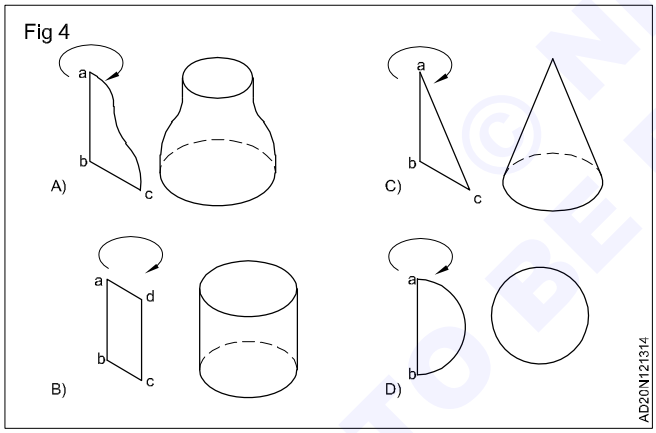


Fig 4



The term solids of revolution are a mathematical concept and a physical requirement in geometry.

Frustums: When the pyramids or cone are cut parallel to the base and top of remaining the pyramid or cone is removed; the parts are called frustums.

If the cutting plane is at an angle to the axis/base, of the pyramids or cone they are called "Truncated pyramids or cones".

Fig 5 shows frustums and truncated pyramids.

All items we use are solids. Their shapes may confirm to individual geometrical solids like prisms, cones or other combination.

Figure 6 shows some such items.

Fig 5

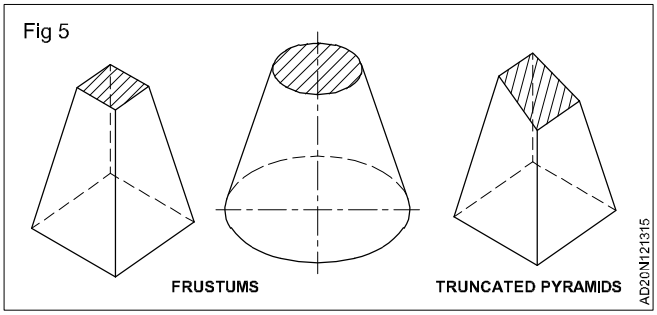
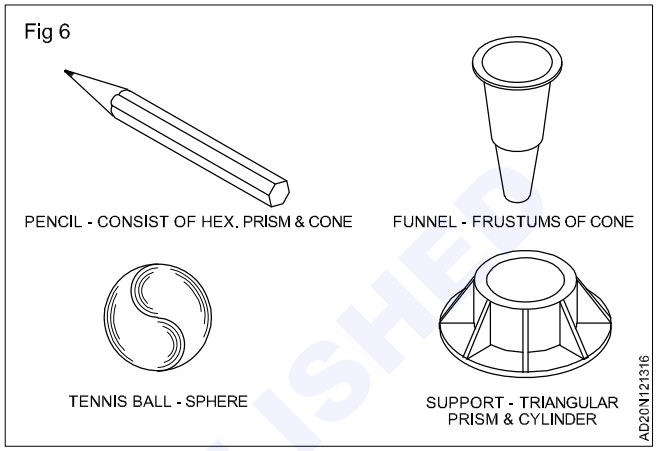


Fig 6



Views of solids: When dealing with projection of plane figures earlier was stated that solids are enveloped by planes and therefore drawing the views of solids would actually mean drawing the views of planes the solids are composed of.

The faces of solids which are parallel to the planes of projection will be seen in true shape in the respective planes. When planes are not parallel to the plane of projection the views will have a disorted look.

Figures 7, 8, 9, 10, 11, 12 & 13 indicate the plan, elevation and end view of some solids for the position defined against each.

Fig 7

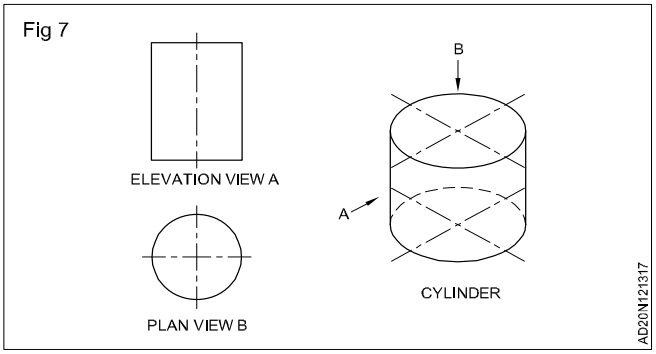


Fig 8

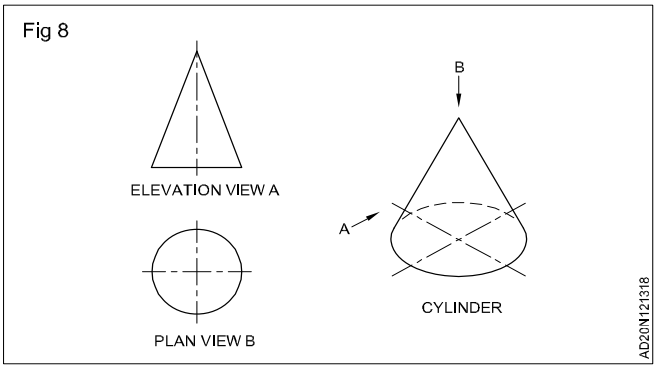


Fig 9

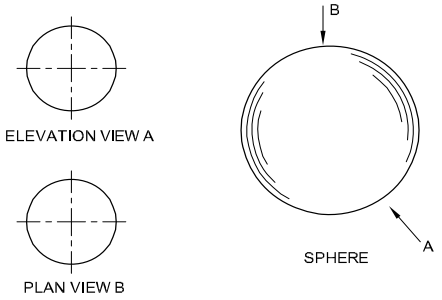


Fig 10

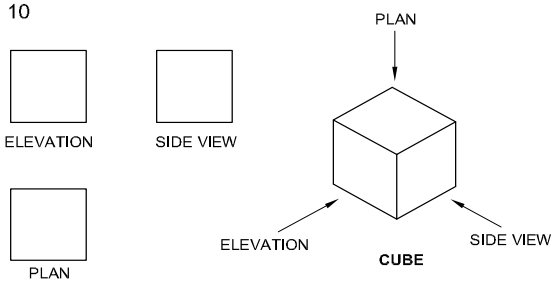


Fig 11

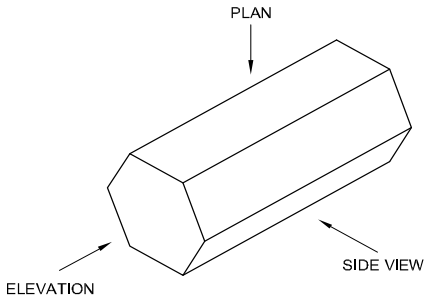


Fig 12

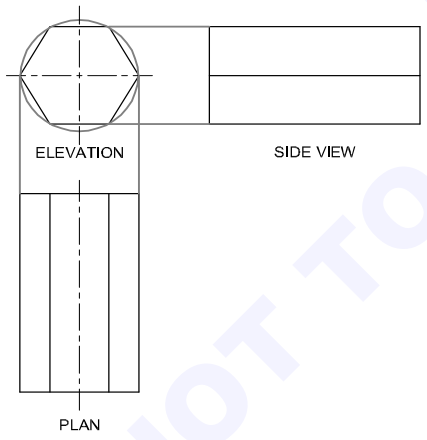
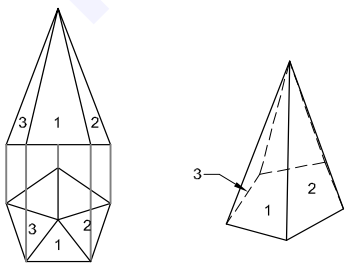


Fig 13



While drawing the views of solids all the edges of solids may not be visible in the views concerned. For example in the figure shown the edge will not be visible in the front view. Such edges ae referred as hidden or invisible edges. All visible edges in a view are drawn usually thick lines. But, invisible edges are drawn using dotted lines of medium thickness. (The thickness of dotted lines is in-between thickness of thick lines and construction lines) Dotted lines are short dashes.

In some cases, it is required to show the axis of solids. Axis is represented by another type of line called center line.

Centre lines are thin lines consisting of alternating, long and short dashes. (Figs 14,15 & 16)

Fig 14

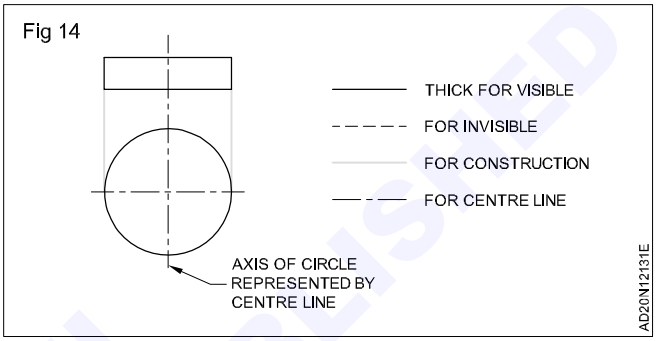


Fig 15

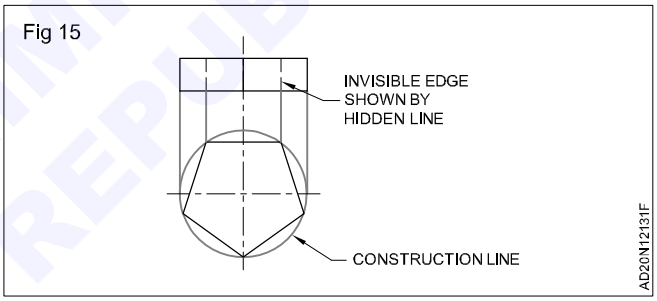
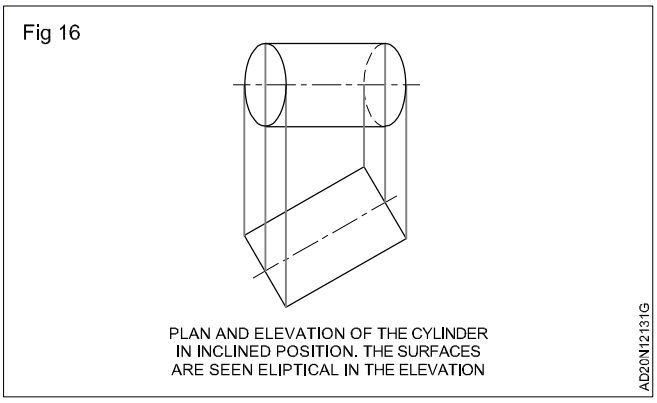


Fig 16



Dimensioning

Objectives: At the end of this lesson you shall be able to
- **define dimensioning.**
- **to dimension the drawings as per Indian Standard Specification.**

Introduction

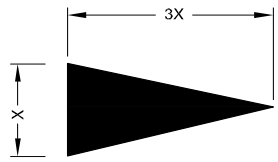
1 Dimensioning plays a predominant role in engineering drawing. It expresses the quantity, adds value and signifies relation to the parts of the diagram. This information is very vital. Without dimension, the meaning of the drawing is lost.

2 Dimensioning is provided in every part of the drawing to provide enough of details, to avoid misconception, confusion, leaving to chance and doubts etc.

3 Dimensioning must be clear and appear only once.

Arrow heads (Fig 1)

Fig 1



Arrowheads are marked at both ends of the dimension lines. The size of the arrowheads should be proportionate to the size of the drawing.

Oblique strike and origin indication

1 Where space is insufficient for arrowheads, oblique's stroke or dot may be used.

2 Oblique stroke is drawn as a short line inclined at 45 Degree. The origin indication is drawn as a small open circle of about 3mm Diameter.

Leader line is a line referring to a feature like dimension object and outline it continuous thin line.

1 If the leader line ends with in outline of an object, it should have a dot at the end.

2 It should have an arrowhead if it ends on the outline of an object.

3 It should terminate without dot or arrowhead if it ends on a dimension line.

Dimensioning method (IS: 11669-1986)

Method-1: (Figs 2 & 3) (Aligned system)

1 The dimension's lines are drawn parallel to the object lines.

2 The dimension's values are placed above the dimensions lines and not by breaking the dimensions lines.

3 The dimension's values are placed near the middle and clear of the dimensions lines.

4 All dimensions are so placed that they can be read from the bottom or the right hand edge of the drawing sheet.

Fig 2

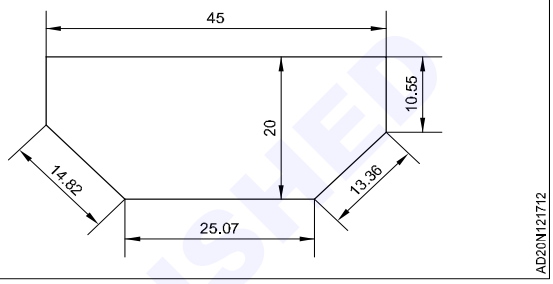
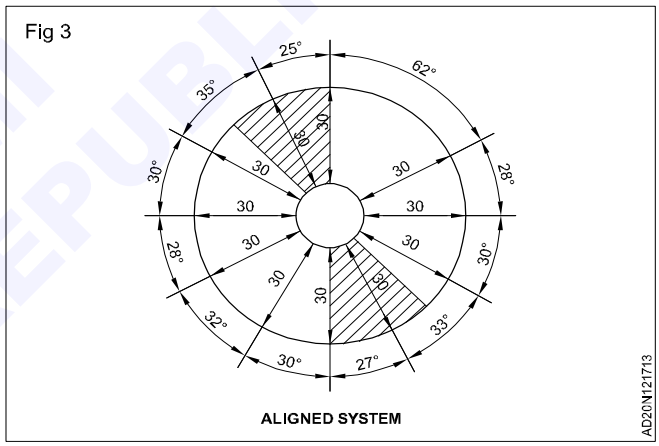


Fig 3



ALIGNED SYSTEM

Method-2: (Unidirectional system) (Fig 4 & 5)

1 The dimension's lines are drawn parallel to the object lines.

2 The horizontal lines are dimensioned as in method-1

3 Vertical and inclined lines are dimensioned by writing the dimension's value in the gap left in the middle of the dimensions lines.

4 All dimensions are so placed that they can be read from the bottom of the drawing sheet.

On any one drawing, use only one method of placing the dimensions.

Unit of dimensioning

1 The recommended unit of dimensioning is millimeters. There is no need to add the symbol for the unit e.g. a dimension value 40 means 40mm but a foot-note like "all dimensions in mm" is written in a prominent places.

Fig 4

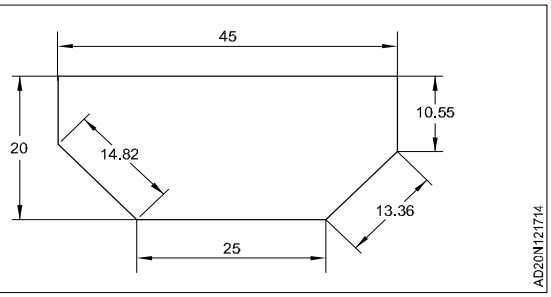
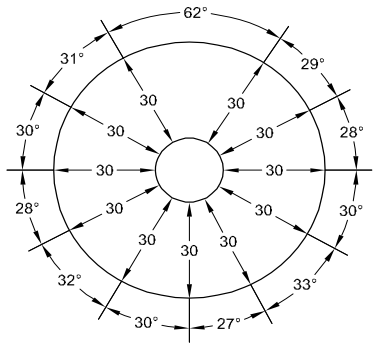


Fig 5



UNIDIRECTIONAL SYSTEM

2 When the dimension is less than 1, a zero should be placed before the decimal point such as 0.75.

Procedure to mark dimensions (Fig 6&7)

1 Draw dimension's line parallel to the object line to be dimensioned at about 8 to 10mm from it.

2 Draw projection lines perpendicular to the object line. Where necessary, they may be drawn obliquely but parallel to each other.

3 Mark arrowheads at both end is of the dimension's line as per method-1 or method-2.

Fig 6

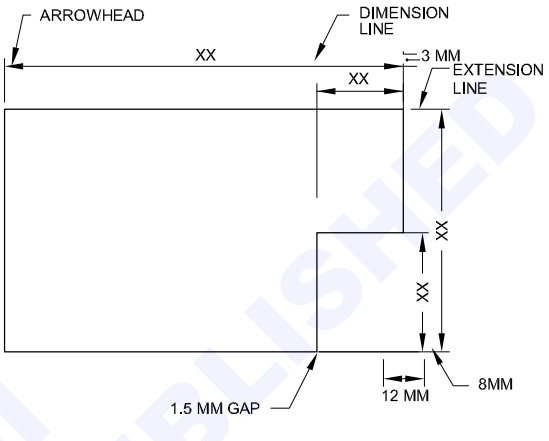
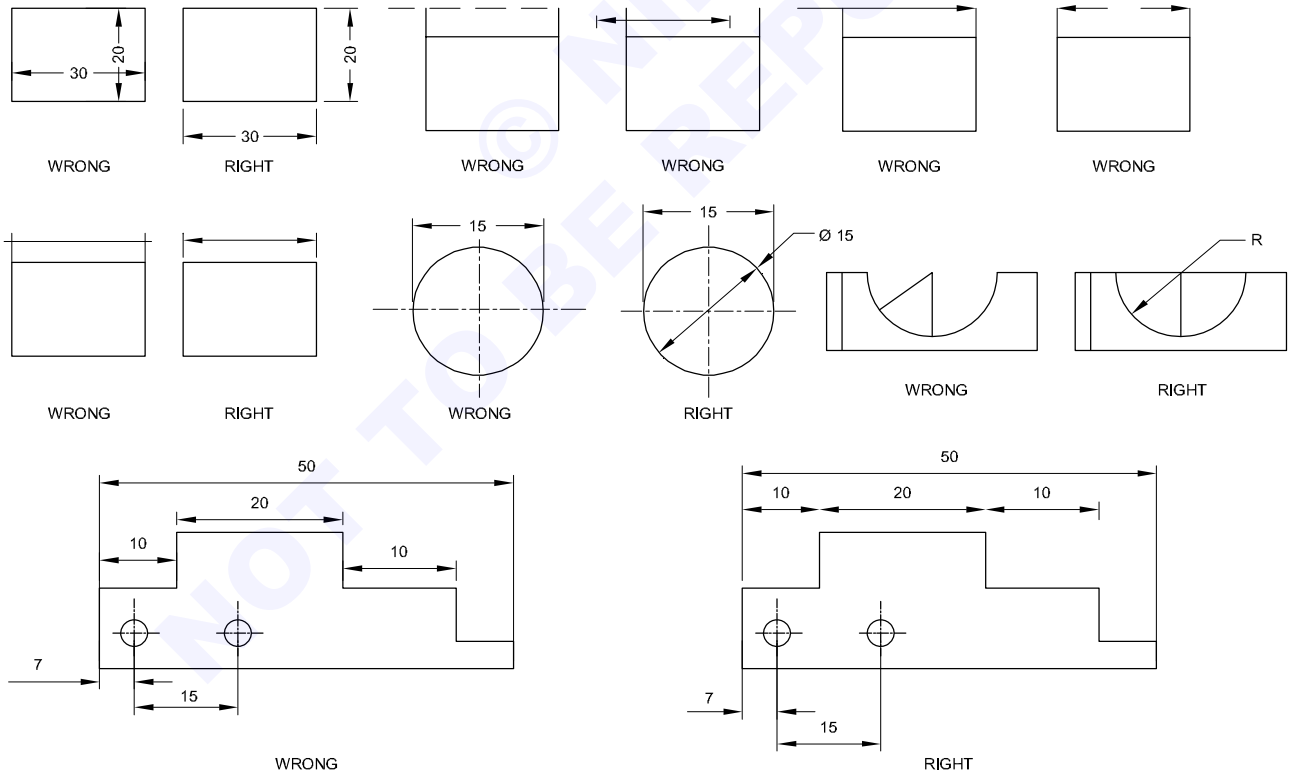


Fig 7



Projection

Objectives: At the end of this lesson you shall be able to
- **define projection**
- **classify projection**s
- **state the types of pictorial projection.**

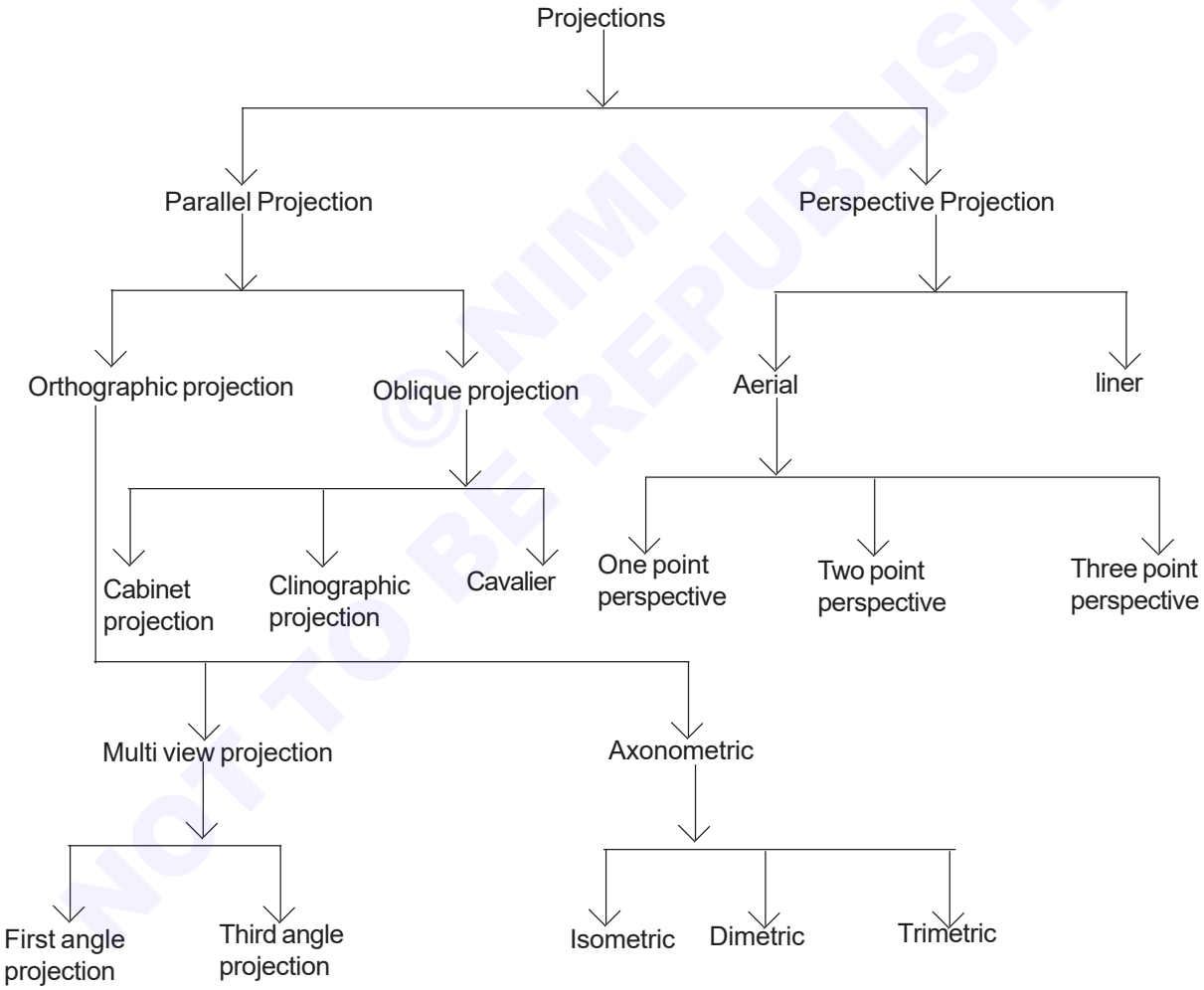
Introduction

As object, have three dimensions like length, width and height/ thickness. The shapes and sizes of three-dimensional objects have to be represented on a sheet of drawing paper, which has only two-dimensional planes.

For obtaining the image of an object, various points on the contour of an object, are thrown forward on to a plane by means of straight lines or visual rays.

The figure formed by joining various points thus obtained on the plane, is the image of the object and is called Projection.

Classification of projections



Pictorial projection

It is used for easy understanding of the drawing and visualizing the object for the persons without technical knowledge. These drawings create three dimensional effect and they reveal the shape of an object, approximately, when an observer, views the object.

But for orthographic projection, persons without technical knowledge cannot understand easily, hence, trainee shall develop the ability to convert orthographic views into pictorial views.

Isometric projection

Isometric projection is a type of pictorial projection in which the three dimensions of solid are not only shown in one view but their actual sizes can be measured directly from it. In isometric projection, there are three principle axes such as height axis, length axis and width axis. Three axis of the object are equally inclined 120^0 to each other and the three dimensions length, height and width are equally fore-shortened by using an isometric scale.

Important points for isometric drawings

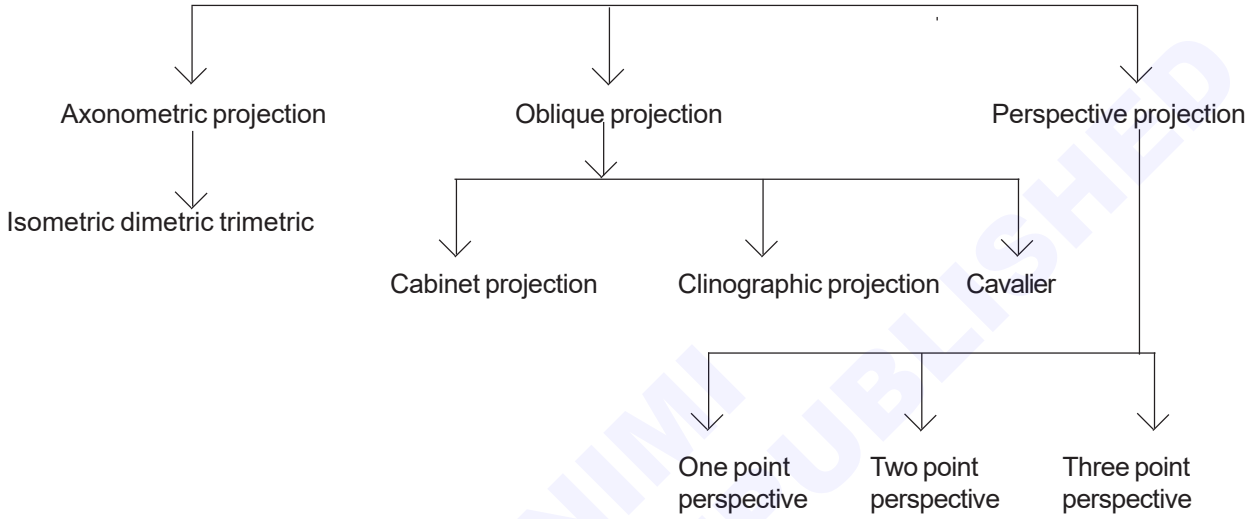
1 In isometric view, the two sides are inclined at 30^0 to the height axis.

2 The length may be drawn on the right or left depending on the side view of the orthographic projection of the object.

3 Hidden features are not to be shown in isometric views.

4 Vertical lines will be drawn vertical, while horizontal line will be drawn at a angle 30^0 to horizontal.

Types of pictorial drawings



Difference between Isometric view and projection

Isometric View	Isometric projection
Draw to actual scale	**Draw to isometric scale**
When lines are drawn parallel to isometric axes, the true lengths are laid off.	When lines are drawn parallel to isometric axes, the lengths are fore shortened to 0.82 times the actual lengths.

Oblique projection

Pictorial projections are becoming more popular due to use of a computer in a modern drawing, dimensional object on the projection plane by one view only. This type of drawing is useful for marking an assembly of an object and provides directly a production drawing (working drawing) of the object for the manufacturing purpose.

Definition

When an observer looks towards an object from infinity the line of sight (projectors) will be parallel to each other and inclined to the plane of projection.

Types of the oblique projection

1 Cavalier projection.

2 Cabinet projection.

1 The oblique projection is based on scales by which the receding lines are drawn.

2 When the receding lines are drawn to full size scale and the projection inclined at an angle of $30^0, 45^0, 60^0$ to the plane of projection. Such oblique projection is known as cavalier projection. The inclined lines in an oblique projection are called receding lines.

3 If the receding lines are drawn to half size scale such oblique projection is known as the cabinet projection.

The difference between the Oblique and Isometric Projections

Sl.No.	Oblique Projection	Isometric Projection
1	Projectors from an object are parallel to each other and incline to the plane of projection.	Projector from an object are parallel to each other and perpendicular to the plane of the picture.

Sl.No.	Oblique Projection	Isometric Projection
2	The object is placed in such a way that one of its prominent faces remains parallel to the Plane of projection.	The rest on one of its Faces. The object is kept in such way that its three mutual perpendicular edges (axes)make equal angles with the plane of the Projection. The object stands on one of its Corners.
3	The object is drawn with the actual Dimensions.	The object is drawn with the reduced (About 82%) dimensions.
4	The faces of object which are perpendicular to the plane of the projection will be Distorted in the shape and size.	All the faces of the object distorted in the Shape and size.
5	The choice of position of the object.	The choice of position of the object is not possible.

Orthographic projection

If the projections from the object are perpendicular to the projection plan, then such a projection of the object is known as Orthographic Projection. A thorough knowledge of the principles of pictorial projection is required for converting pictorial views into orthographic views.

General Procedure

1 Determine the overall dimensions of the given object for the required orthographic views.

2 Draw rectangles for the views using suitable scale. It is also required to keep sufficient space between the views and from border lines.

3 Draw center lines for circles and arcs.

4 Draw circles and arcs of circles first, next draw straight lines for the main shapes of the object.

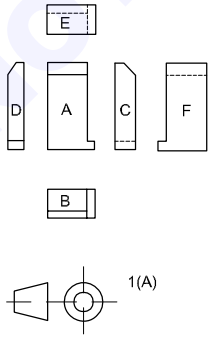
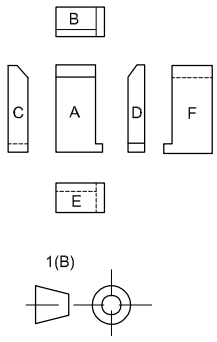
5 And finally draw straight lines and small curves for the minor details of the object.

Points to be considered for converting a pictorial view in to orthographic views

- Dimensions which are parallel to the direction of viewing will not be seen. Edges which are parallel to the direction of viewing are seen as points. Surfaces which are parallel to it are seen as lines.
- The visible edges and the intersection if the surfaces are shown by object lines. But the hidden edges are shown by dotted lines.
- The center linens of the symmetrical parts like whole cylinder etc. should be clearly shown.

System of orthographic projection

Orthographic views can be obtained by two methods:

First Angle projection	Third angle projection
Arrangement of views in first Angle projection. With reference to the front view the other arranged as follows: Fig 1  1(A)	Arrangement of views in Third Angle Projection. With reference to the front view the other arranged as follows:  1(B)

First Angle projection	Third angle projection
The view from above is placed underneath	The view from above is placed above.
The view from below is placed above.	The view from below is placed underneath
The view from the left is placed on the right.	The view from the right is placed on the right.
The view from the right is placed on the left.	The view from the left is placed on the left.
The view from the rear may be placed on the left or on the right as may be found convenient .	The view from the rear may be placed on the left or on the right as may be found convenient .
The distinctive symbol of this projection is Fig 1A	The distinctive symbol of this projection is Fig 1B

- When a hole or a cylindrical part in seen as a circle draw two center lines intersecting each Other at right angles at its center line for its axis.
- When a center line coincides with a visible edge it is drawn as a dotted line.
- When a hidden edge coincides with a visible edge, it is drawn an object line (visible out line)

First angle projection

- When the object is placed in 1st quadrant such that it is between the projection plane and the observer, the projection so obtained is called first angle projections.

Third angle projection

- In this case, the object is placed in the 3rd quadrant and the planes of projections are in between the object and the observer.

Basic principles

- Depending upon the relative position of the object, the picture plane and the station point, the following situation may arise:
- If the picture plane is in between the object and the station point, a normal perspective is obtained.
- If the object is in between the picture plane and the station point, a larger perspective is obtained.
- If the station point is in between the object and the picture plane, the perspective is reversed.

Type of projection

Objectives: At the end of this lesson you shall be able to
- **explain the four dihedral angles**
- **state the meaning of orthographic projection**
- **explain terms plan and elevation as applied to orthographic views**
- **state the relative position of views in first and third angle projection**
- **state the projection of lines of different orientation.**

An engineering drawing conveys many different types of information of which the most important thing is the shape of the object. Fig 1 shows a sample drawing. In this drawing the shape of the part is represented by three views.

For an untrained person it will be very difficult to conceive the shape of the object from the above drawing.

But in Fig 2, the same object is shown pictorially in a different ways and the shape is easily understood even by a layman.

From Figs 1 & 2, it is clear that there are different ways of describing the shape of a part on a paper. Figure 1 is called as Multiview drawing or Orthographic drawing and the method adopted in figure 2 is called pictorial drawing. The different views in a multiview drawing are called as 'Orthographic views' or Orthographic projections.

Fig 1

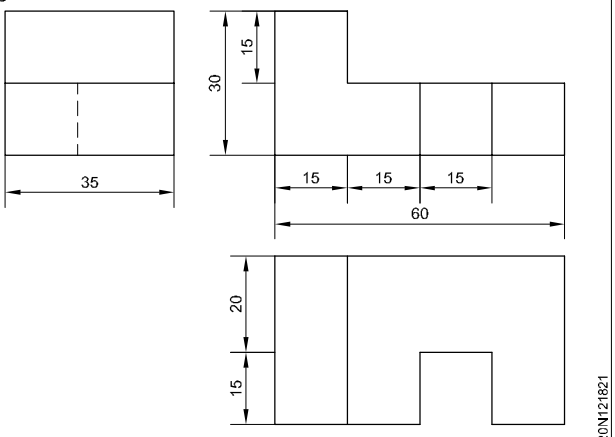
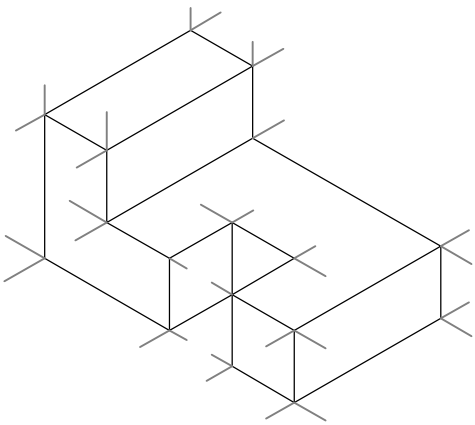


Fig 2



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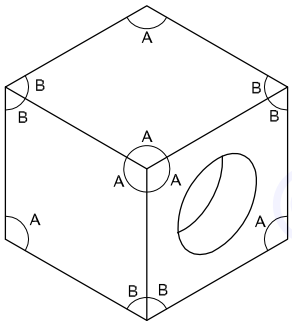
To describe the shape of a part in engineering drawings, multiview or orthographic view method is preferred as only Orthographic view can convey the true shape of the object. Whereas in pictorial drawing through this shape is easily understood and it is distorted. To emphasise this point, see Fig 3, wherein a cube with a circular hole is represented pictorially. We know that all corners of the cube are of 90°. But in the pictorial drawing in Fig 3, the same 90° is represented at some places by acute angles and at some other places by obtuse angles.

Fig 3



A - OBTUSE ANGLES
B - ACUTE ANGLES

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Projection: Projection is commonly used term in draughtsmans vocabulary. In the context of engineering drawing, projectors means image and it is comparable to the image formed on the retina of the eyes. (Projection can also be compared to the image of the object on the screen, where the film is projected (by the cinema projector) by the light rays.

Projection or images can also be formed in-between the eyes and the object by keeping a transparent plane. (Fig 4)

In this figure 4 the rays from the object converge to the eyes and this image (Projection) is smaller than the object. However, if the rays are parallel as in the case of rays coming from the sun, the image (Projection) will be of the same size as that of the objects. Such a projection is called orthographic projection. The parallel lines/rays drawn from the object are called projectors and the plane on which image is formed is called plane of projection. In orthographic projection, the projectors are perpendicular to the plane of projection. (Fig 5)

Fig 4

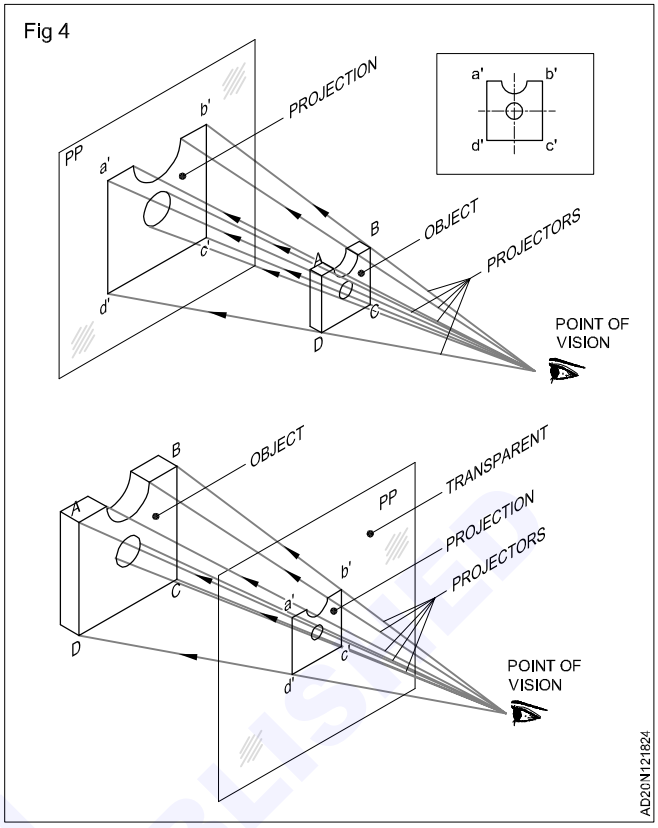

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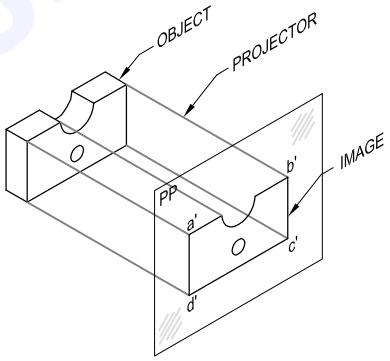
Fig 5



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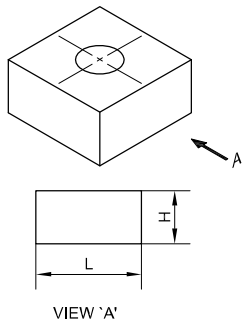
Orthographic projection: The term orthographic is projection derived from the words. Ortho means straight or at right angles and graphic means written or drawn. The projection comes from the Old Latin words PRO means forward and Jacene means to throw. The orthographic projection literally means "Throw to forward", "drawn at right angles" to the planes of projection.

An orthographic system of projection is the method of representing the exact shape and size of a three dimensional object on a drawing sheet or any other plain surface such as drawing board.

A single orthographic view of an object will show only two of its three dimensions. The view in figure 6 shows only the length and height of the object only.

Therefore, it becomes necessary to have an additional view to show the missing dimensions (width). Therefore, we have to make two views to represent the three dimensions of an object.

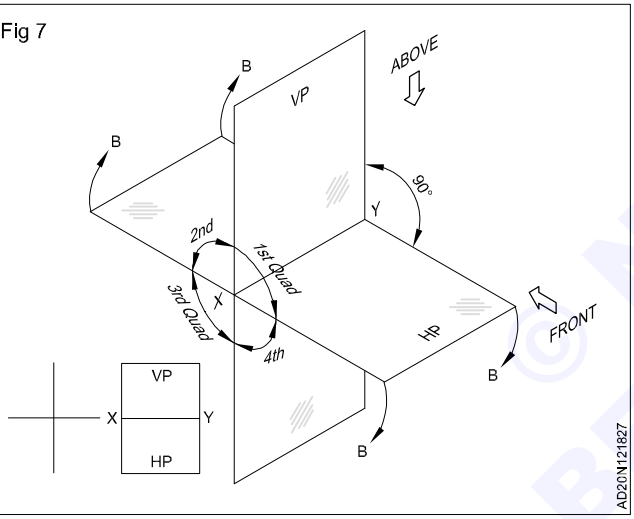
Fig 6



The two views thus required are to be obtained on two different planes which are mutually perpendicular (one HP and one VP) with the object remaining in the same position. The projection or the view obtained on the horizontal plane is called the top view or plan and the view obtained on the vertical plane is called elevation.

First angle and third angle projection: One vertical plane (VP) and one horizontal plane (HP) intersect at right angles to each other. (Fig 7)

Fig 7



All the four quadrants have one HP and one VP formation. As per convention in mathematics, the quadrants are numbered as 1st, 2nd, 3rd and 4th. These four quadrants are called four dihedral angles, namely 1st angle, 2nd angle, 3rd angle and 4th angle.

To draw two views of an object, we assume that the object is placed in any one of the quadrant/angles, 1st angle & 3rd angle Fig 8a, 9a and its plan and elevation projected to the respective planes. Now to make it possible to draw the two views (Plan & elevation) in one plan i.e the plan of the drawing paper, the horizontal plane is assumed to be unfolded in clockwise direction through 90° Fig 8b & 9b. We proceed this way, when the views are made. When the object is placed in the 2nd or fourth quadrant the plan and elevation will get super imposed (one up on the other) Fig 10a & b. Due to this reason the 2nd and 4th angle are not used for making engineering drawings as the three dimensions cannot be easily identified. Hence for representing the three dimension of the object, we assume the object is placed either in 1st angle or in 3rd angle. (Figs 11 & 12)

Fig 8

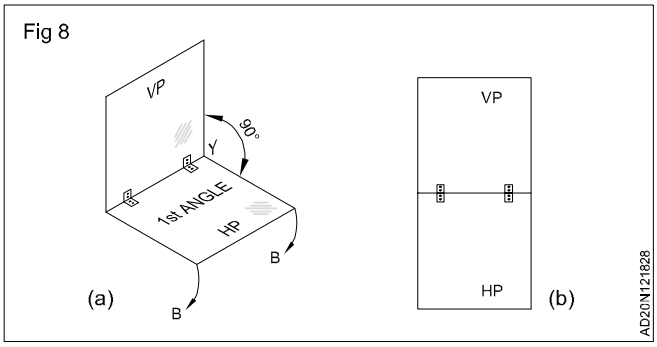


Fig 9

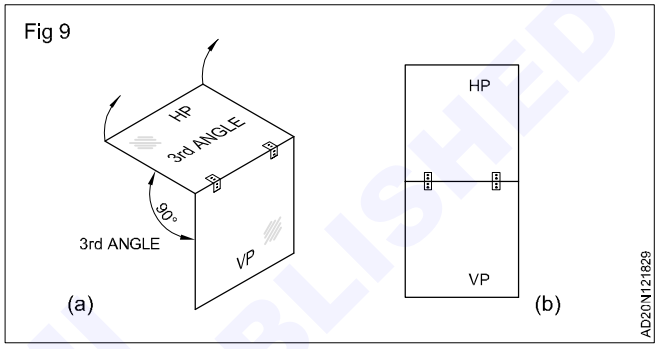


Fig 10

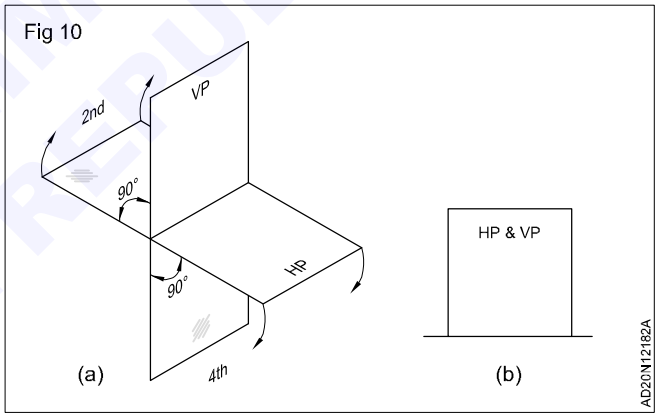


Fig 11

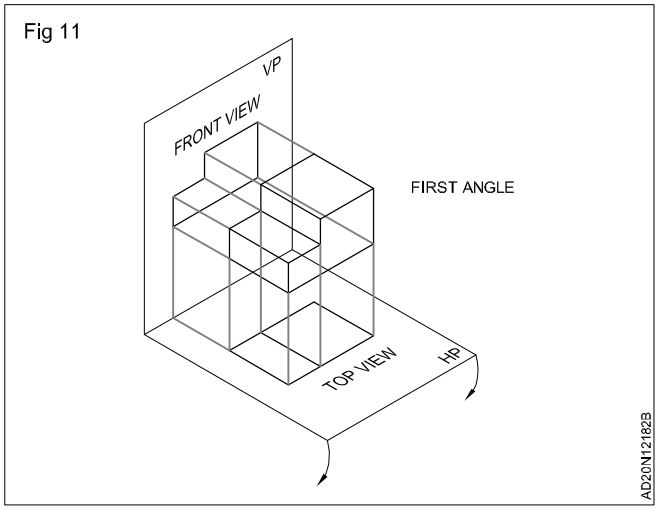
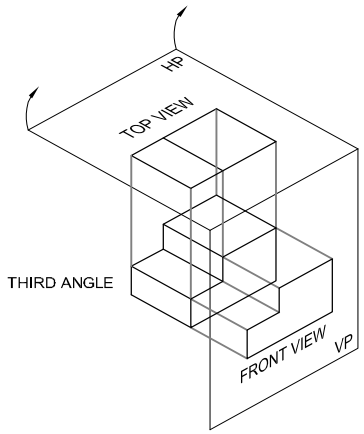


Fig 12



The placement of plan and elevation when the horizontal plane is unfolded will be different in these two systems. It may be observed in Fig 13 that in the first angle projection plan (top views) will be directly below the elevation, whereas in 3rd angle projection plan lies directly above the elevation. (Fig 14)

Fig 13

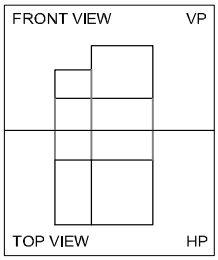
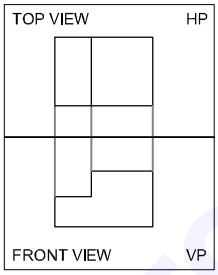


Fig 14



Views can be drawn in any one of these two methods. However, Bureau of Indian Standard (BIS) has recommended the first angle method to be used in our country.

Orthographic views are drawn, based on the principle of projection. To acquire sound knowledge to make orthographic views, one has to study solid geometry which deals extensively with principle of projections. Remember that the purpose of studying solid geometry is to have clear in sight of principle of projection which is the basis of describing the shapes of solid objects on a plain paper.

Solids are made of planes and planes are made of lines and lines are made of points. Hence the solid geometry will be dealt in the order of points, lines, planes and solids.

Projection of a line: A straight line connects two points. In other words the line has a start point and one end point.

By projecting start point and end point as discussed earlier and joining them we get the projections of a line. However, the following points should be noted as guidelines.

– If a line is parallel to the plane of projection, the projection will be of the same length as that of the line. (Fig 15)

– If a line is perpendicular to the plane of projection, it will be a point.

– If a line is inclined to the plane of projection, its projection is smaller in than the actual length of the line. (Fig 16)

– If the line is inclined to all the true planes i.e plane of projection (HP, VPI and VPII) its projections will be of in smaller than the actual length of the line in all the three planes. (Fig 17)

Fig 15

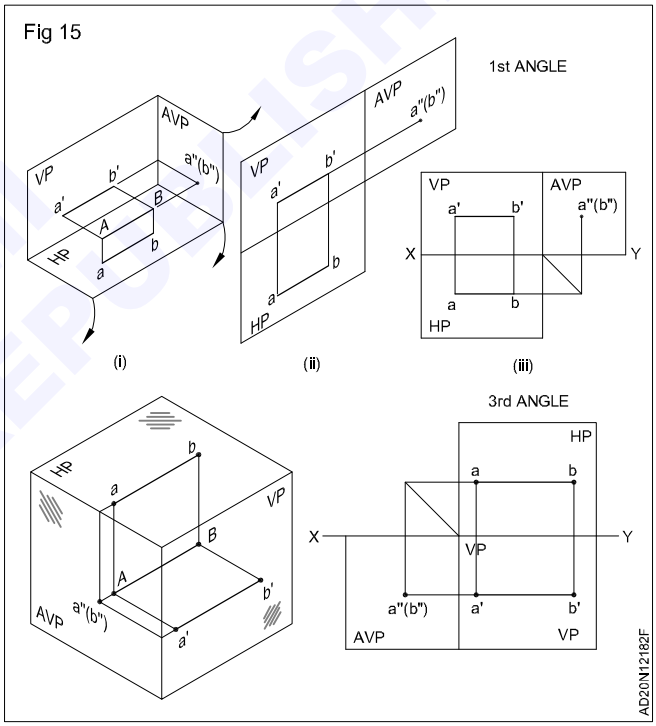


Fig 16

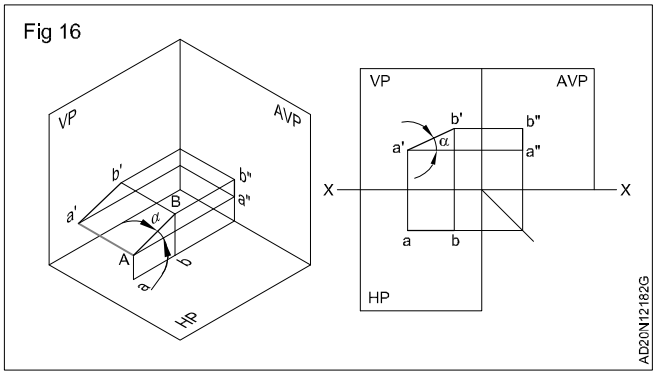
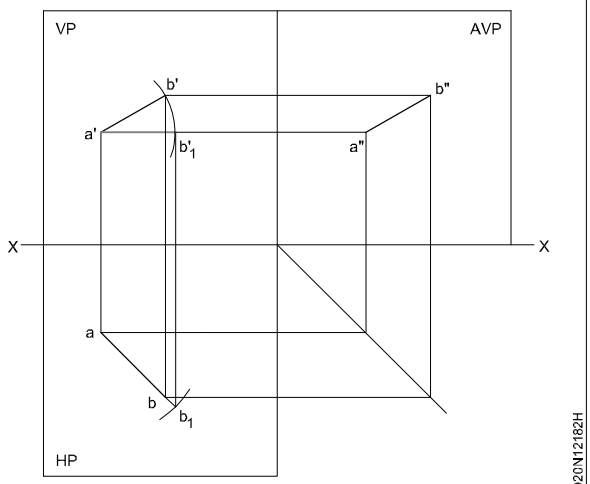


Fig 17



Projection of plane figures

Objectives: At the end of this lesson you shall be able to

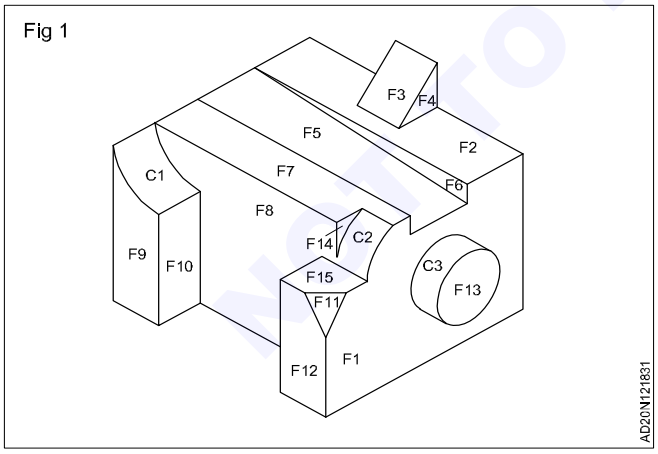
- **distinguish between a two dimensional and a three dimensional figure**
- **identify the type of surfaces**
- **explain as to how the projection of a given surface will be on the different planes of projection**
- **state the meaning of the term true shape and the condition to obtain true shape and the views.**

Two dimensional and three dimensional figures: We know that solid object are enveloped by surfaces while solids are classified as three dimensional surfaces and implies volume and two dimension implies area.

When we draw orthographic views to represent solids in effect, we are drawing the projection of the solids.

Types of surfaces (Fig 1): Surfaces may be flat or curved. Flat surfaces are also referred as planes. (Plain surfaces) Flat surfaces, depending on their orientation, may be vertical, horizontal or inclined. Fig 1 shows a solid and it has flat surfaces and curved surfaces. Flat surfaces are marked as F_1,F_2 etc.

Fig 1



Surfaces F_1,F_4,F_6,F_8,F_9,F_{10},F_{12},F_{13} and F_{14} are vertical surfaces.

F_2, F_7 and F_{15} are the horizontal surfaces.

C_1,C_2 and C_3 are the curved surfaces.

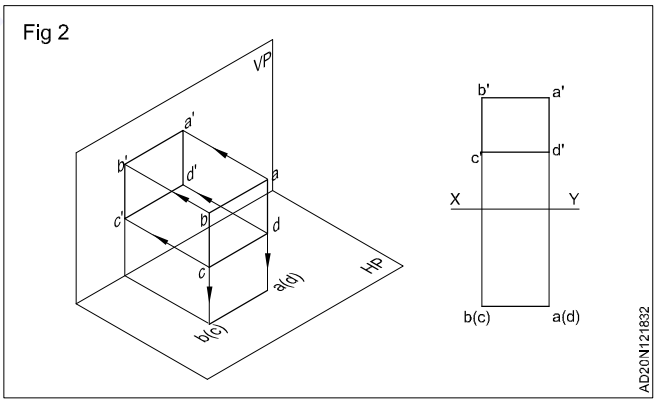
F_3, F_5 and F_{11} are inclined or oblique surfaces or them combination.

For example, in F_3 is rectangular while F_{13} is circular. But surface F_1 is a combination of several plane figure.

Projection of Flat surfaces: While drawing the projection of surfaces (plane figures) the following points should be noted.

If the surface is parallel to the plane of projection, the resulting projection will be the true shape of the surface. (Fig 2)

Fig 2



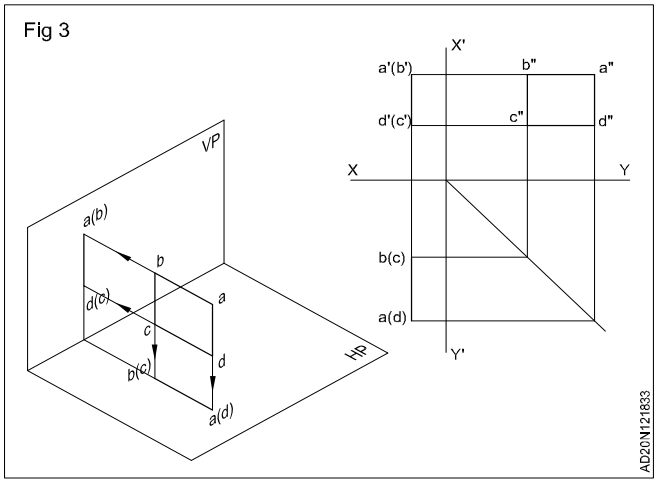
True shape: When the projection of a surface is identical to the surface projected, the projection is said to be of true shape.

When the surface is perpendicular to the plane of projection, the resulting projection will be a straight line. (Fig 3)

If the surface is inclined to the plane of projection, its projection will not have the true dimensions. They are fore shortened. (Fig 4)

Foreshortened view: Where the projection of a surface is not identical to the surface projected, the projection is said to be foreshortened.

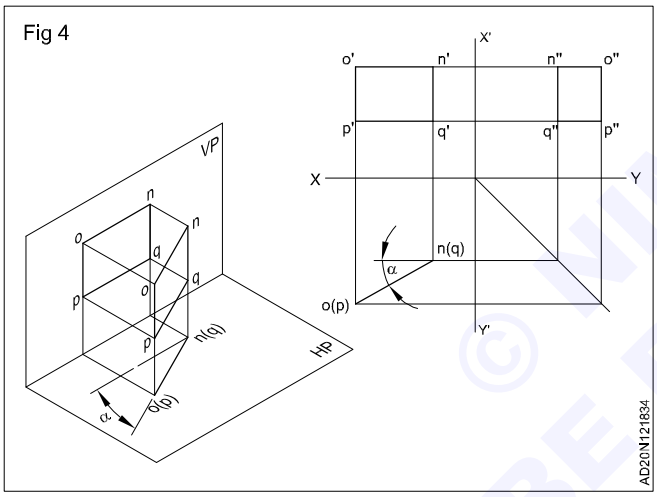
Fig 3



In figure 4, the length pq or the length on is of true length in plan, but in front elevation and in side view same is foreshortened in a different way according to the inclination of the surface to the plane of projection.

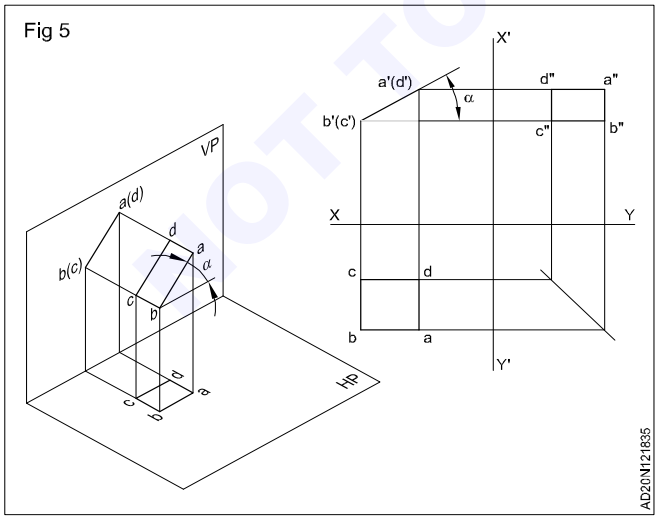
If a surface is inclined to a vertical plane, the angle of inclination will be seen on HP and vice-versa. (Fig 4)

Fig 4



If a surface is inclined to horizontal plane the angle of inclination will be seen on VP and vice-versa. (Fig 5)

Fig 5

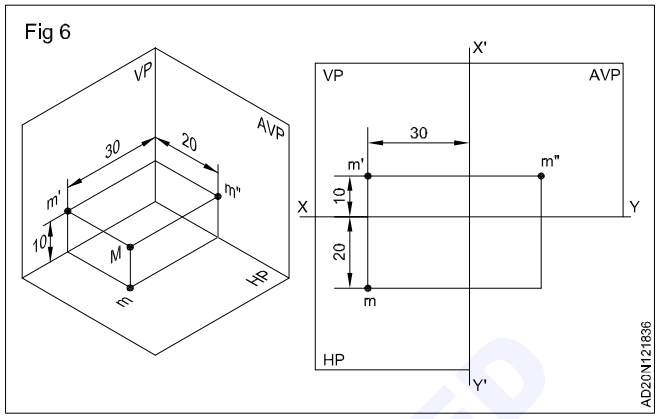


Guidelines to be followed: The intersection (folding lines) between HP and VP is marked as XY whereas the intersection between VP and AVP is marked as X'Y'.

In exercises/problems wherein the distances of the object (point, line, surface) from HP, VP and AVP are not given a convenient distances may be assumed and followed.

Terminology of views/projections (Fig 6)

Fig 6



- The view projected on HP is termed as plan or top view.
- The view projected on VP is termed as elevation or front elevation or front view.
- The view projected on AVP is termed as side view or end view or side elevation or end elevation.

The distance from XY to a point in the plan and to the corresponding point in the side view from X,Y, is equal to the distance from VP.

The distance from XY to point in the front elevation and to the corresponding point in the side view from XY is equal to the distance of the point from HP.

The distance from X,Y, to a point in the front elevation and the corresponding point in the plan from X,Y, is equal to the distance of the point from AVP.

The above three statements may be summerised as follows:

the distance of a point from one plane will not reflect in the projection on that plane, but it will be reflected in the projections of other planes.

This can be observed in the figure shown.

Point M is 10 mm from HP, 20 mm from VP and 30 mm from AVP.

In the figure B, the projections of point M in the three planes and distances from XY and X,Y, are marked.

Point M is really 10 mm from HP, but the distance of 10 mm is not reflected in HP. Similarly 20 mm is not reflected in VP and 30 mm is not reflected in AVP.

Distance of 10 mm from HP is reflected in front and side views.

Distance 20 mm from VP is reflected in plan and side view.

Distance 30 mm from AVP is reflected in plan and front view.

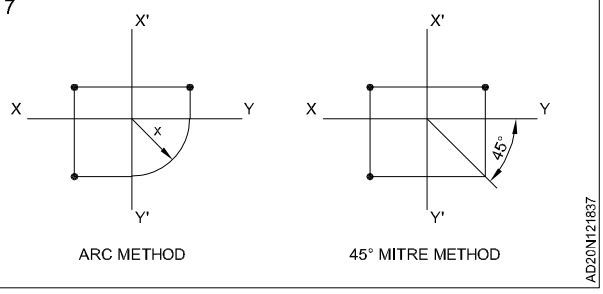
If we know the projection of point in two planes, its projection to third plane can be obtained by projecting from the given/known two views and transferring distances.

For example, if you draw the front view and side view of a point (Fig 7), plan can be completed by drawing projection from the front view and side view. Transfer of distances from two views to third view may be done either by arc method or by 45° miter line method.

Following standard conventional markings are to be followed for points, lines and surfaces on plan, front view and side views.

Plan	Final	just an alphabet	(a)
	1st stage		(a1)
	2nd stage		(a2)
Elevation	Final	alphabet with a dash	(a')
	1st stage		(a1')
	2nd stage		(a2')
Side elevation	Final	alphabet with two dash	(a")
	1st stage		(a1")
	2nd stage		(a2")

Fig 7



Isometric projection

Objectives: At the end of this lesson you shall be able to
- **state the method of isometric projection**
- **explain isometric scale**
- **explain box method of isometric view**
- **explain off set method of isometric view.**

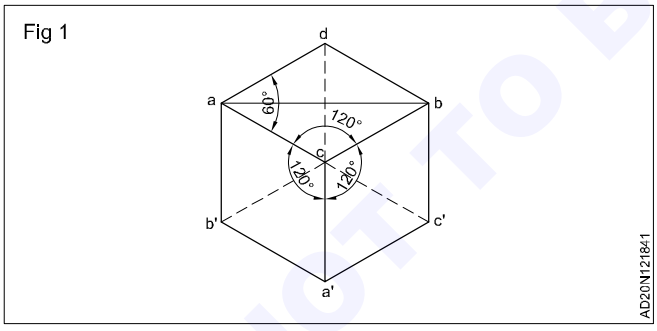
Isometric projection: Isometric scales are used to get the foreshortened lengths required for isometric projection.

Before constructing an isometric scale, you must understand is the relationship between the true length of an edge and the length of the same in isometric projection.

To determine the relationship between the true length and corresponding length in isometric projection, proceed as follows:

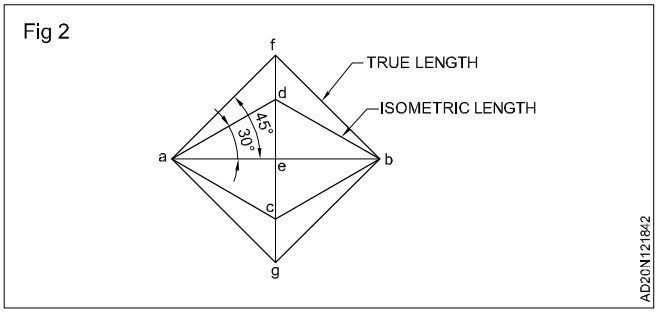
Consider the isometric projection of a cube. (Fig 1)

Fig 1



Separately draw the top face of the cube adbc and join the longer diagonal ab. (Fig 2)

Fig 2



Note that the diagonal ab is of same length both in the isometric view of the face and the true face. Assume the top true face of the cube as afbc.

Now superimpose the true top face afbg keeping the diagonal ab common. (Fig 2)

$\angle FAE = 45°$ and $\angle DAE = 30°$

x $AE = AF \times Cos45°$ and $AD = AE \div Cos30° = AF \times$

$$\frac{\text{Isometric length}}{\text{True length}} = \frac{AD}{AF}$$

$$\frac{AD}{AF} = \frac{AF \times Cos45°}{AF \times Cos30°} = \frac{Cos45°}{Cos30°}$$

$$\frac{AD}{AF} = \frac{AF \times Cos45°}{AF \times Cos30°} = \frac{Cos45°}{Cos30°} = 0.8165$$

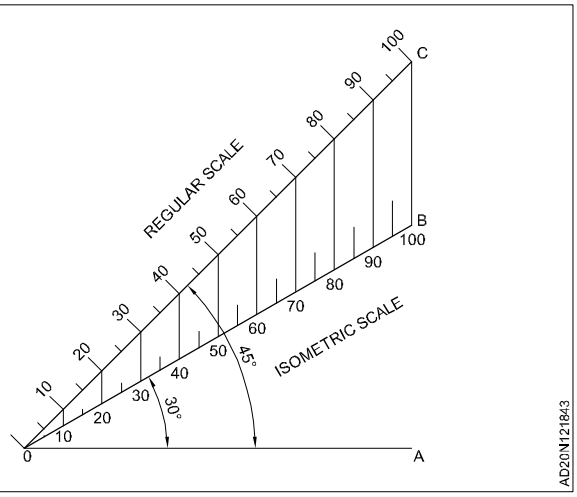
AD = 0.82 AF. This means that the length of a line in isometric projection is 0.82 times of it true length. While drawing an object in isometric projection, the dimensions on or parallel to isometric axes are reduced to this proportion. To make things easier we can construct a scale to the above ratio. Such a scale is called as isometric scale.

Procedure to construct

Isometric scale (Fig 3)

– Draw a horizontal line OA.

Fig 3



– Draw lines OB and OC making 30° and 45° with OA respectively.

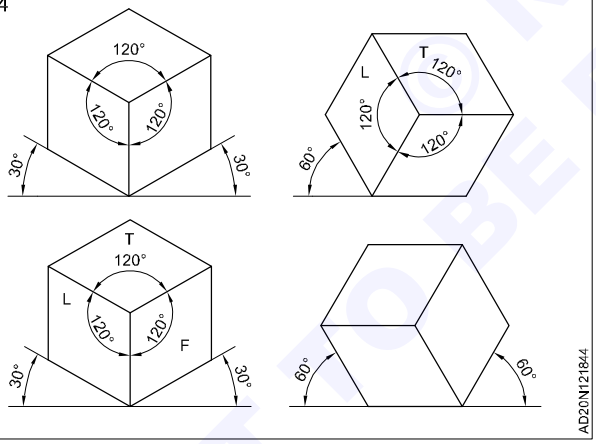
– Mark 5 mm, 10 mm, 15 mm up to 100 mm on line OC.

– From the marked points on the regular scale OC, draw perpendiculars to OA meeting at OB.

– Print the corresponding values on the line OB resulting in the isometric scale.

Orientation of isometric axis: While the isometric axis make 120° to each other they may have different orientation as shown in Fig 4. Each of the orientation show3 of the 6 faces (left, right, top, bottom, front and rear) are shown in different combinations.

Fig 4



Isometric view and Isometric projection: A drawing is made with true lengths (dimensions) is called isometric view or isometric drawing. Whereas the same drawing made with isometric lengths is termed as isometric projection. (Fig 5)

Isometric and non-isometric lines: Fig 6 shows the isometric view of a shaped block. Here all lines except AB, BC and DE are parallel to isometric axis. Lines such as then which are parallel to isometric axis are called isometric lines whereas such as lines AB, BC and DE which are not parallel to isometric axis are called non-isometric lines.

The length of non-isometric lines will not follow the scale used for isometric lines. To proove this point consider the non-isometric lines AB or BC. The true length of both AB and BC is 5 cm while BC will be longer. Because of this reason non-isometric lines are drawn first by locating their starting and end points on isometric lines.

Fig 5

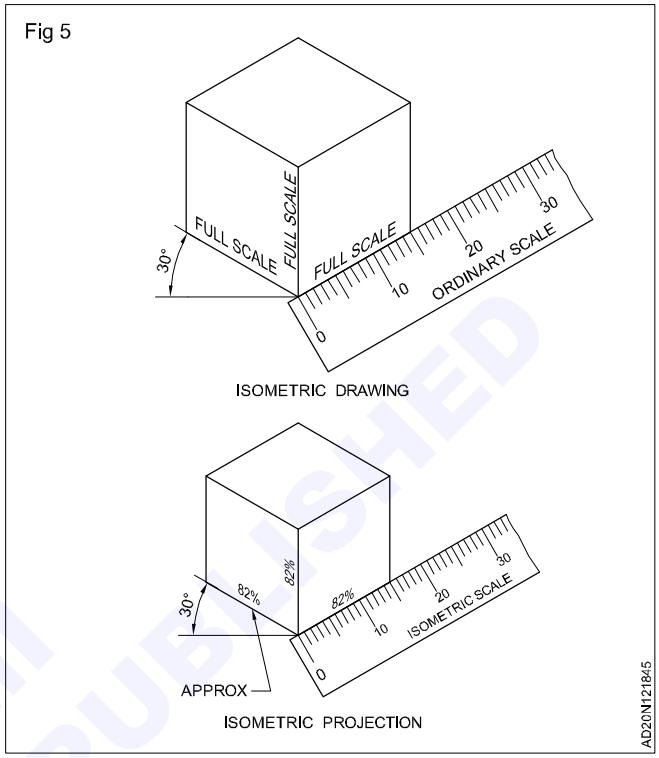
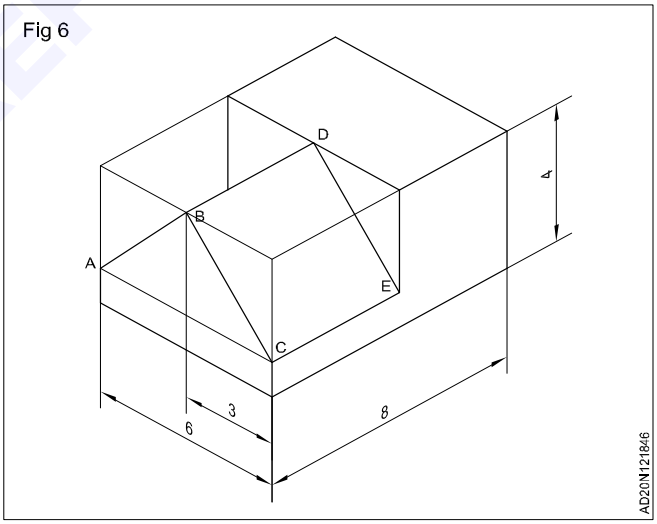


Fig 6



To locate the end points and to draw the non-isometric lines two methods are employed. They are

– Box method

– Off-set method

Box method: The object is assumed to be inside a rectangular box. Starting and end points are located and marked. By joining the points isometric view is drawn.

Off-set method: This method is most suited for the objects consisting of number of planes at a number of different angles.

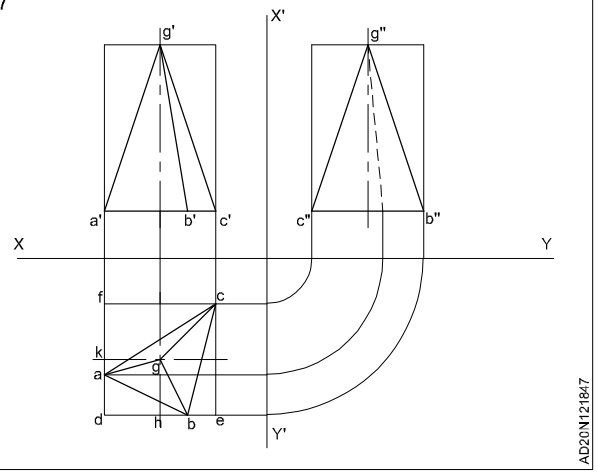
These methods are not only useful for isometric views involving non-isometric lines but also for the isometric views involving isometric lines.

Box method of drawing a pyramid

Example

Draw an isometric view for the triangular pyramid shown in Fig 7 using a box method.

Fig 7



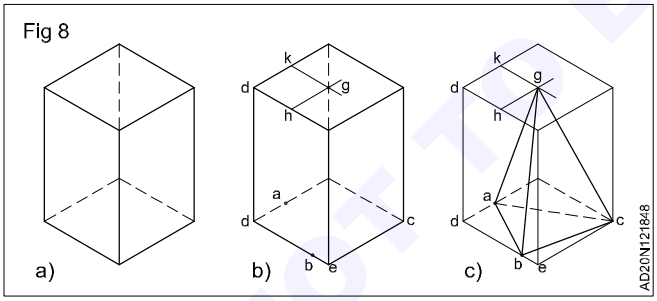
– Construct a rectangular box to the overall size of the pyramid (Fig 8a)

– Mark the distances ad and be from the plan of Fig 7 in the base of the box.

– Mark the distances kg and dh on the top face of box. (Fig 8a)

– Join the points AB, BC, CA, AG, BG and CG and complete the isometric view of the pyramid in box method. (Fig 8b)

Fig 8



Off-set method of drawing a pyramid

Example

Same triangular pyramid (Fig 7) is considered for drawing isometric view using offset method.

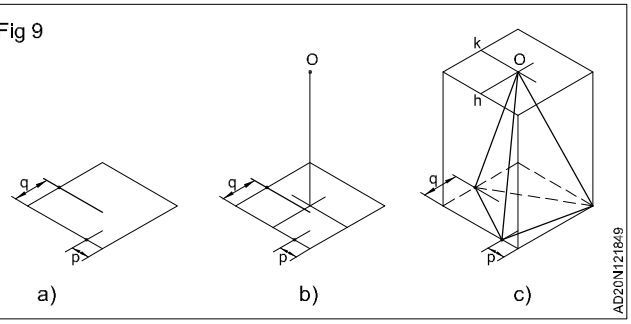
– Draw an isometric square/rectangle considering the corners of the base of the pyramid. (Fig 9a)

– Locate the corners 1,2 & 3 with help of offsets P and Q.

– Locate the projection of the vertex O_1 on the base by offsets x and y and draw the vertical center line O_1O to the height of the pyramid. (Fig 9b)

– Join 1-2, 2-3, 1-3, 0-1, 0-2, 0-3 and complete the isometric view of the pyramid. (Fig 9c)

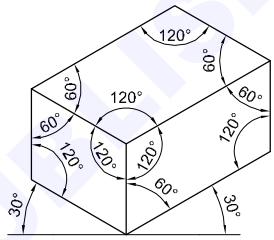
Fig 9



Angles in isometric projection: The angles of inclined surfaces will not have true value in the isometric projection, but will be more in some cases and less in other cases.

For example, in the isometric view of prism shown in Fig 10 the true value of all the angles is 90°. But in isometric projection the angles are 60° in some cases and 120° in others.

Fig 10



Isometric circles: The term isometric circle refers to the shape of circle in isometric view. An isometric circle will be elliptical in shape as shown in Fig 11 while drawing isometric view of cylindrical features isometric circles will have to be used. (Fig 12)

Fig 11

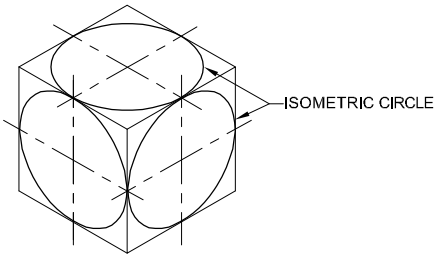
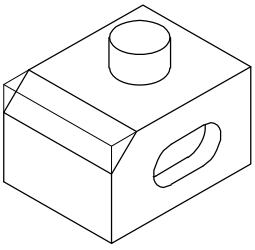


Fig 12

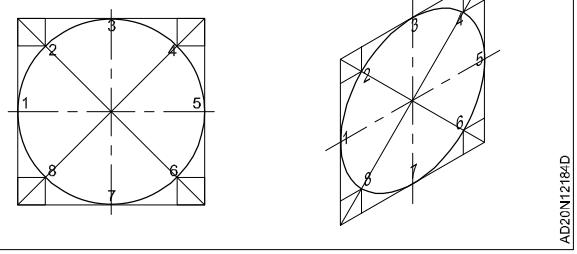


An isometric circle can be drawn either be plotting/offset method or by arc method.

Plotting method (Fig 13)

– Draw a square of side equal to the dia of circle and inscribe the circle.

Fig 13



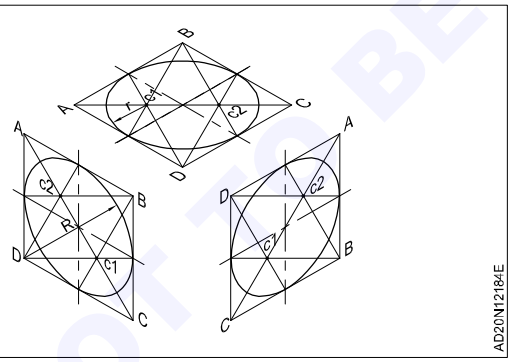
– Divide the circle into any number of equal parts and mark points such as 1,2,3,4,5,6,7,8 on the circle.
– Through the points 1,2,3 etc draw lines parallel to the both the axis of cylinder.
– Draw isometric view of the square.
– Mark points corresponding to 1,2,3....8 with isometric view of the square as points 1',2',3'....8'.
– Join these points with a smooth curve to for an ellipse.

Note: The orientation of the isometric circle will depend upon the plane on which the circular feature exists.

Arc method: Isometric circles drawn by offset method is the ideal method of making isometric circles as the ellipse obtained this way is geometrically true. But by free hand we cannot get a clear line.

Fig 14 shows the construction of isometric circle in 3 different orientation by arc method. Four arcs are to be drawn and the centers an C_1, C_2, B & D. While center B and D are the corner of the rhombus C_1 and C_2 are intersection points of the longer diagonal with lines from points B or D to the mid-point of the side of the rhombus.

Fig 14



Note: The arc method gives a clean ellipse, but this ellipse drawn this way will slightly deviate from true ellipse. It does not matter for our purpose.

The isometric circles can also be drawn using templates which can be bought from stationary shops.

Isometric views profiles: The profile MN of the block shown in Fig 15 is irregular in nature. The isometric views of such lines may be drawn by offset method described earlier. The points 1,2,3 and 4 lie on the profile. Lines A-1, B-2, C-3, D-4 are isometric lines and their length are same both in Figs 15 & 16. After getting the points 1,2,3 & 4, they joined by smooth curve.

Fig 15

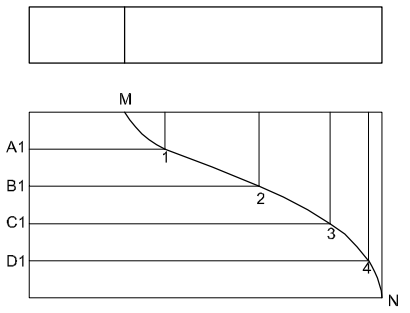
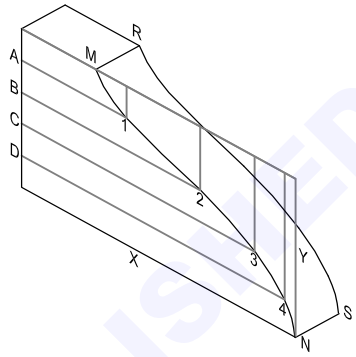


Fig 16



Note: In offset method more the number of points, better will be the accuracy of the curve.

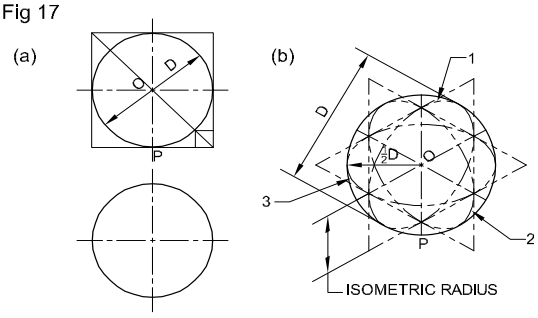
Isometric projection of sphere: The Orthographic view of a sphere seen from any direction is a circle of diameter equal to the diameter of the sphere. Hence, the isometric projection of a sphere is also a circle of the same diameter.

The front view and the top view of a sphere resting on flat surface are shown in Fig 17a.

O as its center, D is the diameter and P is the point of contact with the surface.

Assume a vertical section the center of the sphere. Its shape will be a circle of diameter D. The isometric projection of this circle are ellipses 1 & 2 Fig 17(b) drawn in two different vertical positions around the same center O. The major axis in each case is equal to D. The distance of the point P from the center O is equal to the isometric radius of the sphere.

Fig 17



Again, assume a horizontal section through the center of the sphere.

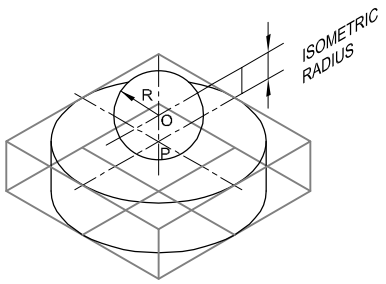
The isometric projection of this circle is shown by the ellipse 3, drawn in a horizontal position around the same center O. In all the three cases 1,2 & 3 the outermost points on the ellipse from the center O is equal to 1/2 D.

Thus, it can be seen that in an isometric projection, the distances of all the points on the surface of a sphere from its center are equal to the radius of the sphere. Hence, the isometric projection of a sphere is a circle whose diameter is equal to the true diameter of the sphere.

Also the distance of the center of the sphere from its point of contact with the flat surface is equal to the isometric radius OP of the sphere.

It is therefore of the utmost importance to note that isometric scale must invariably be used while drawing isometric projection of solids in conjunction with spheres or having spherical parts. (Fig 18)

Fig 18



Sequence of construction of a building

Objectives: At the end of this lesson you shall be able to
- **identify the parts of a building**
- **list the sequence of construction**
- **explain the levels of different parts of building**
- **draw and indicate the parts.**

Introduction A Building consist of sub-structure and superstructure. Foundation, Plinth, walls, floors and roofs are the main structural components of the building. Each of these components is an essential part of a building and requires due consideration in design and construction for their functional performance.

Parts of a building The sectional view of a building shows all constructional details from the foundation level to the top of roof such as total height and different levels i.e. depth of foundation, plinth level ground floor level, thickness of wall, window sill level, floor to ceiling height, window / door height, chajja level, roof top level, parapet level and coping.

The sequence is listed form foundation

1 Foundation

2 Plinth

3 Plinth course

4 Sill

5 Door & window

6 Lintel

7 Floors

8 Roof

9 Parapet

10 Coping

1 Foundation

It is the lowest artificially prepared part, below the surface of the surrounding ground, which is in direct contact with sub-starter and transmits, all the loads to the sub-soil.

2 Plinth

It is the middle of the structure, above the surface of the surrounding ground up to the surface of the floor, immediately above the ground.

3 Plinth course

It is top most course at plinth level which is finished flush with the surface of ground floor.

4 Sill

It is the horizontal member comprising concrete, stone or wood to give support to the vertical members of wooden window. It helps in shedding rain water from face to wall.

5 Door & window

Door is a frame work of wood, steel, glass. The purpose of door to give access to the users of the structure and free movement into and outside the structure. The door provides a good ventilation. Windows are constructed for providing light and ventilation in the building.

6 Lintel

A horizontal member of stone, wood, brick, steel, rein forced brick, R.C.C etc above the opening to support the masonry or load above, it is called lintel.

7 Floors

Floors are horizontal elements of a building structure which divide the building into different levels for the purpose of creating more accommodation.

8 Roof

A root is the uppermost part of a building which is supported on structural members and covered with a roofing material. The main function of a roof is to enclose the building and to protect the same from the damaging effects of weather such as rain, wind, snow etc.

9 Parapet

It is the wall built around a flat roof which acts as a protective wall for the users of the terrace. In case of pitched roof, the parapet wall is used to conceal to gutter at eaves level.

10 Coping

The coping is covering of bricks or stones which is placed on the exposed top of on external wall to prevent seepage of water through joints of top most course in a wall.

Parts of a building (Fig 1)

Buildings: Building is not only a "SHELTER" but:

1 Energy saving

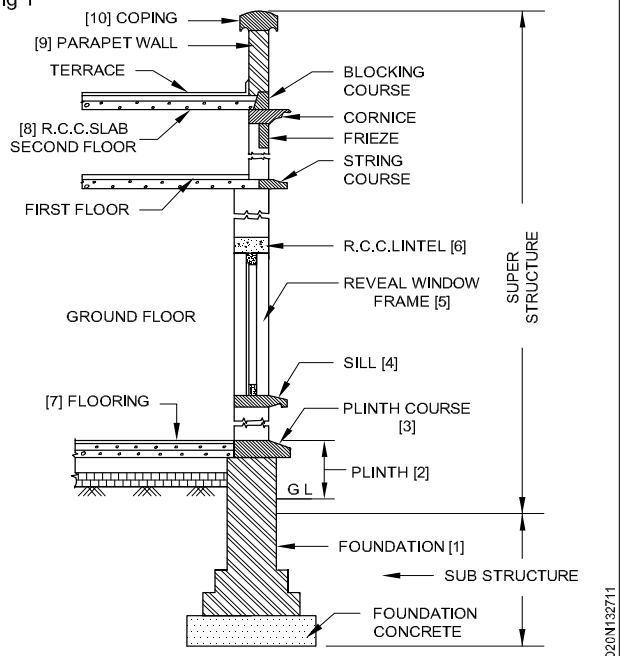
2 Efficiency improving

3 Environment friendly

4 Users friendly

5 Building can be defined as the three dimensional shape or form in the space, resting on the earth, secured to the earth by foundation for stability.

Fig 1



Different stages in the life of building

Planning: Decides the initial form

Designing: Decides the final form

Drawing: Tool to convert requirements into reality.

Construction: Conversion of two dimensional drawing into three dimensional structure. It is engineering in action, hence needs Construction Management.

Occupation: Environment Design Evaluation is essential after occupation to assess achievements in Planning, Designing and Construction by observing behavior of user and by obtaining user's views.

Maintenance and preservation: Preparation of maintenance programmer to maintain livability throughout the life of the building by observing effect of Sun, Rain, Wind, and Human Behavior on building materials and construction.

Brick Masonry

Objectives: At the end of this lesson you shall be able to
- **explain load bearing, non-load bearing and retaining walls**
- **state the technical terms used in masonry**
- **explain the general principles in brick masonry**
- **explain scaffolding**
- **explain hollow clay block masonry.**

Introduction of masonry

The term masonry is used to indicate the art of building the structures either in stone or brick or combination of materials such as stones, bricks, tiles, concrete block etc. Even though new principles of construction and new materials are adopted in the construction process, masonry has got highest importance in the building industry. Masonry is normally used for the construction of foundation, walls, pillars and other structural components of buildings.

Masonry

Masonry is the art of binding building blocks (stone, brick, or other building blocks) with binding material or an assembling of masonry units properly bonded together with mortar.

Materials required for a masonry

Masonry units: Masonry units shall confirm to accepted standards. Masonry units may be of the following types.

a Common burnt clay bricks

b Stones (in regular sized units)

c Sand lime bricks and

d Concrete blocks

Mortar

Where specified for normal masonry and in all cases for load bearing masonry walls, mortar shall be sampled and tested for flow and water retention.

Classification of masonry

The masonry is generally classified as follows.

1 Stone masonry

2 Brick masonry

3 Hollow block concrete masonry

4 Reinforced masonry and

5 Composite masonry

General

Masonry may be defined as the construction of building units bounded together with mortar. Masonry is basically a wall material. Masonry walls can be divided into following three categories.

Load bearing walls

Non load bearing walls

Retaining walls

Load bearing wall

A wall designed to carry superimposed loads from floors is termed as load bearing walls. Such walls have continuous foundation to carry the entire super imposed load including their self-weight.

Non load bearing wall

Also known as panel wall to carry or curtain wall or filler wall is a type of wall which carries no superimposed load.

It is provided to serve as screen for privacy and to keep out wind and weather.

Retaining wall

This is a type of wall built to resist the pressure of earth, granular material or liquid filled behind it after it is built.

Technical terms used in masonry

The terms which are in common use in masonry have been defined below:

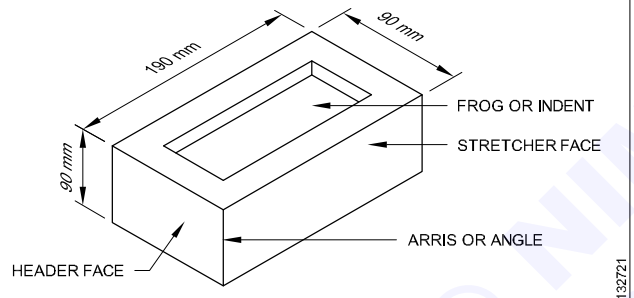
Header: It is a full brick or stone which is laid with its length perpendicular to the face of the wall (Fig 1)

Stretcher: It is a full brick or stone which is laid with its length parallel to the face of wall (Fig 1)

Face: The surface of wall exposed to weather is termed as face (Fig 1)

Frog or indent: It is a depression on the top face of a brick. Frog provides a recess for the mortar which on setting forms a key and prevents the displacement of the brick above (Fig 1)

Fig 1



STANDARD SIZE OF BRICK (WITHOUT MORTAR)

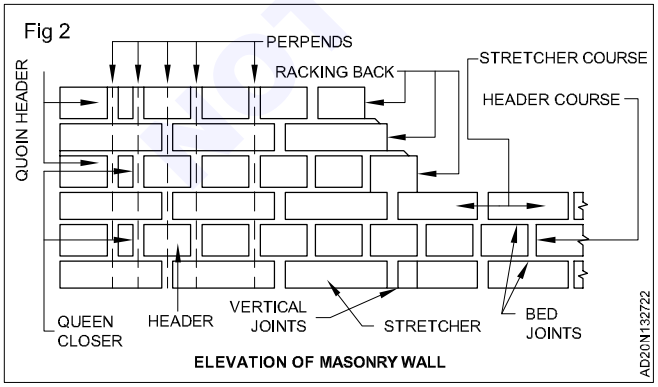
Course: A horizontal layer of bricks or stones is termed as a course

Header course: It is a course of brickwork entirely composed of headers (Fig 2)

Stretcher Course: It is a course of brickwork in which all the bricks are laid as stretchers (Fig 2)

Bed: It is the lower surface of brick or stone in each course (Fig 2)

Fig 2



ELEVATION OF MASONRY WALL

Back: The inner surface of wall which is not exposed to weather is termed as back

Joint: The junction of two or more bricks is called joint (Fig 2)

Racking back: The process of stopping the unfinished end of a wall in stepped fachion (Fig 2)

Perpend: It is a vertical joint on the face of wall directly over vertical joint in alternate course (Fig 2)

Quoin: The exterior angle or corner of wall is termed as quoin (Fig 2)

Bat: It is the portion of the brick cut across the width (Fig 3)

Closer: It is the portion of brick cut in such a manner that its one long face remains uncut (Fig 3)

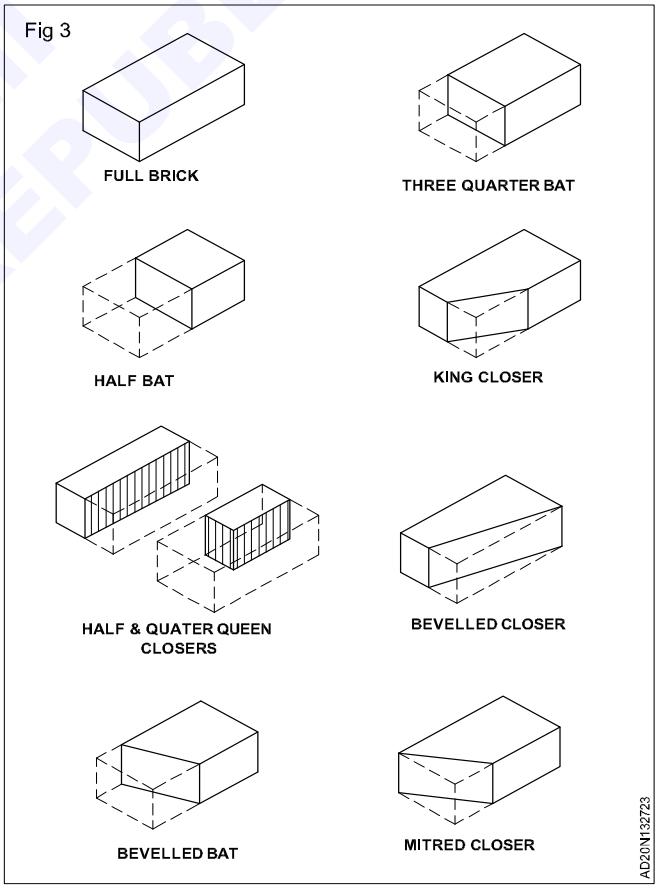
King Closer: It is formed by cutting off the triangular piece, between the center of one end and the center of on end (Fig 3)

Queen closer: It is the portion of a brick obtained by cutting a brick length - wise into two equal portions (Fig 3)

Bevelled closer: It is the special form of king closer in which the whole length of the brick is bevelled is such a way that half width is maintained at one end and full width is obtained at the other end (Fig 3)

Mitred closer: It is a brick whose one end is cut splayed or mitred for full width (Fig 3)

Fig 3



Toothing: Bricks left projecting in alternate courses for the purposes of bonding future masonry work

Through stone: A stone passing through a wall from front to back face and acting as a binder for the two face of the wall is termed as through stone (Fig 4)

Types of bricks

Bricks can be divided into two types

- Traditional bricks 230 x 115 x 75mm
- Modular bricks 200 x 100 x 100mm
- Brick tiles 190 X 90 X 40mm.

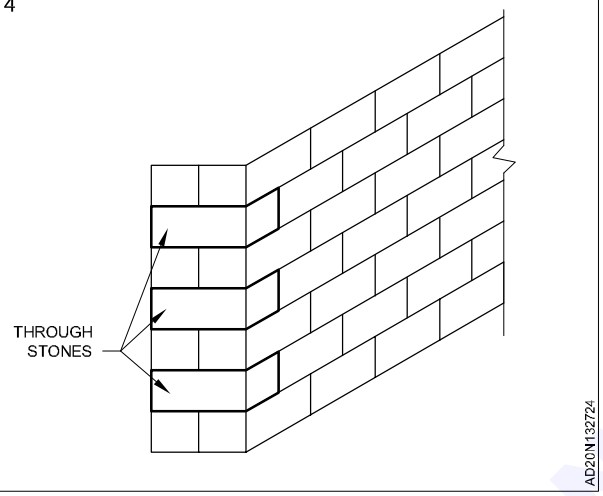
General principles in brick masonry

1 The bricks in a good work should be sound, hard and well burnt with uniform size, shaped and colour

2 The length of the brick should be twice its width plus one joint, so that uniform lap is obtained. Good bond is not possible if lap is non uniform.

3 The amount of lap should be minimum 1/4 brick along length of the wall and 1/2 brick across the thickness of the wall

Fig 4



4 Use of brick bats should be discouraged, except in special locations

5 The vertical joints in the alternate courses should be along the same perpend

6 All the finished masonry should be kept wet for at least seven days

Scaffolding

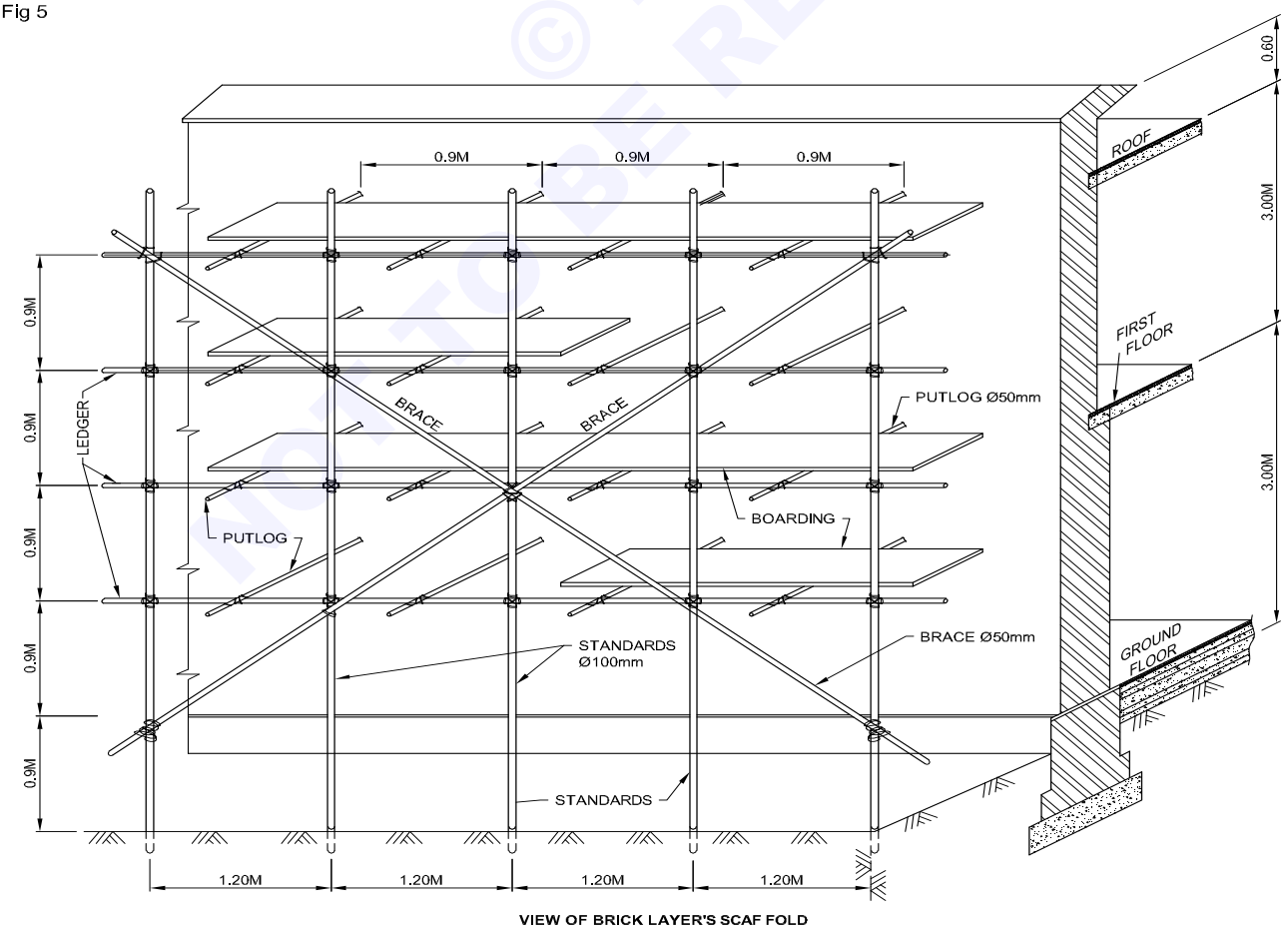
Scaffolding is a temporary rigid structure having platforms raised up as the building increases in height. Scaffolding enables the mason to work at different stages of a building and to hoist the materials for the immediate use at various heights (Fig 5)

1 **Brick - layer's scaffold :** They are provided on the building side of the standards and are secured in position by rope lashings. They are provided to support the working platform.

2 **Mason's scaffold :** They are supposed to carry the loads of heavy blocks of stones and the stresses produced on account of the lifting device and hence they are made stronger by placing the standards at fairly close distance apart.

3 **Steel or Tubular Scaffold -** Tubular scaffold has several advantages over the timber scaffolding such as rapid erection and dismantling, greater strength and durability and higher fire resisting value, it proves to be economical in the long run and hence it is being extensively used these days.

Fig 5



VIEW OF BRICK LAYER'S SCAF FOLD

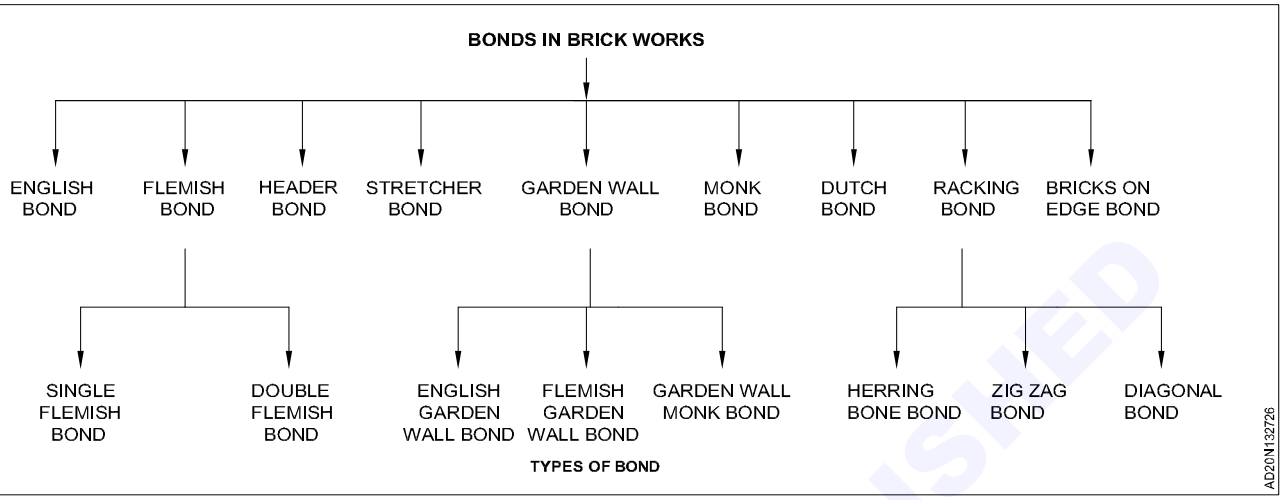
4 **Needle Scaffold :** When scaffolding is to be provided for a building on the side of a busy street where the construction of ordinary scaffolding will obstruct the traffic on road, needle scaffold is used.

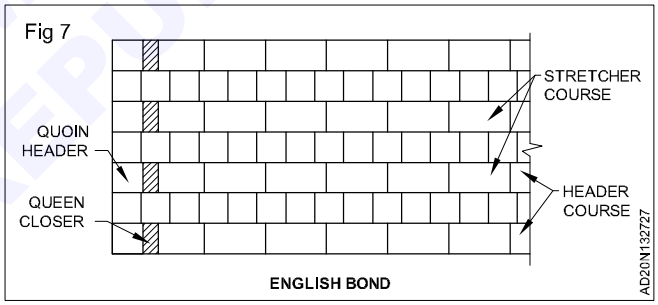
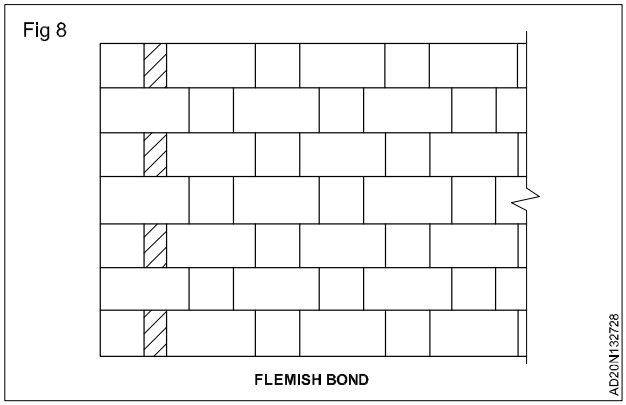
5 **Wooden Scaffold** is also known as gantries. This is needed for providing a working platform above ground level and leaving the space below free from obstruction.

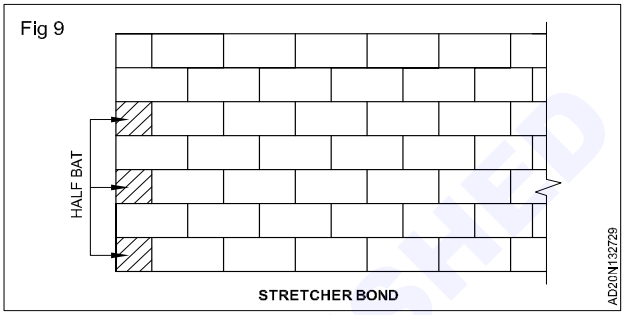
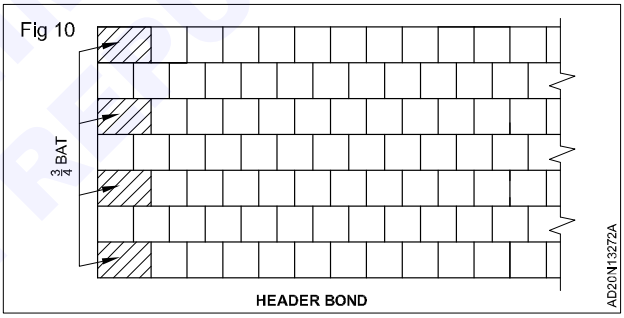
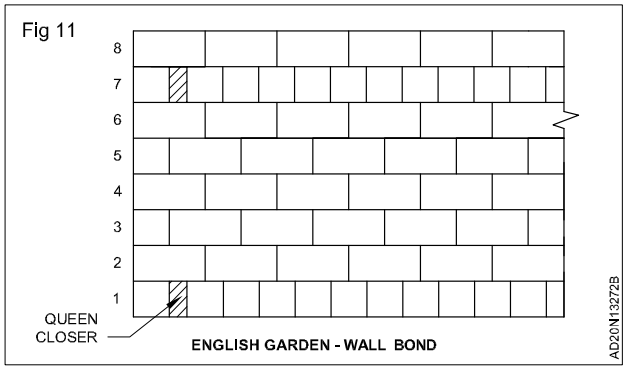
Types of Bond (Fig 6)

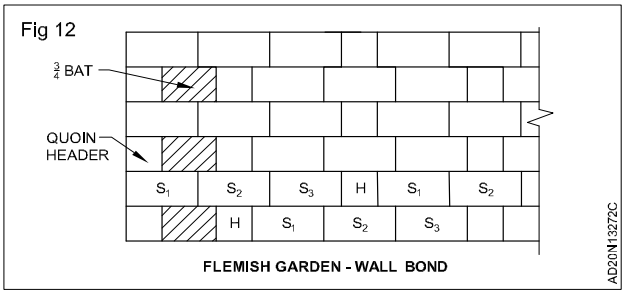
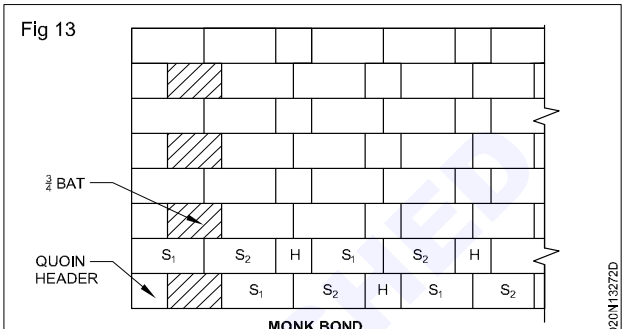
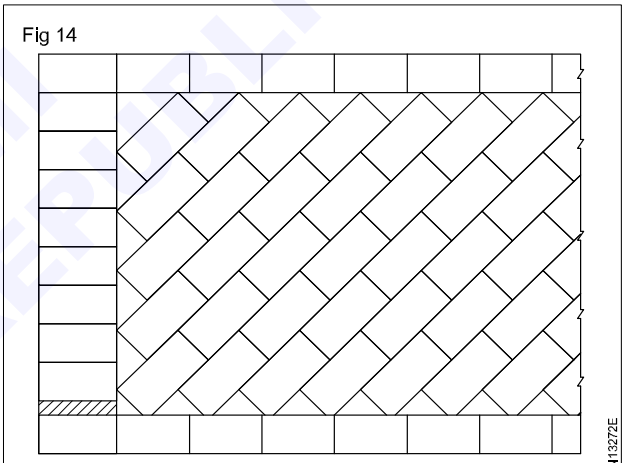
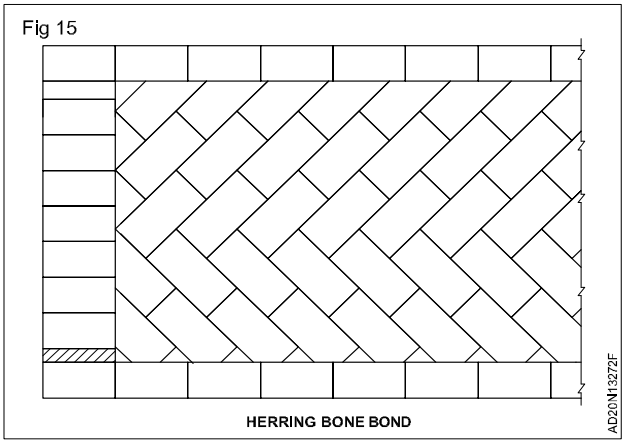
Bonds in brick works

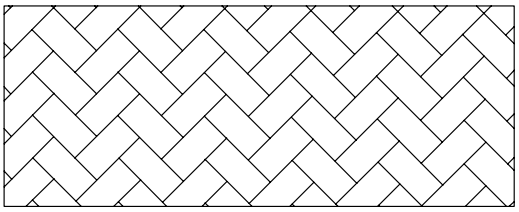
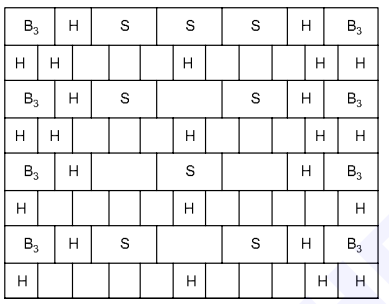
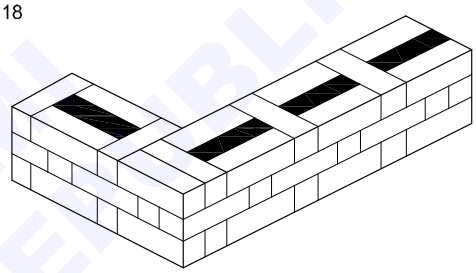
Fig 6



Name of bond	Features and uses	Figure
English bond	The headers and stretchers are arranged in alternate courses (Fig 7). Queen closer put next to the quoin header to get lap. Each alternate headers centrally supported on stretchers. Continuous vertical joints are not formed except at stopped ends. Header course should never start with a queen closer. Queen closers are not required in stretcher course. Minimum lap should be ¼ th brick. 1,2,3...thick wall same look on both faces Multiple of half thick wall not in same look in facing and backing.	Fig 7  **uses :** 1 Stronger bond than other types, thus it is used widely for walls carrying heavy loads 2 Easy to construct 3 Less supervision required 4 Less mortar required
Flemish bond	Headers and stretchers are placed alternatively in each course. (Fig 8) A queen closer is put next to the quoin header. Every header is centrally supported over a stretcher below it. Required more skill to built Brickbats are to be used in the odd multiple of half brick.	Fig 8 

a) Single flemish bond b) Double flemish bond	a) The facing elevation is Flemish bond but backing and hearting are of English bond b) The headers and stretchers are placed alternatively in facing as well as backing. Uses:- 1. Economical as move brick bats are used 2. Having pleasing appearance.	
Stretcher bond	1. All the bricks are arranged in stretcher course. (Fig 9) 2. It does not develop proper internal bond 3 overlap is usually half brick, is obtained by commencing each alternate course with half brick bat **Uses :** 1 used for half brick walls (no header is used) 2 used for cavity walls, partition walls	Fig 9 
Header bond	1. All the bricks are arranged in header course. (Fig 10) 2. Overlap is kept equal to half brick width achieved by using ¾ bats. Uses : 1 For circular wall 2 For circular manhole 3 used for brickwork in foundation	Fig 10 
English Garden wall bond	1. One header course is provide to three to five stretcher course. 2.Quoin headers are placed in alternate bond course and queen closer is placed next to the quoin header in header course to develop lap 3. The wall is one brick wall thick and the bond height is 2m (Fig 11). Uses:-The bond is used for Garden walls and compound wall. Faster construction of non-load bearing wall 1 and 7 is header course 2 to 6 is stretcher course	Fig 11 

b) Flemish garden wall bond	1. Each course contains one header to three or five stretcher (Fig 12) 2. A ¾ th bat is placed next to the quoin header. 3. A header is placed centrally over each middle stretcher.	Fig 12  FLEMISH GARDEN - WALL BOND
c) Monk bond	1. Each course contains one header to two stretchers (Fig 13) 2. The header rest on the joint between two headers. 3. A 3/4th bat is placed next to the quoin header.	Fig 13  MONK BOND
6. Raking bond a) Diagonal bond	1. Courses are inclined 2. Inclination should be in opposite direction in alternate courses. 3. Brick are laid at 45° Bricks are laid longitudinally, Useful for 2-4 brick thick.(Fig 14)	Fig 14  PLAN SHOWING ARRANGEMENT OF BRICK IN DIAGONAL BOND
b) Herring bone bond	Brick are laid at 45° from the center in both the direction, Useful for ornamental finish.(Fig 15). It is called 'Herring bone' due to its visual similarity to the bone structure of herring fish.	Fig 15  HERRING BONE BOND

c) Zig-zag bond	Bricks are laid at 45° in zig-zag fashion and used for flooring (Fig 16)	Fig 16  ZIG - ZAG BOND AD20N13272G
Dutch bond	1. Alternate courses of headers and stretchers. (Fig 17) 2. The quoin of stretcher course is ¾ bat. 3. The alternate headers of each course one centered on the stretcher of course below. Uses:- Corner of wall can be strengthened.	Fig 17  H = HEADER S = STRETCHER B_3 = ¾ BRICK BAT DUTCH BOND AD20N13272H
Rat trap bond	1. Locally made bricks having thick ness less than 10cm are used. (Fig 18) 2. all the bricks are laid on edge. 3. Alternate headers and stretchers are used in same course. 4. A cavity is formed inside the course. 5. It is strong ,sound and heat proof.	Fig 18  RAT TRAP BOND AD20N13272I

Comparison of English bond with Flemish bond

Features	English Bond	Flemish Bond
Arrangement of brick	a. Headers and stretchers are laid in alternate courses b. Each alternate header is centrally supported over a stretcher	a. Headers and stretchers are laid alternatively in each course. b. Every header is centrally supported over a stretcher below it.
Strength	Strongest type of bond	Weakest bond for all walls
Appearance	Provides rough appearance	Provides good appearance
Skill	Requires less skill	Requires more skill
Material cost	Costly, brick bats are not used	Economical, as brick bats are used.
Mortar	More mortar required	More mortar required for additional joints.

Hollow brick masonry

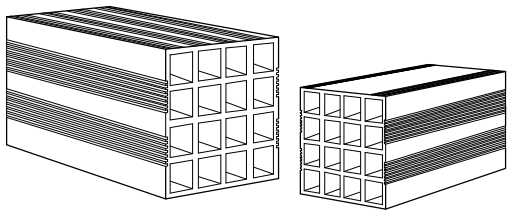
Objectives: At the end of this lesson you shall be able to
- **understanding hallow brick masonry, AAC block, fly ash brick and brick laying.**

Hollow brick masonry (Fig 1)

Hollow bricks are horizontally perforated bricks having hollow spaces or holes through them which total at least 25%-60% of their bed area. The hollow spaces may be cores, cells, deep frogs, or combinations of these. These bricks are mostly suitable for the construction of partition

walls. However, by some advanced manufacturing process some types of hollow bricks can be used in load-bearing structures up to G+3 buildings. (Ex: Porotherm Smart Bricks)

Fig 1



HOLLOW BRICK

AD20N132731

Hollow bricks enable faster construction due to their larger size and lightweight, they can be easily handled on the site, These bricks absorb very less water hence are environment friendly Hollow bricks also known as hollow concrete blocks, are building material used in construction they are made of concrete and other cementitious material.

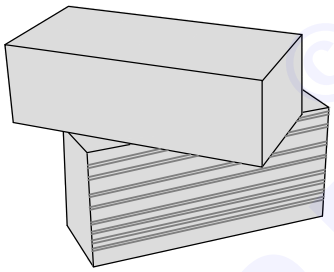
The most common sizes are given below (Length x Width x Height):

- 400 mm x 200 mm x 200 mm
- 400 mm x 150 mm x 200 mm
- 400 mm x 100 mm x 200 mm

However, the size defers from manufacturer to manufacturer.

AAC BLOCKS (Fig 2)

Fig 2



AD20N132732

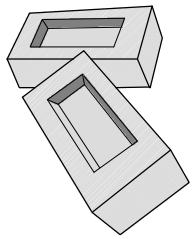
Autoclaved Aerated Concrete (AAC) is a lightweight, precast, cellular concrete, eco-friendly building material, suitable for producing concrete masonry unit like blocks. It is composed of quartz sand, calcined gypsum, lime, portland cement, water and aluminum powder. AAC blocks are available in different sizes, which include: 600mm x 200mm x 50 mm. 600mm x 200mm x 75 mm. 600mm x 200mm x 100 mm

- They are Thermally Insulated & Energy Efficient and enable Faster Construction in therefore it is adopted in many high rise building constructions.

Fly ash bricks (Fig 3)

Fly ash brick is a building material, specifically masonry units, containing class C or class F fly ash and water. Fly ash bricks reduce the dead load on structures due to their light weight. Fly ash provides high fire resistance.

Fig 3



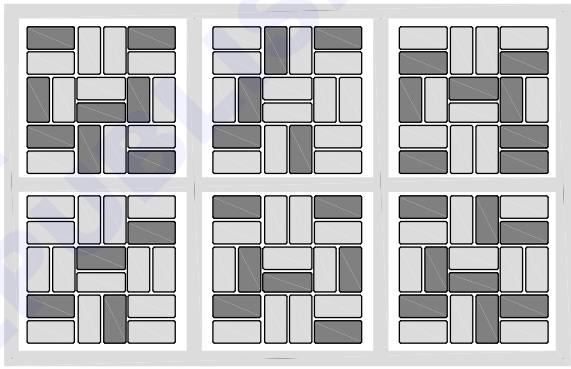
AD20N132733

Fly ash or coal combustion residuals - is a coal combustion product that is composed of the particulates that are driven out of coal-fired boilers together with the flue gases from power plants.

Due to their high strength, there is very little breakage during transport and use. Due to their uniform size, mortar required for joints and plaster reduces almost by 50%.

Brick laying (Fig 4)

Fig 4



AD20N132734

The first brick should be laid at one end and tapped slightly to 'bed in'. The next brick should be 'buttered up' with mortar spread onto each end before being placed to abut the first brick. The trowel should be used to cut away excess mortar that is squeezed out from underneath or in between the bricks.

The bricks should be laid around 10mm apart to allow space for your mortar. This will determine the number of bricks per course.

The herringbone pattern has a mesmerizing look but could not be simpler. The bricks are merely laid at 90 degree angles to one another in zig zag pattern. This pattern requires no cuts in the field area. But if you want straight edges you have to cut every outer brick at a 45 degree angle.

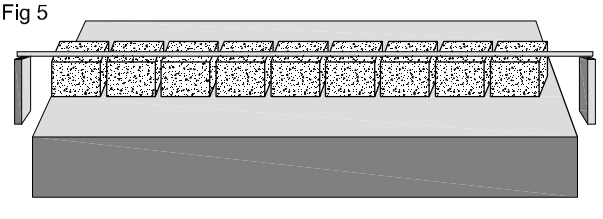
Setting out

Setting out a building is the process of transferring design proposals from drawings onto the ground.

Assuming that the brick work is being built on a levelled concrete footing, layout a course of bricks, without mortar, along the foundation. The bricks should be laid around 10mm apart to allow space for your mortar. This will be determine the number of bricks per course.

Having done this set a tall stake at each of the end of the wall and then run a string line between the two stakes to give you the exact line of the wall face. Take your time as this process will determine the straightness of the wall. (Fig 5)

Fig 5



For this purpose, the inside faces of each brick are buttered with mortar before the next brick is laid and pressed against it by tapping it with the handle of the trowel or wooden mallet. On completion of a course, the vertical joints are fully filled with mortar from the top. Finally, we press the side bulging mortar in firmly to be level with the face of the wall if it is to be left unplastered.

The walls are raised truly plumb. All courses are laid truly horizontal and all vertical joints truly vertical. Vertical joints in alternate courses should come directly, one over the other. The thickness of the brick course is to be kept uniform.

Grouting

When brickwork is set with a fine joint, it is usual to fill the interior joints with a thin liquid mortar. This process is called grouting.

i At the end of the day's work, the top of the brickwork shall be thoroughly cleaned of all mortar and the frogs, if laid up, are kept exposed to their full depth so as to provide proper keying for the next course. The face of the brickwork shall also be cleaned of all mortar droppings, etc.

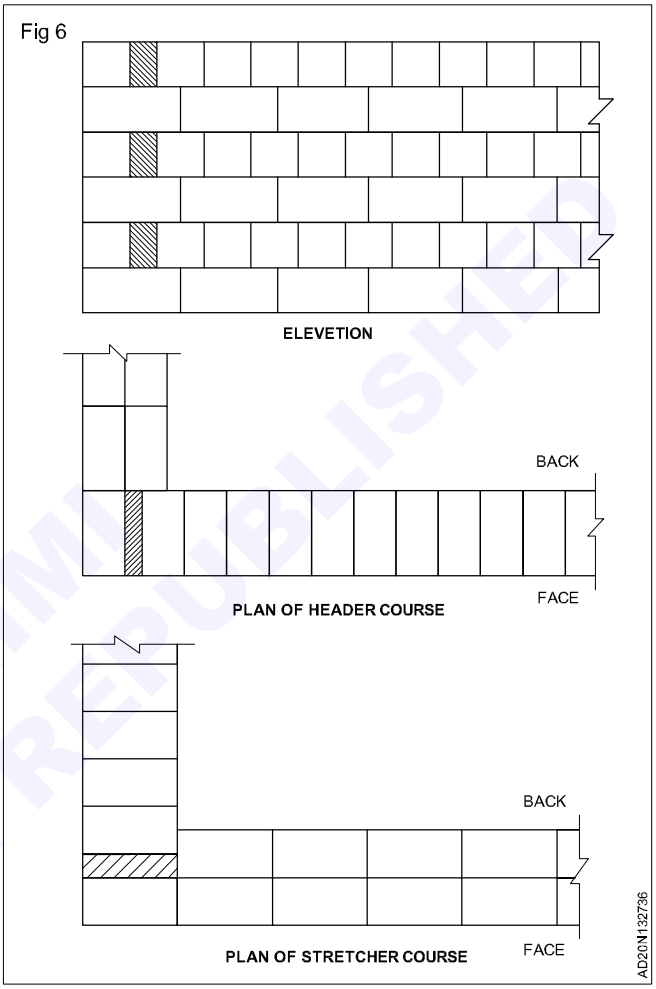
ii When circumstances render it necessary to carry on a portion of a building in uneven courses, the work shall be built back (according to the bond used on the work) at an angle not steeper than 45 degrees so as to ensure a uniform and effective bonding. It should not be left toothed.

iii If facework is to be left unplastered, every joint should be neatly struck at the close of the day's work and before the mortar has completely set to give a good appearance. Otherwise, for faces to be plastered, finishing of the face joints should be carried out as discussed in below (This is very important.)

iv The walls should be uniformly raised all around not leaving any part one meter (three feet) lower than the other. A day's work should not be more than 1.5 m high. (Fig 6)

v All iron fixtures such as holdfasts, pins, etc., to be built in the wall should be embedded in cement mortar or cement concrete in their correct positions preferably during the progress of the work itself or arrangements should be made to fix it without breaking the wall.

Fig 6



Stone Masonry

Objectives: At the end of this lesson you shall be able to
- **define stone masonry**
- **state the general principles of construction of stone masonry**
- **describe the types of rubble and ashlar masonry.**

Introduction: In ancient times most of the building construction was done in stone masonry. Stones are available in large quantity but not in all parts of India. Stones are used for the construction of walls ,pillars, lintels, arches footings etc.' of the building. Most common types of stones available in India for stone masonry are granite, sand stone, limestone, marbles, slates etc., Usually lime and cement mortar are used in the stone masonry.

Definition: The art of building the structures with stone is called stone masonry.

General principles of construction of stone masonry

- Stones shall be hard, tough, compact and durable.
- Stone should be laid on their natural bed.
- Proper bond should be maintained.
- Masonry should be raised uniformly otherwise too things or recesses or steps should be provided.
- The hearting of masonry should be properly filled with stones and spalls or snicks with mortar.
- Vertical faces should be checked with plumb rule.
- The masonry should not be subjected to tensile stress.
- When construction is to be done over old surface it should be well cleaned and wetted before starting the work.
- The stones should be wetted before used to avoid absorption of water from mortar.
- The exposed joints should be pointed.
- The entire masonry should cure for two weeks.
- Through stones should be used at every 1.5m height.

Materials required for stone masonry

1 Stone

2 Mortar

1 Stone: Stones should be hard, durable, tough and free from any defect. **Eg** : Basalt, Granite, Laterite, Marble, Quartzite Sandstone, Slate.

2 Mortar: Mortar is used to keep the stones in position. Selection of mortar depends on strength required load coming and resistance desired for weathering agencies. **Eg**: Lime mortar, Cement mortar, Lime cement mortar, Cement lime mortar.

Rubble Masonry: In the rubble masonry the blocks of stones used are either undressed or rough dressed. The strength obtained from

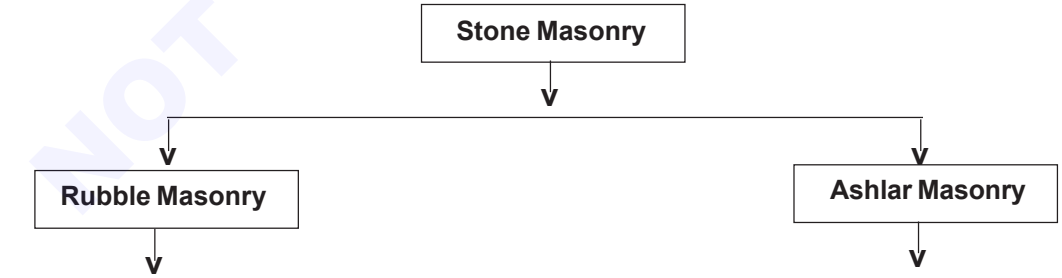
1 Quality of mortar

2 Using of through stone in certain intervals

3 Filling up mortar thoroughly between the facing.

Ashlar Masonry: In ashlar masonry regular stones of square or rectangular shape with accurate bed joints are used.

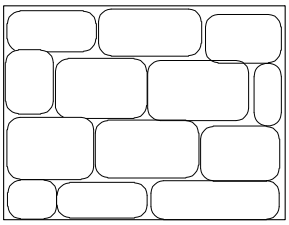
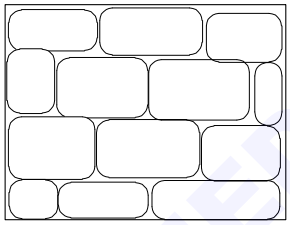
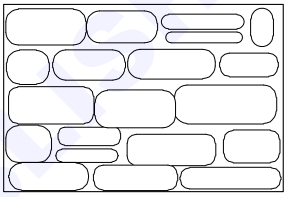
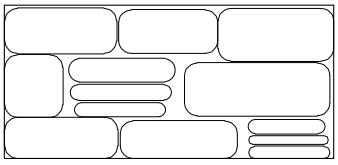
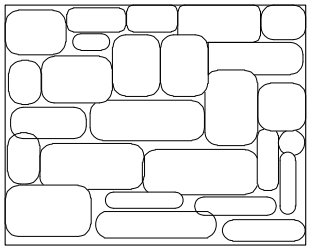
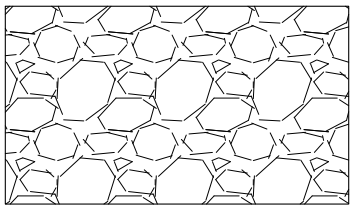
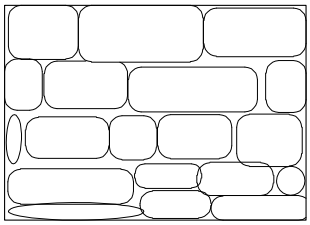
CLASSIFICATION OF STONE MASONRY

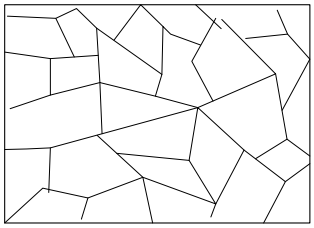
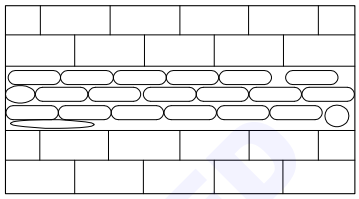


1 Coursed Rubble
2 Uncoursed Rubble
3 Random Rubble
4 Dry Rubble
5 Polygonal Rubble
6 Flint Rubble Course

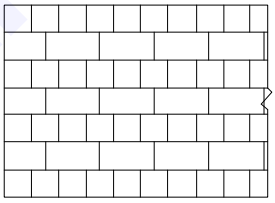
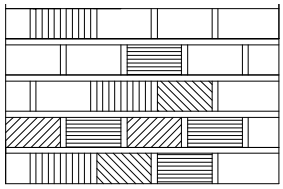
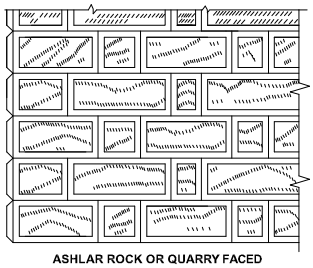
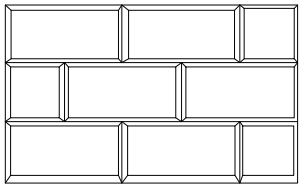
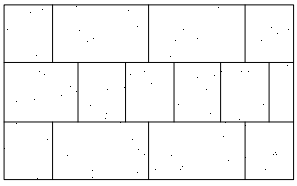
1 Ashlar Fine
2 Ashlar Rough Tooled
3 Ashlar Rock or Quarry Faced
4 Ashlar Chamfered
5 Ashlar Block in course masonry

RUBBLE MASONRY

Sl No	Name of masonry	Description	Figure
1	Coursed rubble masonry	Heights of stones vary from 50mm to 200mm. Stones in particular course are of equal heights. Used for public buildings, residential buildings etc.,	
1a	Coursed rubble (1st sort)	Face stones are hammer dressed, bushings do not project more than 40mm, mortar joint does not exceed 10mm.	
1b	Coursed rubble (2nd sort)	Stones are of different heights, two stones are to be used to make up the height of one course mortar joint 12mm.	
1c	Coursed rubble (3rd sort)	Minimum height 50mm,only three stones are to be used to make up the height of one course, mortar joint is 16mm.	
2	Un coursed rubble masonry	Stones are used as they are available from the quarry, course is not regularly, and the thickness of mortar joint is 12mm. This masonry is used in compound wall, go downs, garages etc.,	
3	Random rubble masonry	The stones are irregular size and shape but arranged so as to have good appearance, so more skill is required. Mortar joint does not exceed 6mm. Used for residential building, compound wall etc.,	
4	Dry rubble masonry	Similar in construction to the coursed rubble masonry3rd sort except that no mortar is used. It require more skill in construction Used for compound wall ,pitching on bridge approaches ,retaining wall etc.	

Sl.No	Name of masonry	Description	Figure
5	Polygonal Rubble Masonry	Stones are hammer dressed. Stones are selected for face work are dressed in a irregular polygonal shape. More skill required for the construction. Used for face work.	
6	Flint Rubble Masonry	Stones used are flint which is irregularly shaped nodules of silica. Face arrangements may be coursed or uncoursed. Strength is increased by introducing lacing course. Used at place where flints are available readily	

Ashlar Masonry

Sl.No	Name of masonry	Description	Figure
1	Ashlar Fine	The beds, sides ,and faces are finely chisel dressed. The stones are arranged in proper bond. Thickness of mortar joints does not exceed 3mm.It gives smooth appearance ,but it is very costly. Used for superior work.	 ASHLAR FINE
2	Ashlar rough tooled (Bastard ashlar)	Beds and sides are finely chisel dressed. Faces made rough. Thickness of mortar joints does not exceed 6mm. A strip is provided around the perimeter. Used only for exposed surface.	 ASHLAR ROUGH TOOLED
3	Ashlar rock or quarry faced	All the faces and sides except exposed face is left as received from quarry. Only bushings are removed. A strip is provided around the perimeter.	 ASHLAR ROCK OR QUARRY FACED
4	Ashlar chamfered	A strip is provided 25mm wide, it is chamfered or beveled at an angle of 45° using chisel. Another strip 12mm wide remaining exposed face of the stone. Remaining part just like received from quarry. It gives neat appearance.	
5	Ashlar block in course masonry	It occupies a position between the rubble masonry and ashlar masonry. Faces are hammer dressed. Thickness mortar joint does not exceed 6mm. It is used for retaining walls, sea walls, railway stations, temples bridges etc.,	

Composite masonry

Objectives: At the end of this lesson you shall be able to,
- **explain composite masonry**
- **list out the measures adopted for composite masonry**
- **explain usual combinations to obtain composite masonry.**

Introduction: When facing and backing of walls are constructed using different types of materials, the construction so obtained is known as composite masonry. The composite masonry reduces the overall cost of construction. This also makes the structure more durable by providing materials of better quality and good workmanship in the facing so as to minimize the effects of atmospheric influences on the wall.

Measures adopted for composite masonry: This type of construction results in a large number of mortar joints in the inside than at the outside of the wall. This may lead to unequal settlement. The following measures must be adopted to prevent the unequal settlement.

1 Use large number of tough stones.

2 Provide metal cramps, dowels, lead plugs, etc, between facing and backing of the wall.

3 Provide the hearting portions in rich cement mortar.

4 Carry up the facing and backing portions of the wall simultaneously

The usual combinations adopted to obtain composite masonry can be listed as below (Fig 1): Facing of ashlars and backing of rubble masonry or brickwork figure.

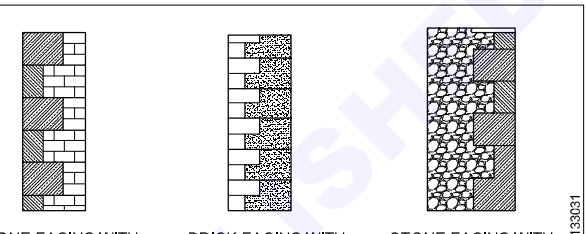
1 Facing of stone slabs and backing of concrete.

2 Facing of brickwork and backing of ashlar masonry.

3 Facing of brickwork and backing of concrete, and

4 Facing of brickwork and backing of hollow concrete blocks.

Fig 1



Tile masonry

Objectives: At the end of this lesson you shall be able to,
- **explain preparation of tile masonry**
- **describe tile masonry for floor setting-out, measurement and finishing**
- **describe tile masonry for walls, setting-out, measurement and finishing.**

Introduction

Tile masonry is a skilled work that involves cutting, grinding, shaping, laying, fixing, and finishing tiles on floors and walls. Tiles are usually thin, square or rectangle covering material made from ceramic, natural stones, clay etc. They are generally fixed in place in an array to cover surface of walls, floors and roofs also.

Preparation:

- Cleaning of complete wall and concrete floor, Repair any cracks and holes
- Remove the old wallpaper, paintings, nails and other fittings
- Soak the tile in water before starting the work
- Level the surface, fill any low spots
- Plan the layout put markings of the correct tile layout
- make sure the plan is aligned with the markings on wall/floor surface
- provide temporary but rigid lumber for guide reference to check the plumb and alignment
- do not begin the tilework until all concealed conduits have been fixed securely
- ensure that waterproofing for wet areas, anti termite treatments are already done including leak test
- discard any tiles that chipped, bent or cracked
- make sure all the required tools for marking, cutting and levelling are available.

Tile masonry for floor:

Flooring is the horizontal surface of a building which supports the occupants and the activities they pursue in the building. Tile flooring has many benefits, including:

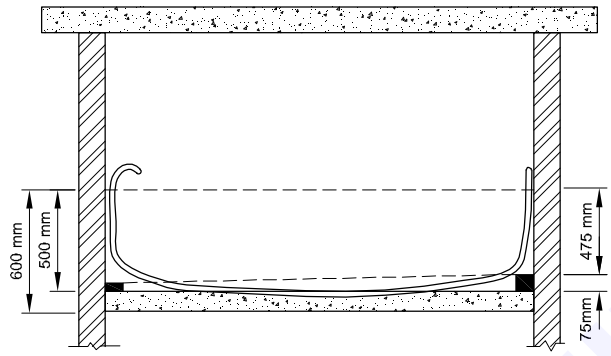
- Water resistant: ideal for kitchen and bathroom floors
- Durable than plain cement flooring, vinyl flooring, can withstand wear and tear
- Low maintenance and easy cleaning suitable for public areas
- Tile resists dirt, stains and wear much more effectively than most carpet and wooden floors.
- Tiles give unique appearance at affordable price.

Setting out & measurement:

- All tile flooring should be laid above plain cement concrete floor

- Establish a datum level for finished floor
- After cleaning the slab mix a cement slurry and pour at the area where the installation occurs before mortar bedding
- Follow the approved drawing where the first tile location installed, first tiles should be the guide for installation
- Measure the wall to wall distance and divide the size of tile to calculate the number of tile required
- Floors in verandahs, courtyards, balcony, bathroom, kitchen, terraces etc should be provided a cross slope for easy drainages.
- Normally a 1 in 60 slope is adequate. However the slope in W/C area should be in 1 in 30. In terrace and courtyards however a slope of 1 in 100. (Fig 1)

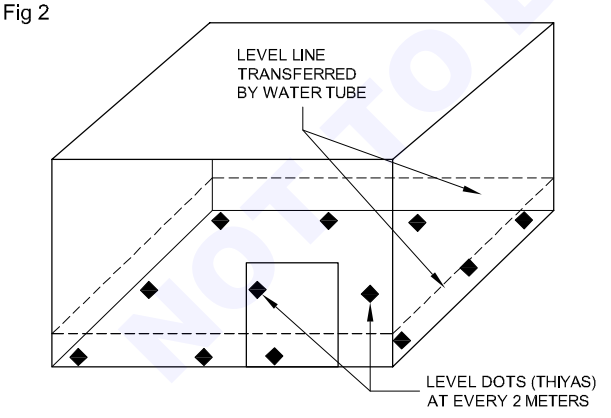
Fig 1



REFERENCE LEVEL WITH THE HELP OF LEVEL TUBE

- Flooring work has to be started only after all door frames have been fixed.
- On main door of the building mark fixed line at 600mm above desired finished floor level and transfer this marking level to all door frames with the help of level tube (Fig 2)

Fig 2



SCHEMATIC VIEW OF MARKING OF LEVEL DOTS IN ROOM FLOOR

- Prepare the bedding mortar in 1:3 cement & sand ratio, and level the floor surface with suitable slope
- Apply thin set mortar on the tiles in 3-4mm thickness, set the tile with bedding mortar and use plastic or rubber hammer to pushup to correction level and location.
- Tile spacers may be used for correct positioning
- After initial setting Clean the tiles from mortar dirt, remove all spacers before grouting.
- Use the approved grout and apply smooth, level and clean in every joint

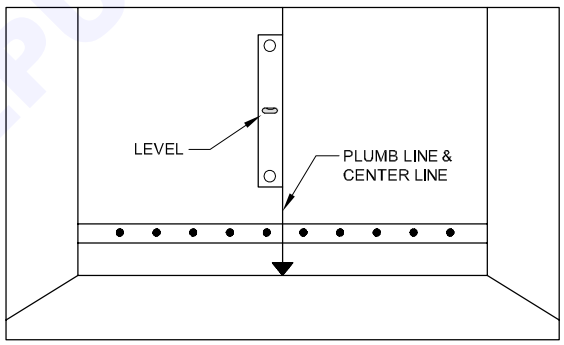
Tile masonry for walls: Wall is the vertical surface of a building; tiles are fixed with mortar for variety of purposes including,

- In kitchen: protecting walls from cooking and kitchen splashes,
- In Bathrooms: water resistant tiles protects from dampness and water seepage,
- In hospitals and public buildings: easy to clean and maintain,
- For decorative purpose: durable protection cover than cement plaster and painting and also they can add aesthetic look into the walls for both interior and exterior.

Setting out & measurement:

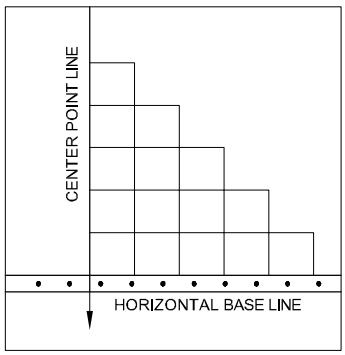
- Provide a rough wall finish of plastering prior to install the tiles
- Establish datum lines, it should be parallel and align with the floor layout (Fig 3 & 4)

Fig 3



ESTABLISHING LEVEL LINES ON WALL

Fig 4

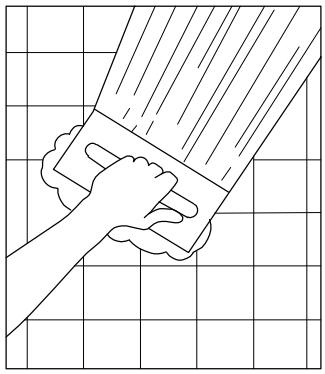


TILE FIXING ALONG WITH REFERENCE LINES

- Tile layout plan is made in accordance with the approved shop drawing
- Reference line has to be shown by nylon string.
- Colour tone, distortion, size shall be checked and sorted out before preparing tile

- Prepare the cement paste or suitable adhesive and apply thin layer of 3-4mm thickness on the tiles
- Use wooden or plastic hammer to push up the tile to correct the level
- Check the joint levels are parallel and in pure horizontal by level tube.
- Edges of wall tiles may be covered with plastic or aluminium beadings
- Clean the tile from cement dirt's and apply suitable grout paste in all joints (Fig 5)

Fig 5



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Foundation

Objectives: At the end of this lesson, you shall be able to,

- **define foundation**
- **state types of foundation**
- **explain purpose of foundation**
- **explain various loads on foundation**
- **describe causes of failure of foundation and its remedies.**

Introduction: Every structure consists of two parts, namely foundation and super structure. Foundation is the lowest part of a structure which transmits the weight of the structure, together with the effect of live loads and pressure, to the material on which the structure rests in such a manner that the underlying material is not stressed beyond its safe bearing capacity.

Definition: The lowest artificially prepared part of the structure, usually located below the ground level, which transmit the load of the superstructure to the ground is known as substructure or foundation.

Purpose of foundation

1 To distribute the loads of the structure over a larger area so as to bring down the intensity of load at its base, below the safe bearing capacity of sub soil.

2 To distribute the non-uniform load of the super structure evenly to the sub soil, thus prevent unequal settlement.

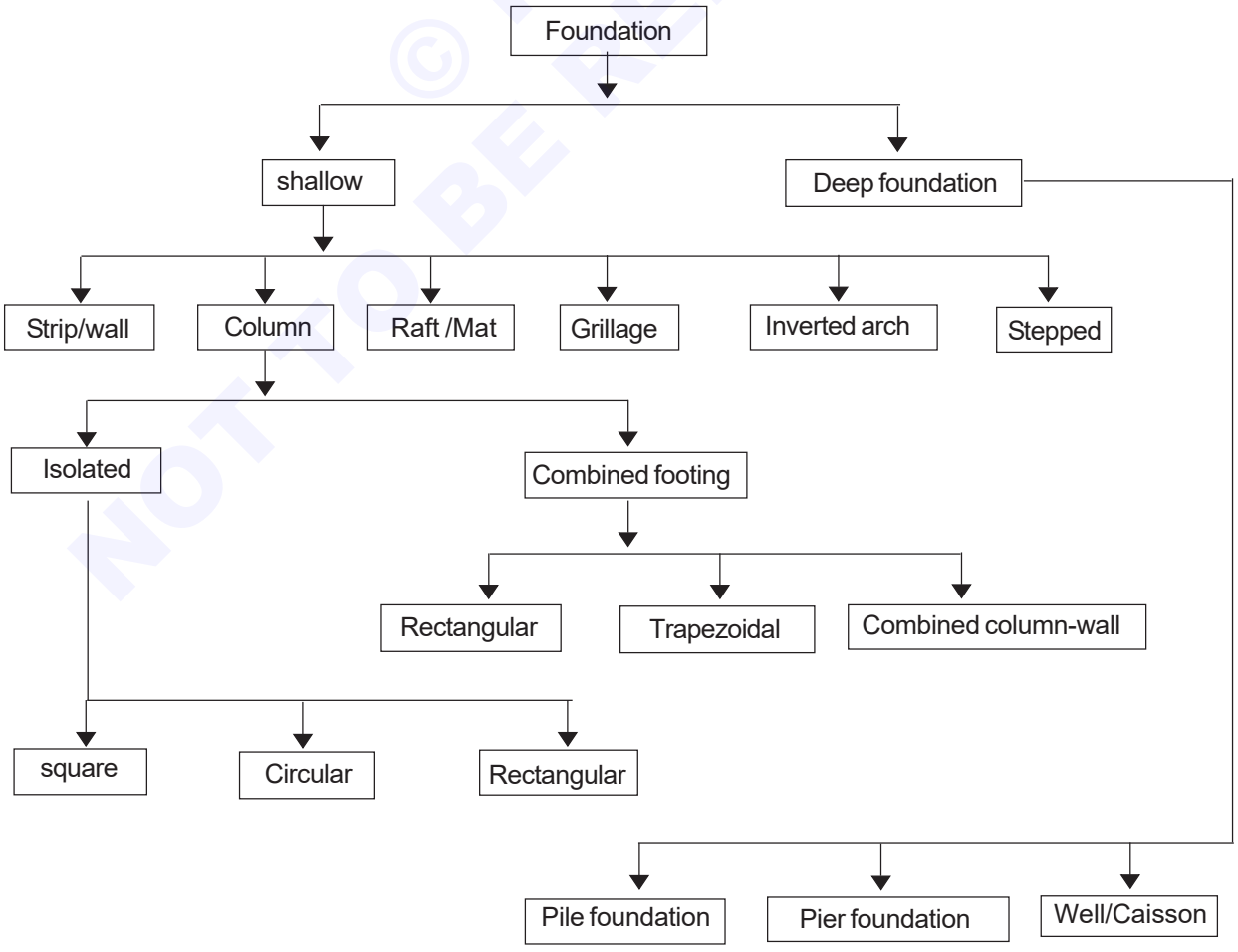
3 To give anchorage to the super structure with the ground and thus increase its stability and prevent overturning.

4 To prepare a level surface for the masonry work and for concreting.

5 To transmit the super imposed loads through side friction and end bearing in case of deep foundation.

6 To provide the structural safety against undermining or sourcing due to animals and flood water etc.

Types of foundations



Bearing capacity of soil

The maximum load per unit area which the soil or rock can carry without yielding or displacement is termed as the bearing capacity of soil.

Method of improving the bearing capacity of soil

Following methods are generally adopted to improve the bearing capacity of soils:

1 Increasing the depth of the footing is the simplest method of increasing the bearing capacity, this method is restricted to sites where excavations do not increase the cost of foundation disproportionately.

2 Drainage is a well known method to improve the bearing capacity of certain soil.

3 By blending granular material, like sand, gravel or crushed stone into the natural soil by ramming.

4 By driving sand piles.

5 By confining the soil in an enclosed area with the help of sheet piles.

Design loads on the foundation

The foundation must be strong enough to support all the possible types of loads to which it is liable to be subjected.

These loads can be mainly classified into three categories:

1 Dead load

2 Live load

3 Wind load

Dead load

Dead load is the load of all immovable permanent construction in the building.

This includes self weight of the walls, partitions, floors, roofs, weight of footings, foundation etc.

Live load

Live load is the movable load on the floor

It includes the load of persons standing on a floor, articles of furniture. Weight of the materials temporarily on a floor, weight of snow on a roof etc.

Wind load (wind pressure)

In case of tall buildings the effect due to wind should be considered.

The exposed vertical surfaces of wall, columns and inclined roofs are subjected to wind pressure.

The wind pressure will depend on the velocity of the wind location of structure and various other local meteorological data.

In case of sloped roofs, the wind pressure raises with the degree of slope.

Causes of failure of foundations and its remedies

Sl.No.	Causes	Remedies
1	Unequal settlement of the subsoil	Foundation should rest on rigid strata. Design of foundations should be appropriate to the nature of subsoil.
2	Unequal settlement of the masonry	Using mortar of proper strength. Masonry work should be raised evenly. Proper Curing.
3	Withdrawal of moisture from the subsoil	Provide drive piles up to the hard rock.
4	Lateral pressure on the superstructure	Provide sufficient wide base.
5	Horizontal movement of the earth	Construct retaining walls to prevent the escape of earth.
6	Transpiration of trees and shrubs	Foundations should be sufficiently deep. Trees should not be planted near the building.
7	Atmospheric action	Provide suitable underground drains. Providing gentle ground slope away from the wall.

Shallow foundation

Objectives : At the end of this lesson you shall be able to,
- **define shallow foundation**
- **explain various types of shallow foundation**
- **describe setting out of building on ground.**

Introduction

It is possible to construct foundation of a building at a reasonable shallow depth, the foundations are termed as the shallow foundations.

Definition

The depth of foundation is equal or less than its width, is known as shallow foundation.

Setting out of building on ground

1 Clear the Site.

2 Prepare a plan of setting out on paper.

3 Centre lines of walls to be marked on plan

4 This is to be marked on ground.

5 Mark the center lines of walls by stretching a string between wooden pegs.

6 Cross walls set by 3, 4,5 method.

7 Corners of building are laid and sides checked by measuring diagonals.

8 Entire width of foundation marked

9 For big projects reference pillars of brick may be constructed.

Shallow foundation

Foundation having its depth less than or equal is its width are known as shallow foundation. Since such foundation are constructed by open excavation.

Hence those foundation having its depth even greater than its width but are constructed by way of open excavation are also come under shallow foundation.

Design of shallow foundation

Following data are required before design of a foundation

a The total load to be transmitted by the wall or pier to the foundation bed.

b The results of trial pit and the corresponding bearing capacity of each strata of soil.

The design of foundation required the three terms,

a Width of foundation.

b Depth of foundation below ground level.

c Depth of concrete block below the masonry rooting.

Width of foundation: The width of foundation should be sufficient enough to bear the super imposed load per unit length on the foundation bed. The width of foundation is obtained by

i Dividing the total load per unit length on foundation bed by safe bearing capacity of the soil.

Thus, width of foundation = $\frac{w}{p}$

Where, w = total load in tone/meter

p = safe bearing capacity of soil in tonne/m^2

ii Width of foundation = 2 (T+J) Where,

T= thickness of wall above the plinth level.

J= the projection of concrete block on the either side of the lowermost masonry footing. which should be atleast 10cm-15cm.

Depth of foundation below ground level

This is generally determined by the rankine's formula. Which gives the maximum depth.

Depth of foundation below the ground level,

$$d = \frac{p}{w}\left[\frac{1-\sin\theta}{1+\sin\theta}\right]^2$$

Where p = total load on soil in kg/m^2

w = wt of soil in kg/m^3

θ = Angle of repose of the soil.

In order that all the shallow foundation should be taken to a minimum depth of 80cm below the natural ground level. Unless hard soil is available within 80cm.

Angle of repose

Angle of repose is the angle 95 the loose soil will make with the horizontal, if allowed to remain free in loose condition. The angle of repose of the soil varies with the type of earth.

Depth of concrete block

The depth of concrete block below the masonry footing is calculated by using the formula.

$$d = \sqrt{\frac{3PJ^2}{m}}$$

Where, P = the load on soil in kg/m^2

J= The projection of concrete on either side of the lowermost masonry footing which should be at least 10-15cm.

m= modulus of rupture of concrete in kg/m

The depth of concrete block below the masonry footing is also determined by the formula

$$d = \frac{5}{6}T$$

Where T = thickness of wall above the plinth level.

Types of shallow foundation

A Spread footing: The total load of the structure is transmitted to the base of the structure is spread out to a large area by spread footing.

a Strip footing

Spread footing for a wall is known as strip footing.

b Pad footing

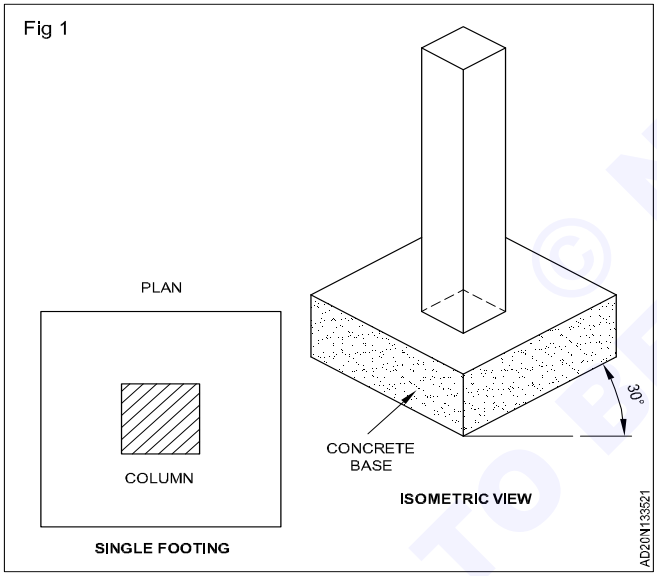
The spread footing for a single column is known as pad footing or isolated footing.

The spread footing may be of the following types

i Single footing

Fig 1 shows the single footing for a column in which the loaded area (bxb) of the column has been spread to the size (BxB) through a single spread.

Fig 1



ii Stepped footing : The Fig 2 shows the stepped footing for a heavily loaded column which require greater spread. The base of the column is made of concrete.

iii Sloped footing : Fig 3 shows the sloped footing made in concrete base of non uniform thickness. Greater thickness at its bottom, smaller thickness at the top.

iv Wall footing without step : Fig 4 shows the stepped footing for a wall consisting of concrete base without step.

v Stepped footing for a wall : Fig 5 shows the masonry wall have stepped footing with a concrete base.

vi Grillage foundation : A grillage foundation is a special type of isolated footing. Generally provided for heavily loaded steel stanchions or column, specially in those location where bearing capacity of soil is poor. The depth of foundation is limited from 1-1.5m. The load of the column or stanchion is distributed or spread to a very large area by means of layers of tiers of joist, each tier being placed at right angle to the next tier.

Fig 2

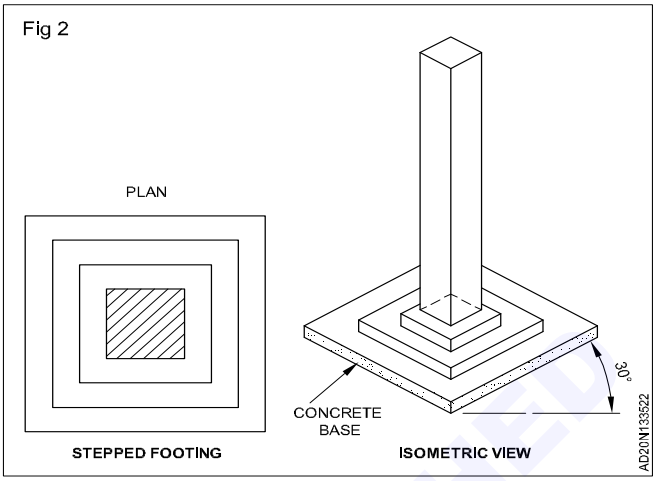


Fig 3

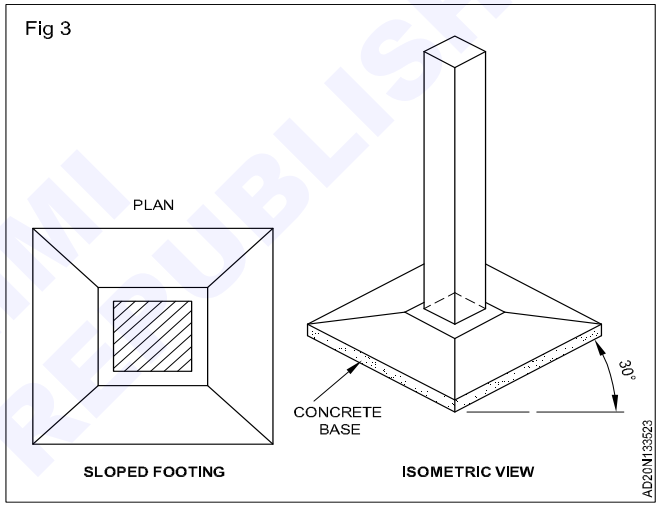


Fig 4

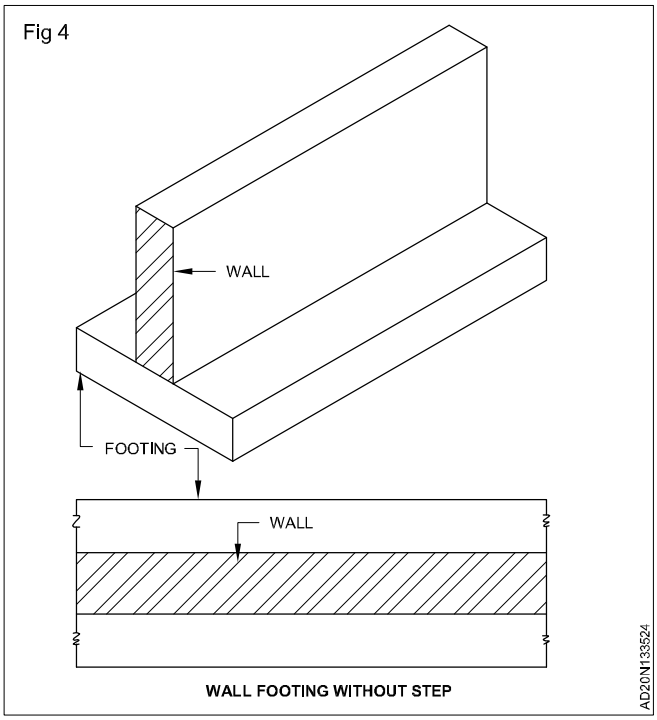
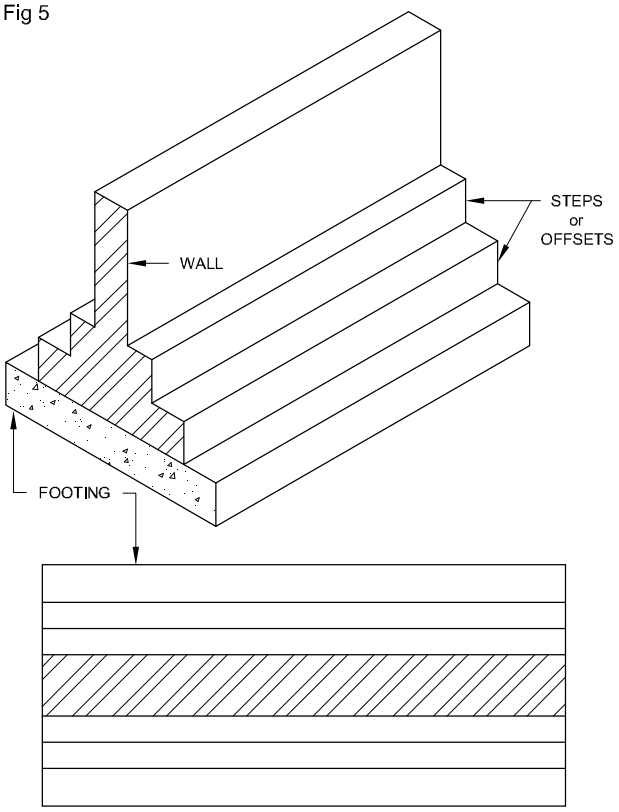


Fig 5

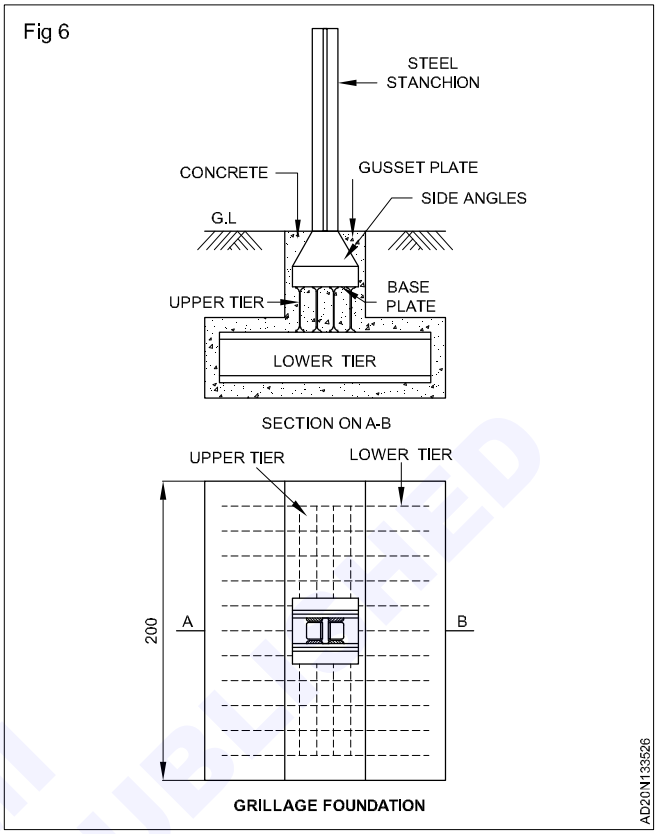


(b) STEPPED FOOTING

SPREAD FOOTINGS FOR WALLS

section of timber placed at center to center distance of about 3.5cm-40cm.

Fig 6



GRILLAGE FOUNDATION

Grillage foundation are of two types

- Steel grillage foundation
- Timber grillage foundation

Steel grillage foundation

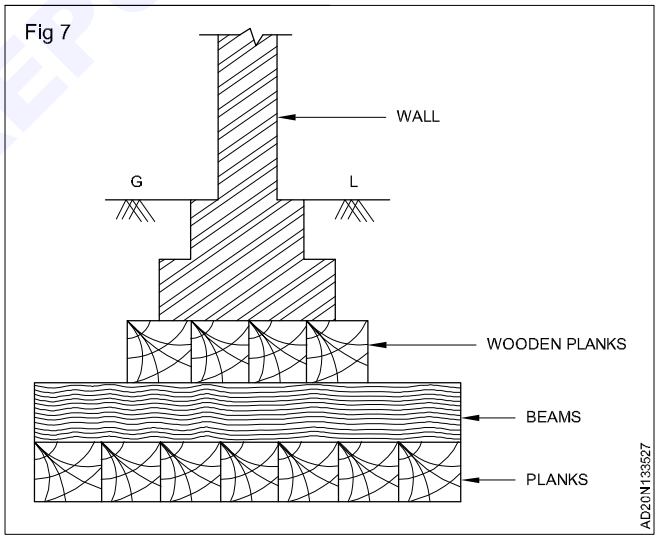
Steel grillage foundation is constructed of steel beams, structurally known as rolled steel joist (RSJ) provided in two or more tiers. In case of double tier grillage (which is commonly provided) the top tier of grillage beams is laid at right angle to the Bottom tier. The joists or beams of each tier are held in position by 20mm diameter pipe separators (tie rod 20mm diameter) as shown in Fig 6.

The grillage beams are embedded in concrete. Generally, the minimum clearance of 8cm is kept between the grillage beams. So that the concrete can be easily poured ,properly compacted. However the distance between the flanges should not exceed 30cm or 1 1/2 times the flange width. So that the filled concrete acts monolithically with the beams. It should prevent their corrosion. A minimum concrete cover of 10cm is kept on the outerside of the external beams as well as upper flanges of top tier.

Timber grillage foundation (Fig 7)

Temporary grillage foundation in the form of timber beams may be provided to timber columns, posts or walls etc. They can be design for supporting light building. In water logged areas. The loading on the soil is limited is 5.5 tone/m. The grillage takes the form of a platform of wooden planks arranged in 2 layers at rectangle to each other. The two layers of planks are separated by rectangular

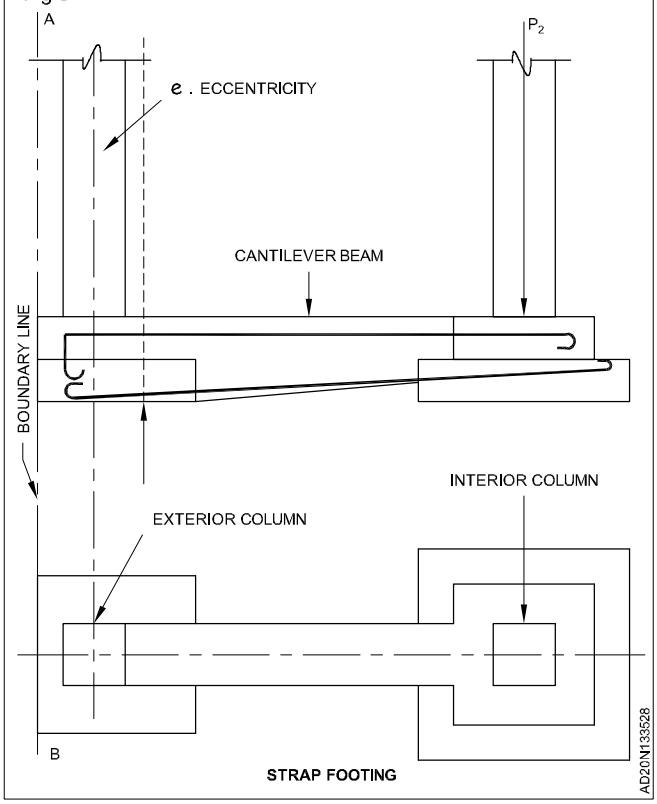
Fig 7



B Strap footing or cantilever footing (Fig 8)

A strap footing comprises of two or more footings of individual columns, connected by a beam called a strap. When a column is near or right next to a property limit, its foundation cannot extended beyond the property line, and if the distance between this columns and the adjoining column is large, in that case strap footing may be provided. The strap beam connecting the spread footings of the two columns do not remain in contact with soil and does not transfer any pressure to the soil. The function of strap beam is to transfer the load of heavily loaded outer column to the inner column. In doing so the strap beam is subjected to bending moment and shear force and it should be suitably designed to withstand these.

Fig 8

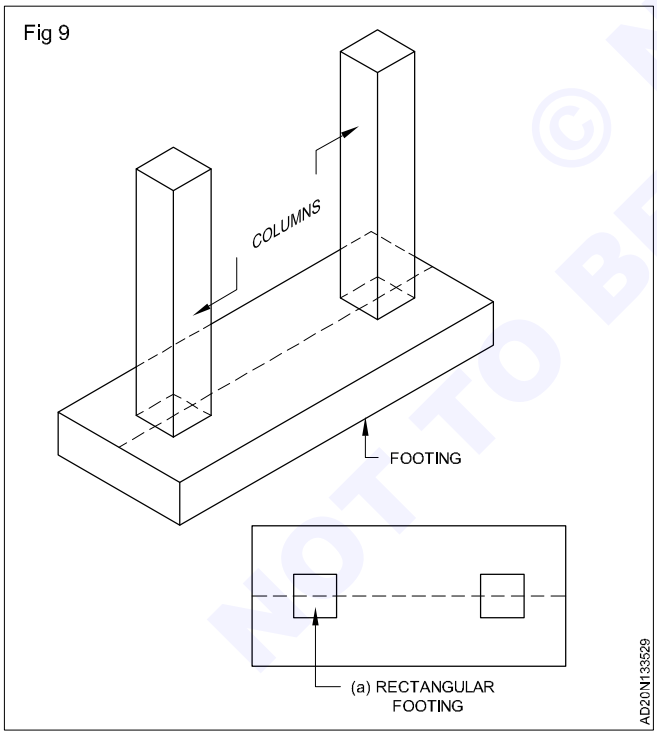


STRAP FOOTING

iii Combined footing

Rectangular footing (Fig 9)

Fig 9



A spread footing which supports two columns is termed has combined footing. If the footing supports more than two columns it is known as continuous footing.

A combined footing is provided under the following circumstances

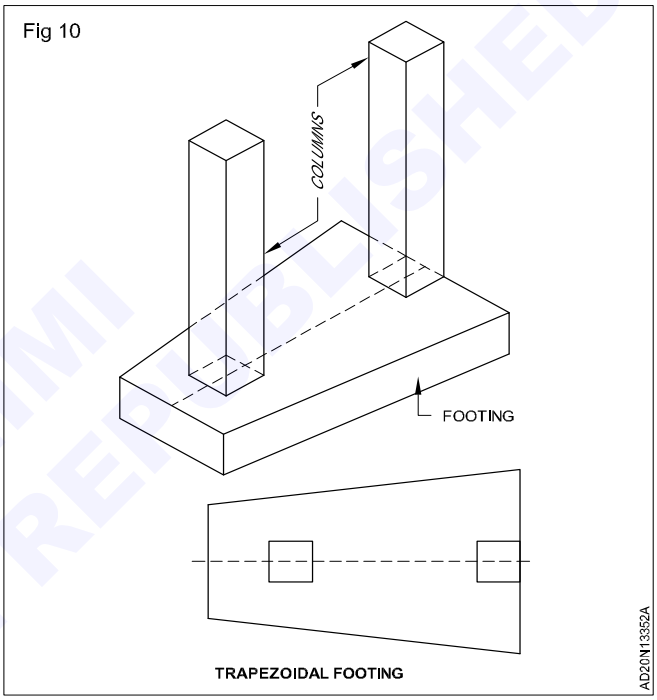
1 When the columns are very near to each other so that their footings overlap.

2 When the bearing capacity of soil is less requiring more area under individual footing.

3 When the end column is near a property line so that its footing spread in that direction.

A combined footing may be rectangular or trapezoidal in plan. The aim is to get uniform pressure distribution under the footing. For this the center of gravity of the footing area should coincide with center of gravity of the combined load of two columns. If the outer column, near the properly line carries heavier load, provision of trapezoidal column becomes essential to bring the c.g of the footing in line with the c.g of the two column loads. In other cases rectangular footing may be preferred. (Fig 10)

Fig 10



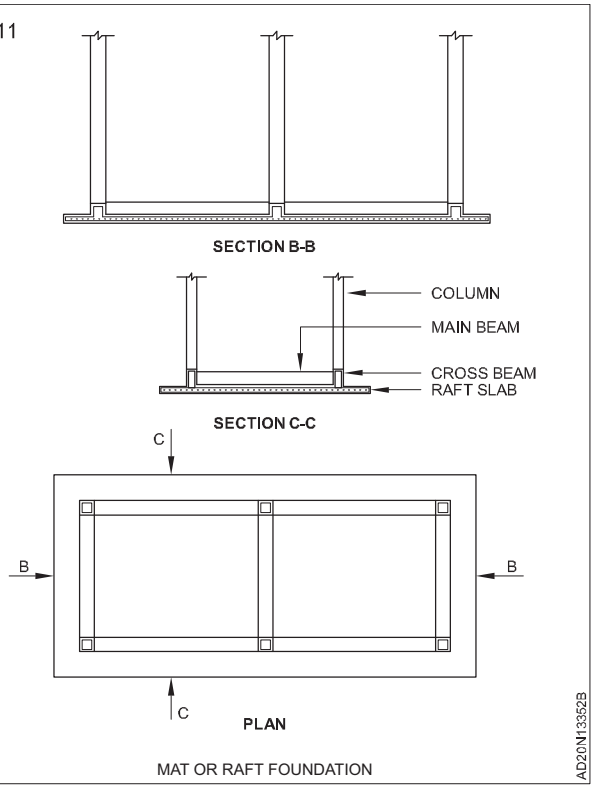
TRAPEZOIDAL FOOTING

iv Mat or raft foundation

Generally a raft or mat foundation is used when the bearing capacity of soil is very poor and when it is required to distribute heavy concentrated load over a large area. The raft foundation is useful where there is a possibility of unequal settlement to occur. The raft foundation consist of thick R.C.C slab covering whole area in the form of a mat. If the required area of footing exceeds half the total area of the structures, raft foundation is used. Raft foundation is also used for increasing the area of foundation to neutralise the hydrostatic uplifts. (Fig 11)

v Inverted arch foundation - The foundation which consist of inverted arches between the pier are known as inverted arch foundation. The rise of the arch is about 1/5th -1/10th of the span. The load transmitted to the soil through inverted arch.These are suitable for the construction of bridges, reservoirs, tanks etc. Now a days this type of foundation is rarely used in India.

Fig 11



MAT OR RAFT FOUNDATION

Deep foundation

Objectives : At the end of this lesson, you shall be able to
- **define deep foundation**
- **state classification of deep foundation**
- **explain pile foundation**
- **identifies various types of piles**
- **describe pier foundation**
- **explain well foundation (caisson).**

Introduction: This construction is adopted when the loose soil extends to a great depth. The load of the structure is transmitted by the piles to hard stratum below or it is resisted by the friction developed on the sides of piles.

Definition: The depth of foundation is greater than its width is called deep foundation.

Classification of deep Foundation

Pile foundation | Pier Foundation | Well Foundation (Caissons)

A Pile Foundation : Pile is a long vertical load transferring member which may be of timber, steel or concrete.

1 The loads are taken to a low level by means of columns in the soil.

2 It may be adopted where no firm bearing strata exists at reasonable depth and the loading is uneven

3 The pumping of subsoil water is too costly for keeping the foundation trench in dry condition.

4 This foundation is to be adopted for the structures in the area where canals ,deep drainage lines, etc. are to be constructed

Pile : Following are the situation in which a pile foundation is preferred:-

a When the load coming from the structure is very high and concentrated.

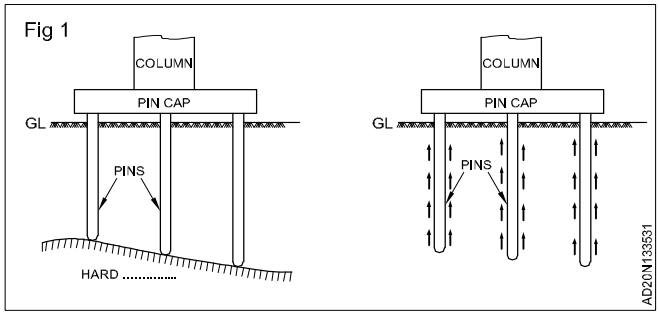
b When the other type of foundation cannot be provided due to heavy cost and site difficulties.

c When the water table is very near to the ground level and may defect the other type of foundation.

d When due to heavy inflow seepage, it is not possible to execute the trenches and keep them dry.

e Where there are chances of construction of irrigation canal in the near by area, which causes seepage of water in the foundation.

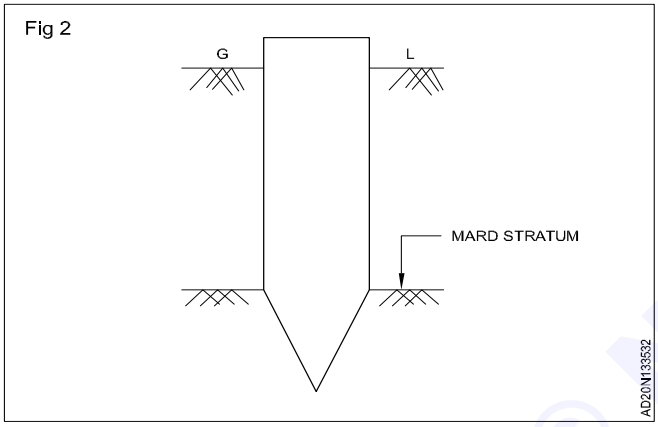
f When hard bearing strata is at a greater depth. (Fig 1)



Classification of piles

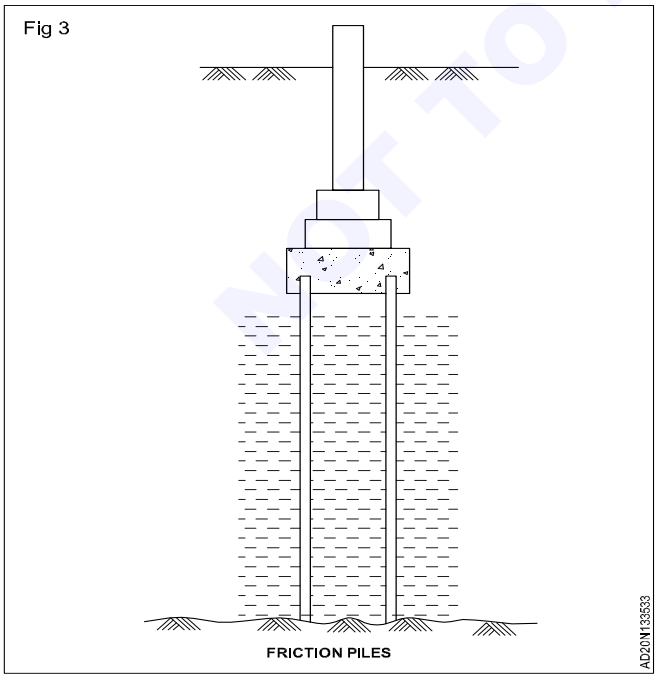
a Classification according to foundation:-

1 End bearing piles (Fig 2)



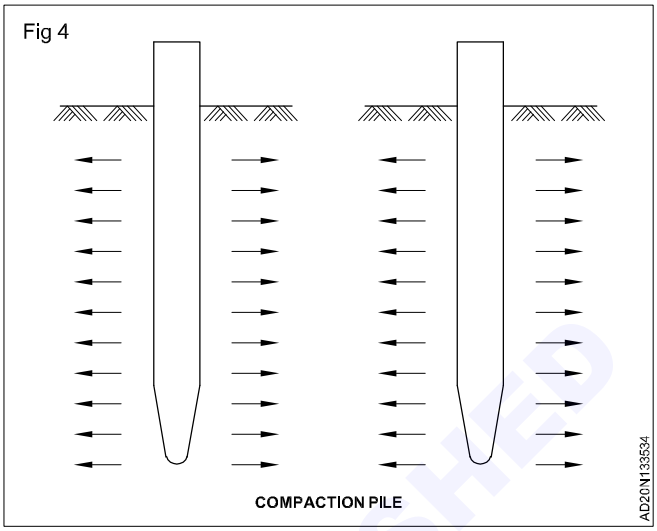
Piles whose lower end rest on hard rock (hard stratum) is known as end bearing piles. These piles are used to transfer heavy load through water or soft soil to a suitable hard stratum.

2 Friction piles (Fig 3)



The piles which support the structure load due to friction between the piles and surrounding soil are known as friction piles. Such piles are generally use in granular soil when the depth of hard strata is very great.

3 Compaction piles (Fig 4)



Compaction piles are used to compact loose granular soil thus increasing their bearing capacity. The compaction piles themselves do not carry any load. Hence they may be made of weaker materials like timber, bamboo sticks etc. Sometimes they may be made of sand only. The pile tube driven to compact the soil, is gradually taken out and sand is filled in its place thus forming a sand pile.

4 Tension or uplift pile

The tension piles anchor down the structures subjected to uplifts due to hydrostatic pressure or due to overturning moment.

5 Anchor piles

These piles provide anchorage against the horizontal pull from sheet piling or other pulling force.

6 Sheet piles

The piles are differ from bearing pile and friction pile. In that they are rarely used to furnish vertical supports, but are used to retain the soil that is, liable to escape laterally when subjected to pressure or to enclose the area required for some foundation. And protect it from the action of running water or leakage.

7 Fender piles and dolphins

These piles are used to protect the concrete deck or other water front structures against impact from ship or other floating objects.

8 Batter piles

These piles are driven at an inclination to resist large horizontal or inclined forces.

b Classification according to materials used

1 Concrete piles

2 Timber pile

3 Steel pile

4 Composite pile

Lengthening joint

Objectives: At the end of this lesson you shall be able to
- **define the term carpentry and joinery**
- **state the different technical terms in carpentry**
- **state the principle of joints**
- **enumerate classification of joints**
- **explain the types of lengthening joint.**

Introduction: Now a days wood is a valuable building material, which is not easily available everywhere, so one has to learn with more care about carpentry joints and fasteners and fixtures. By the study of these a trainee can select a right joint for a right position and to make that joint in the right way.

Definition: The timber which is to be used for the structural purpose (such as doors, windows, frames, trusses etc) is to be dressed, plained, framed and placed in position. Thus a carpenter constructs permanent timber work such as roofs, floors etc. as well as temporary timber work such as scaffolding, shoring , centering etc.

The term joinery is used to indicate the art of preparing internal fittings and finishing of timber. Thus a joint construct timber works such as doors, windows, stairs floorboard, furniture, cup-boards etc. Thus the joinery is used for delicate construction required precise workmanship for enhancing the architectural beauty of timber. In India the workman who is employed for the work of carpentry and joinery is known as carpenter.

Technical Terms in Carpentry: The following technical terms are commonly used in carpentry.

Sawing: It is the art of cutting wood by means of a saw.

Shooting: It is the art of dressing of edges of timber pieces as to make them straight and square with the face.

Chamfering: It consists, of taking off the edge or corner of a wooden member. The Chamfered member has a slopping edge which is usually has a slope of 45^0. If the angle of chamfer is other than 45^0 then it is known as a bevel.

Planing: It is the process of taking off the shaving from wood, with the help of a tool known as planer. By planing, timber surfaces are made smooth.

Mitring and scribing: Mitring is the process of joining two wooden members at a angle, if one end of moulding is cut to suite the profile of another moulding it is known as scribing.

Moulding: It is the process of shaping various units of construction either by hand or by machine.

Rebating: It is the process of cutting a rectangular groove on the edge of a timber piece so as to enable the edge or tongue of another timer piece to fit into the former.

Housing: It is the process of sinking of edge of one piece of timber into another by cutting grooves across it grain.

Groove and grooving: Grooving is a term used to indicate a recess formed in a timber member. If the groove is made parallel to the grain, it is known as plough grooving. If the groove is made across the grains, it is known as cross grooving.

Nosing: Nosing is the edge of portion overhanging a vertical surface.

Studding: It is the term applied to the fixing of small timber battens to timber walls to which laths and boards are to be nailed.

Battens: It is a narrow strip of wood which is nailed over joints of boards.

Veneering: It is the process of covering of entire or part of exposed surface of timber by means of veneers for decorative purpose.

Bead: It is the rounded or semicircular moulding provided on the edge or surface of wood.

Classification of Joints

Joints are classified into the following six categories.

i Lengthening joints.

ii Widening joints

iii Angle joints

iv Oblique – shouldered joint

v Bearing joint

vi Framed joint.

Lengthening Joint: These joints are also known as longitudinal joints or spliced joints. These joints are used to increase the length of wooden member. The method of lengthening depends upon the situation of a member in a framed structure. Lengthening joints are of various types.

1 Lapped joint

2 Fished joint

3 Scarfied joint

4 Tabled joints

Lapped joint (Figs 1 & 2): This is the simplest form of joint and is formed by putting two timber pieces one over the other for a short distance and then binding them together by means of iron straps or stirrups, iron straps are provided with bolts on sides for additional strength if the

member has to resist a tensile stress, the bolts passing through both the pieces may be provided.

Fig 1

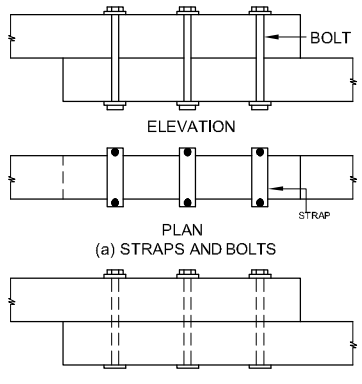
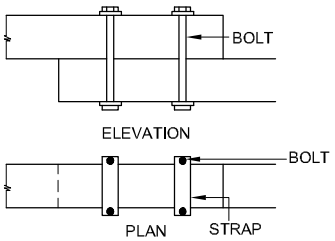
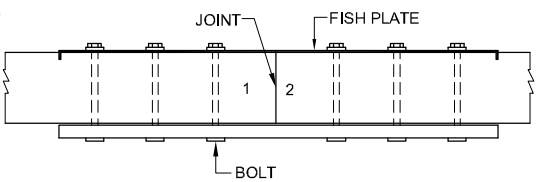


Fig 2



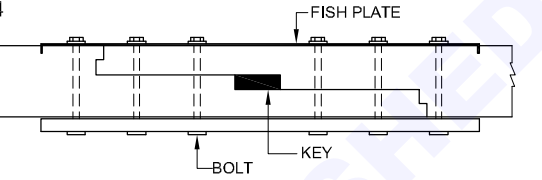
Fished Joint (Fig 3): In this joint the end of the two members are cut square and placed touching each other. They are then jointed together placing wooden or iron fish plate on opposite faces and securing these by passing both through them. The bolts are arranged in zig-zag fashion in plan. So that there is only one bolt hole at any cross-section. The ends of fish plate should be slightly bent and pressed into the timber pieces, to increase the strength of joints. Keys and intended fish plates are also provided to the strengthening the joints. It is used for rough and temporary structure such as scaffolding, centering, shoring and form work etc.

Fig 3



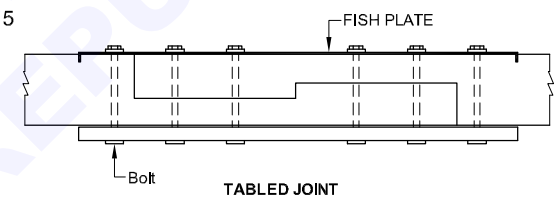
Scarfied joint or spliced joint (Fig 4): In this type of joint, the projections are made at the end of one piece and corresponding depressions are formed on the other piece. Two pieces are then secured together by means of bolts, straps, fish plates and keys. Such joints give good appearance, since the uniform depth of the member is obtained.

Fig 4



Tabled joint (Fig 5): These joints are formed when the member is subjected to both tension as well as compression. It is similar to spliced joint but is formed by cutting special shape in both pieces and securing then with fish plate, bolts, keys etc.

Fig 5



Bearing joint

Objectives: At the end of this lesson you shall be able to
- **explain bearing joint.**

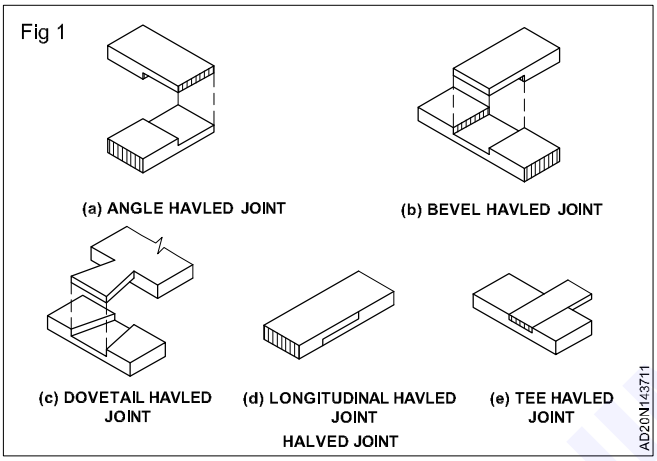
Bearing joint

Bearing joints are provided when two members meet at right angles to each other.

Bearing joints are of the following types

1 Halved Joint (Fig 1)

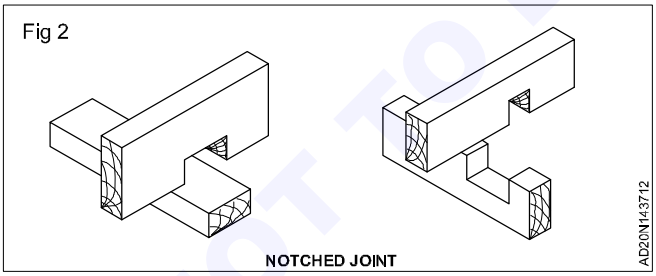
Fig 1



These joints are formed by cutting through half the depth of each member meeting at right angle, so that top surfaces of both the members flush. Various forms of halved joints are angle halved joint, longitudinal halved joint, tee-halved joint, bevelled halved joint and dovetail halved joint.

2 Notched Joint (Fig 2)

Fig 2

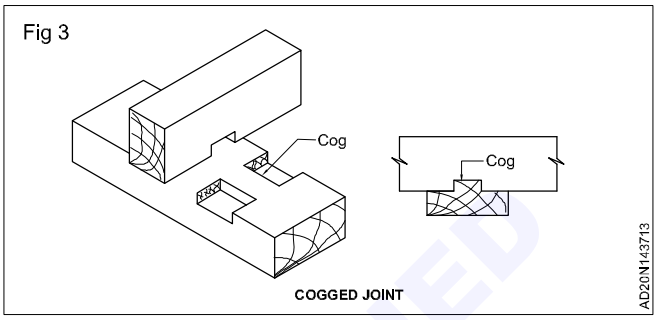


This joint is formed by cutting notch in one or both pieces. The former is known as single notched joint while the latter is known as double notched joint.

3 Cogged joint (Fig 3)

This joint is formed by cutting small notch in the upper timber member and providing notches on the lower member with a projection in the center. The projection is known as cog. The upper piece in which small notch has been formed, accommodates this cog.

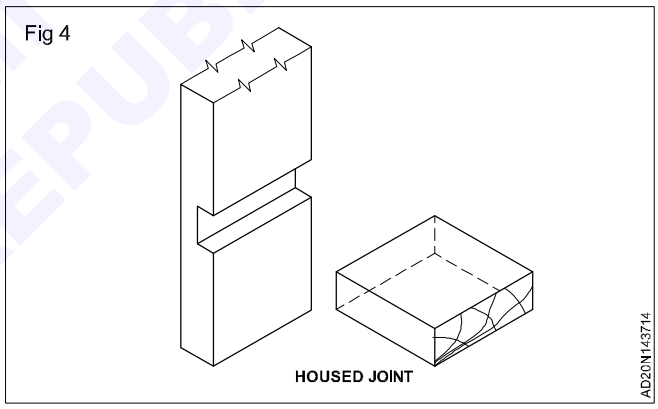
Fig 3



4 Housed Joint (Fig 4)

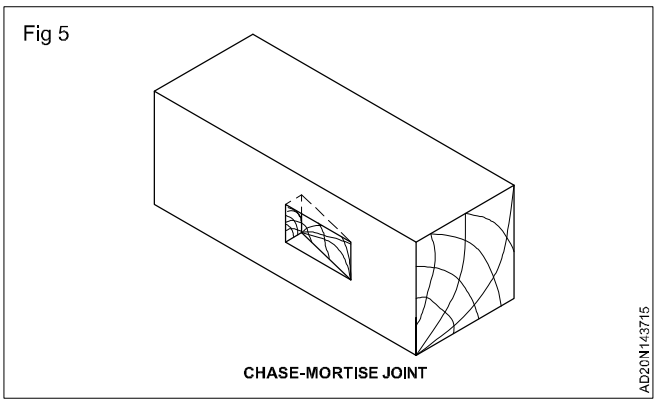
It is formed by fitting the entire thickness of the end of one member for a short distance into another piece. It is used in stairs in which the ends of risers and treads are housed in the strings.

Fig 4



5 Chase – Mortise joint (Fig 5)

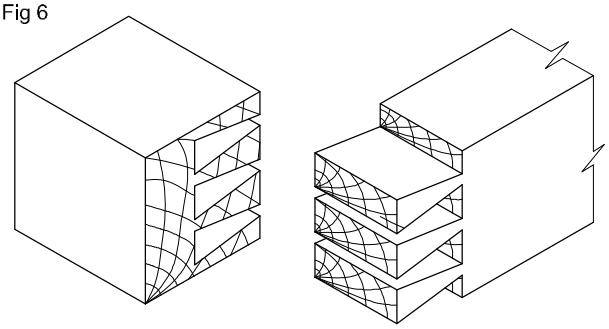
Fig 5



This is used for joining a subsidiary member to a primary member already fixed earlier. A wedge shaped recess is formed in the main member while a tenon of corresponding shape is formed in the secondary member.

6 Dove –tailed joint (Fig 6)

Fig 6



DOVE-TAILED JOINT

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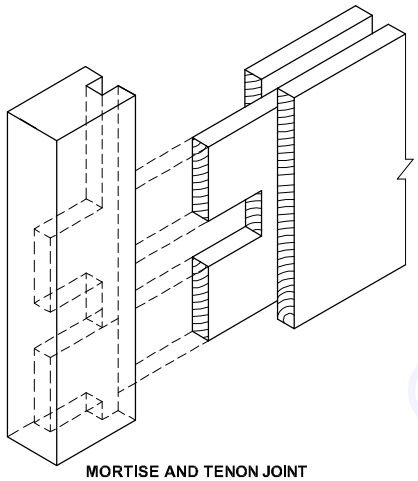
This joint is formed by cutting wedge shaped pieces from each member and by hooking the projection of one member into other. This joint is used for curves of sky-lights and corners of boxes, cabinets, drawers etc.

7 Mortise and tenon joint (Fig 7)

Fig 7



MORTISE AND TENON JOINT

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This joint is formed by cutting projection known as tongue or tenon in one member which fits into a slot called mortise, cut into the other member.

8 Joggle or Stump or Stub tenon Joint (Fig 8)

This is used for framing studs into the sill of wooden partition all. It is similar to mortice tenon joint except that the tenon is short in length and does not extend for full depth of mortised member.

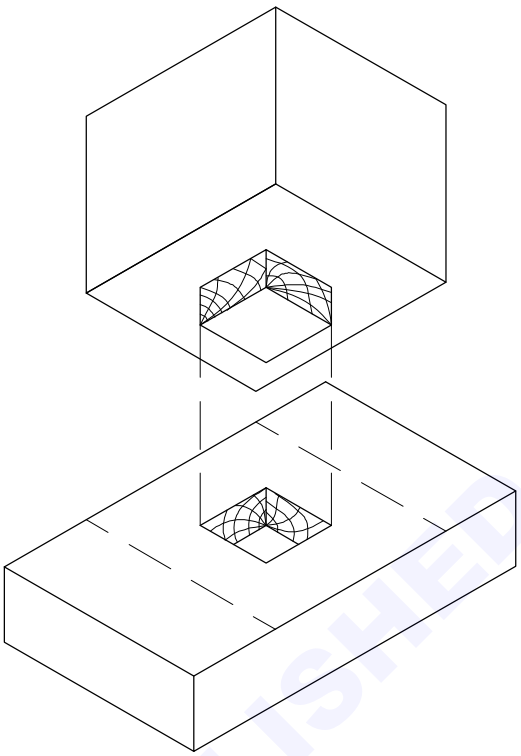
9 Bridle Joint (Fig 9)

This joint is commonly used in wooden trusses at the junction of struts and ties. It is formed by cutting a type of mortise at the end of one piece to fit in the bridle or projection left upon another piece.

10 Fox-tail Wedging joint (Fig 10)

This joint is formed by cutting a slightly dovetail shaped mortice to have a lesser depth than the member. The tenon is cut and two sockets are made in the tenon in which wedges are inserted. The entire assembly is then inserted in the mortice.

Fig 8



JOGGLE OR STUMP OR STUB TENON JOINT

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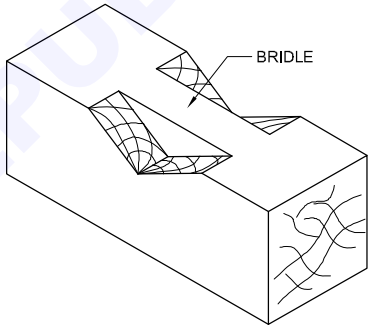
Fig 9



BRIDLE JOINT

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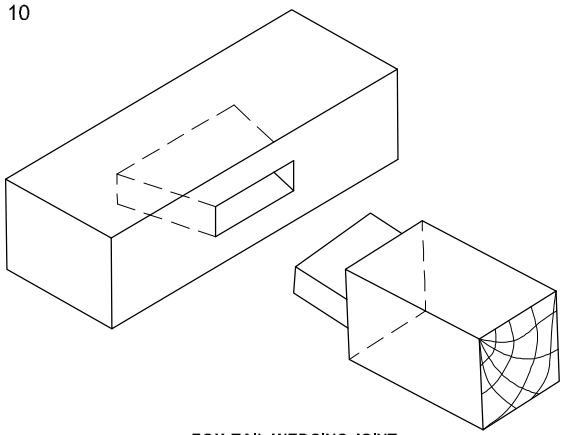
Fig 10



FOX-TAIL WEDGING JOINT

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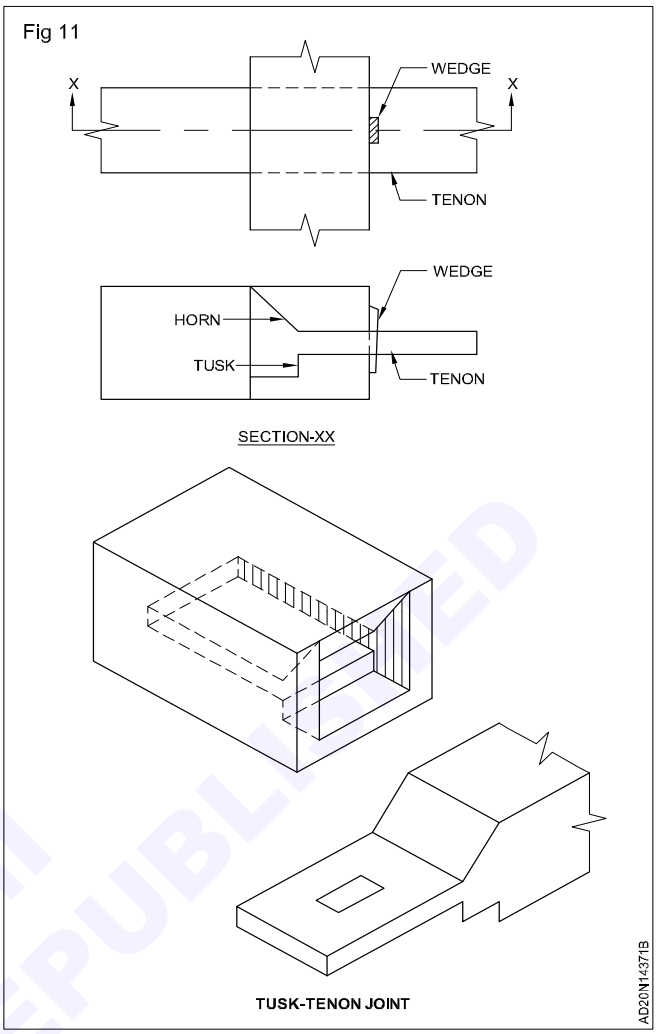
11 Tusk-tenon joint (Fig 11)

This joint is very strong and is commonly used to join timber pieces for construction. The joint is formed of tenon, tusk and horn. It is employed for joining members of equal depth, meeting each other at right angle.

Fig 11



TUSK-TENON JOINT

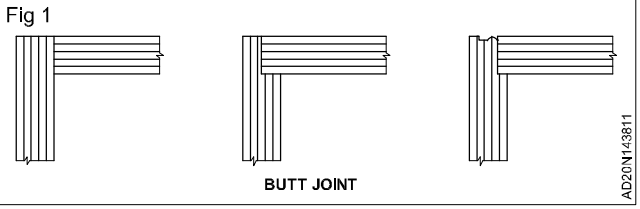
Angle or corner joint and framing joint

Objectives: At the end of this lesson you shall be able to
- **draw and explain angle or corner joint and framing joint.**

Following are the commonly used angle joints

1 Butt joint (Fig 1)

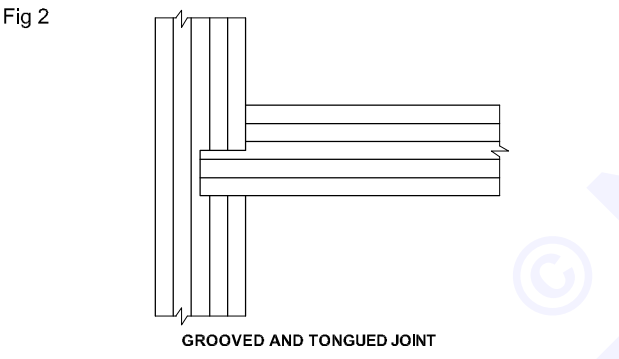
Fig 1



The members are connected by joining them edge to edge. The joints may be rebated and beaded to give better appearance. The joints may also be tongued.

2 Grooved and tongued joint (Fig 2)

Fig 2

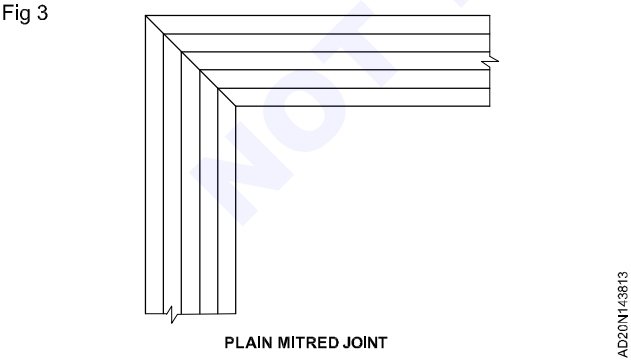


The joint is formed by fitting the projection of one member into the groove of the other.

3 Plain Mitred Joint (Fig 3)

The joint is formed by cutting the edge of both the members by an angle.

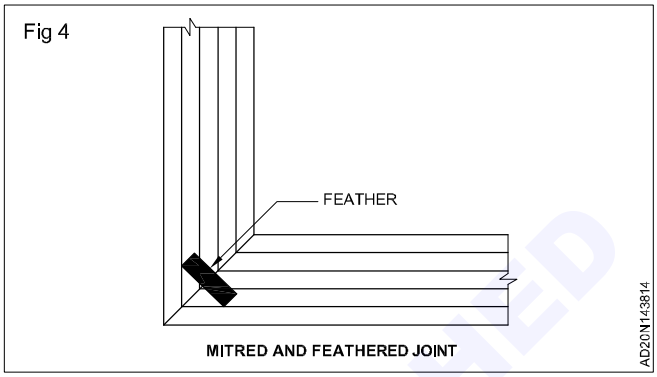
Fig 3



4 Mitred and feathered joint (Fig 4)

In this an additional wooden member called feather is inserted in the middle of the mitred joint.

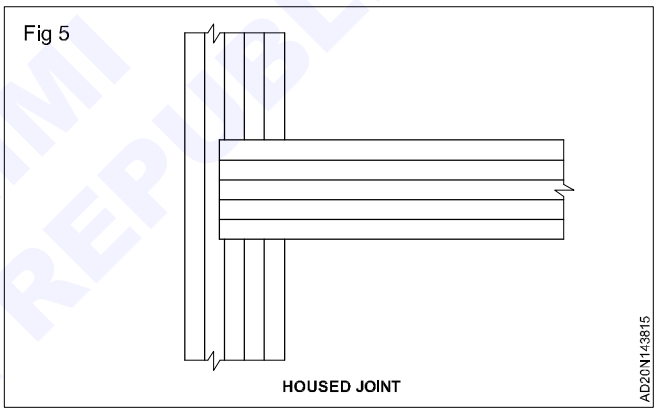
Fig 4



5 Housed Joint (Fig 5)

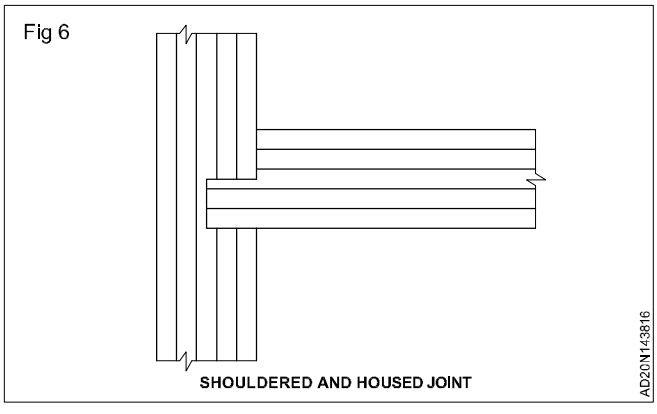
The joint is formed by fitting one member completely into the depression of the other.

Fig 5



6 Shouldered and house joint (Fig 6)

Fig 6

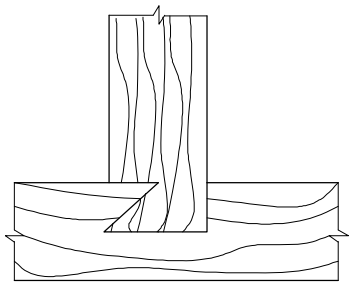


In this joint only a part of one member is fit into the corresponding depression of the other.

7 Dove tailed housed joint (Fig 7)

This is a special type of housed joint in which one member is housed into the other by dovetail shaped projection and cut.

Fig 7



DOVETAILED HOUSED JOINT

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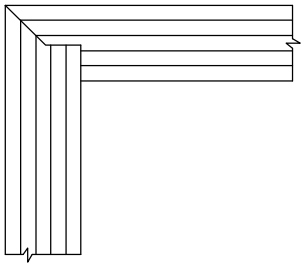
8 Mitred and rebated joint (Fig 8)

The joint is formed by using rebate in addition to the mitre.

Fig 8



MITRED AND REBATED JOINT

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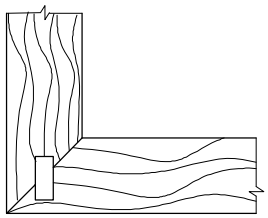
9 Mitred, rebated and feathered joint (Fig 9)

The joint is formed by inserting a feather in the mitred and rebated joint.

Fig 9



MITRED, REBATED AND FEATHERED JOINT

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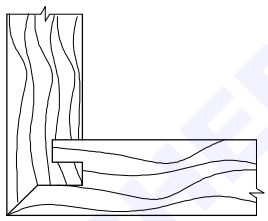
10 Tongued Grooved and Mitred Joint (Fig 10)

This joint is formed by making tongue and groove in the lower edge of the mitred, to give improved appearance.

Fig 10



TONGUED GROOVED AND MITRED JOINT

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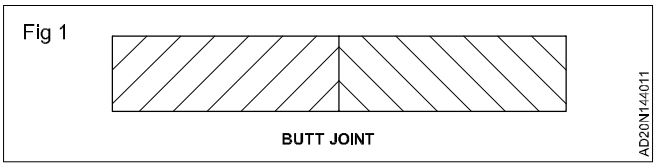
Widening joint

Objectives: At the end of this lesson you shall be able to
- **explain the types of widening joint.**

Widening joint

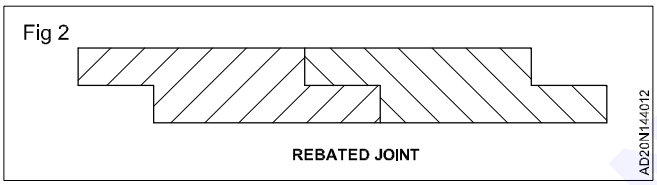
These joints are also called side joints or boarding joints and are used for extending the width of boards or planks. The members are placed edge to edge. These are used for wooden doors, floors, tables etc.

a Butt joints (Fig 1)



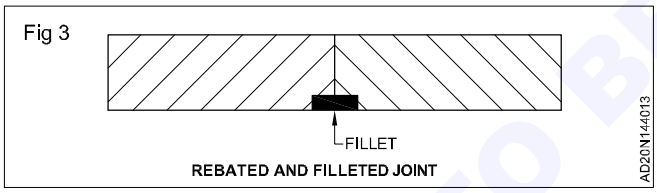
These are also known as square plain or ordinary joints are it is used for ordinary purposes.

b Rebated joints (Fig 2)



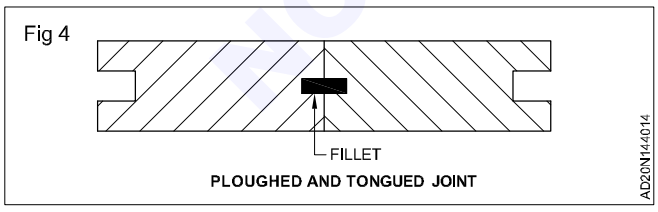
It is formed by overlapping cut portions. The joint remains dust proof after the shrinkage of timber.

Rebated and filleted joints (Fig 3)



It is formed by introducing wooden fillet in the rebated portions, having small depression. It is used for floors of factories etc.

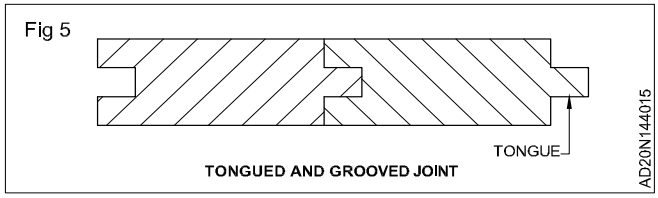
Ploughed and Tongued joint (Fig 4)



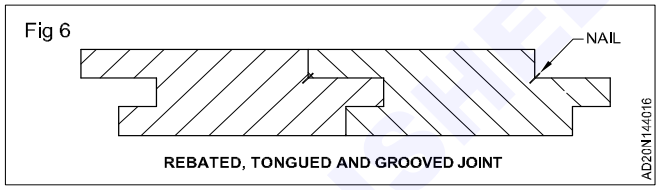
It is formed by introducing wooden fillet in the grooves cut in the two pieces.

Tongued and grooved joint (Fig 5)

It is formed by making fillet in one piece and groove in the other.

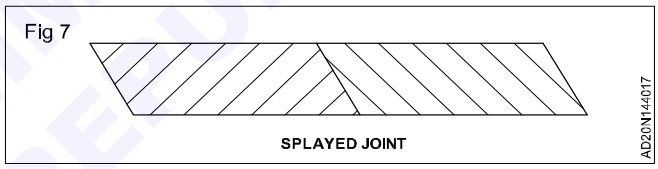


Rebated, tongued and grooved joint (Fig 6)



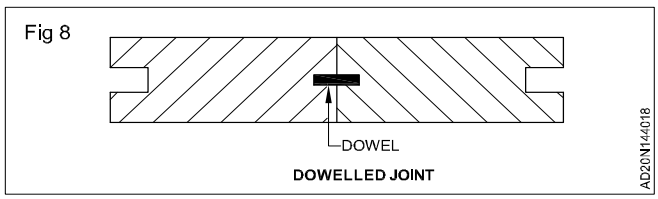
It is formed by forming a rebate in addition to tongue and groove. Nail is placed in such a way that it cannot be seen.

Splayed Joint (Fig 7)



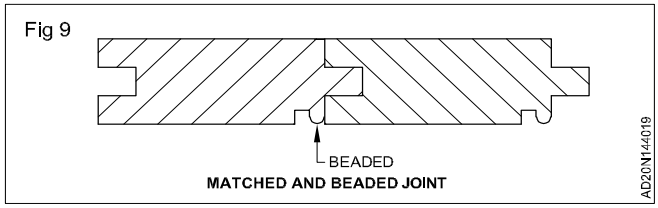
It is formed by splaying the ends of the timber pieces. This joint is used for ordinary purpose but it is superior to butt joint.

Dowelled Joint (Fig 8)



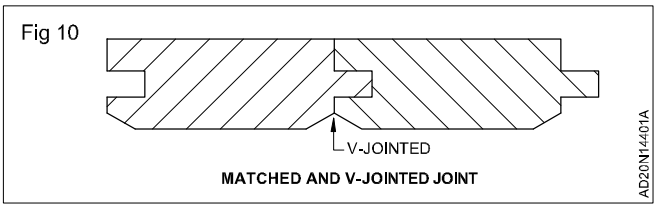
It is formed by making grooves in the center portion at the end of each piece and inserting dowels of gun metal brass, bronze or copper. This joints is very strong.

Matched and beaded joint (Fig 9)



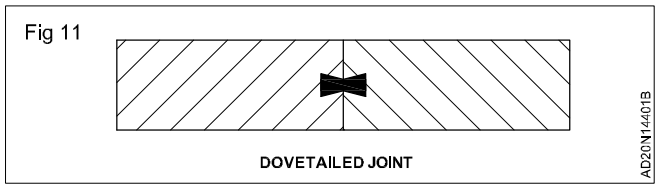
This joint is formed by tongued and grooved arrangement and has special moulding on one slide to give good appearance.

Matched and V- Jointed Joint (Fig 10)



This is a similar to the beaded joint expect that it is chamfered in shape of V.

Dovetailed joint (Fig 11)



It is formed by providing dovetail shaped keys to fit in the corresponding grooves in the connecting members.

Oblique - Shouldered joint

Objectives: At the end of this lesson you shall be able to
- **explain the oblique and shouldered joint.**

Oblique-shouldered joint

These joints are used when two members meet at an angle other than right angle, such as in timber truss construction.

Following are the different types of oblique joints

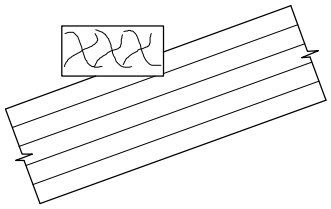
1 Birds mouth joint

2 Oblique-Tenon joint

These joints are similar to those discussed earlier except that members will meet an angle other than right angle.

1 Birds mouth joint (Fig 1)

Fig 1



BIRDS MOUTH JOINT

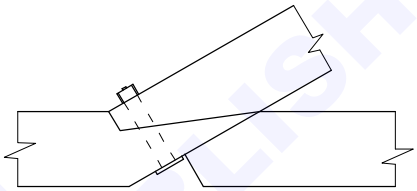
AD20N144111

This joint is formed by cutting angular notch called birds mouth. In the main member to which the other member is partially inserted and fitted.

2 Oblique-Tenon joint (Fig 2)

This is used for connecting horizontal member to an inclined member, both the members being bigger in sizes. The tenon of an inclined member is oblique, which is fixed into the corresponding mortise of the horizontal member. The joint is further strengthened by bolt, key, strap, etc.,

Fig 2



OBLIQUE-TENON JOINT

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Types of doors - I

Objectives: At the end of this lesson you shall be able to
- **define doors & windows**
- **explain the features & location of doors & windows**
- **enlist the technical terms**
- **determine size of doors**
- **explain door frame**
- **enumerate types and classifications of doors**
- **explain types of doors according to arrangement of components.**

Introduction

A door or window is an unavoidable part of building, which may be a frame work of wood, steel, glass to give access to peoples, materials, light and ventilation.

Definition

Door may be defined as an openable barrier secured in a wall opening. A door is provided to give an access to the inside of a room of a building.

Basically a door consists of two parts:

1 Door frame and

2 Door shutter.

The door shutter is held in position by the door frame which in turn is fixed in the opening of the wall by means of hold fasts.

A window is also a vented barrier secured in a wall opening. The function of the window is to admit light and air to the inside of building and to get a view of outside.

A window also consists of two parts:

1 Window Frame.

2 Window shutter.

The frame is secured to the wall opening with the help of hold fasts. And window shutters are held in position by the window frame.

Location of doors and windows

The following points should be kept in mind while locating doors and windows.

1 The number of doors in a room should be kept minimum since large number of doors causes obstruction and consume more area in circulation.

2 The location of door should meet functional requirements of a room. It should not be located in the centre of the length of a wall. A door should preferably be located near the corner of a room, nearly 20cm away from the corner.

3 If there are two doors in a room, then they should preferably be located in opposite walls facing each other, so as to provide good ventilation and free air circulation in the room.

4 The size and number of windows should be decided on the basis of important factors, such a distribution of light, control of ventilation and privacy of occupants.

5 The location of a window should also meet the functional requirements of the room such as interior decoration, arrangement of furniture etc.

6 A window should be located in opposite walls, facing door or another window, so that cross ventilation is achieved.

7 From the point of a view of fresh air, a window should be located on the northern side of a room or located in the prevalent direction of wind.

8 The Sill of a window should be located about 70cm-80cm above floor level of the room.

Technical terms (Fig 1, 2, 3)

Sl No.	Terms	Figure
1	**Frame:** It is an assembly of horizontal and vertical members forming an enclosure to which the shutters are fixed.	
2	**Shutters:** Openable part of a door or window.	
3	**Head:** Topmost horizontal part of a frame.	
4	**Sill:** Lowermost horizontal part of a frame.	
5	**Horn:** Horizontal projection of head or sill.	
6	**Stile:** Vertical outside member of the shutter frame.	
7	**Top rail:** Top most horizontal member of a shutter.	
8	**Lock rail:** Middle horizontal member of door a shutter.	
9	**Bottom rail:** Lower most horizontal member of a shutter.	
10	**Cross rail:** Additional horizontal rails, fixed between the top and bottom rails of a shutter.	
11	**Panel:** Area of shutter enclosed between the adjacent rail and stiles.	
12	**Mullion:** Vertical member of a frame, which is employed to sub-divide a window or a door.	
13	**Transom:** Horizontal member of a frame which is employed to sub-divide a window opening horizontally.	
14	**Hold fast:** Mild steel flats, generally bent into Z-shape, to fix or hold the frame to the opening.	

Fig 1

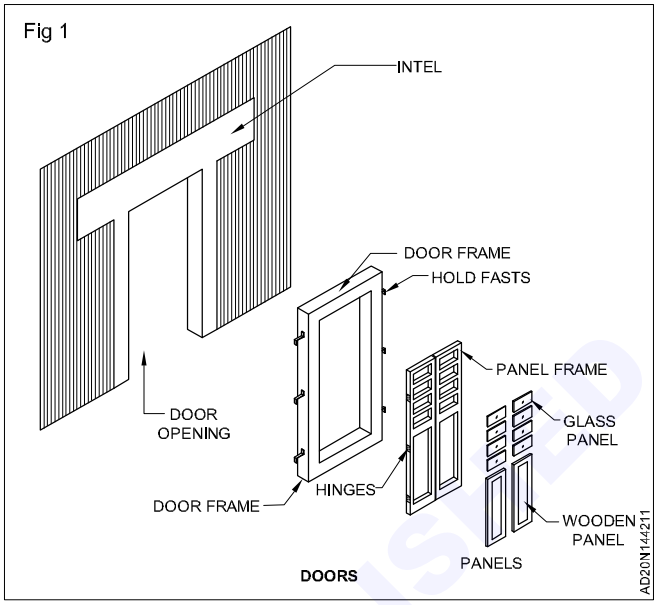
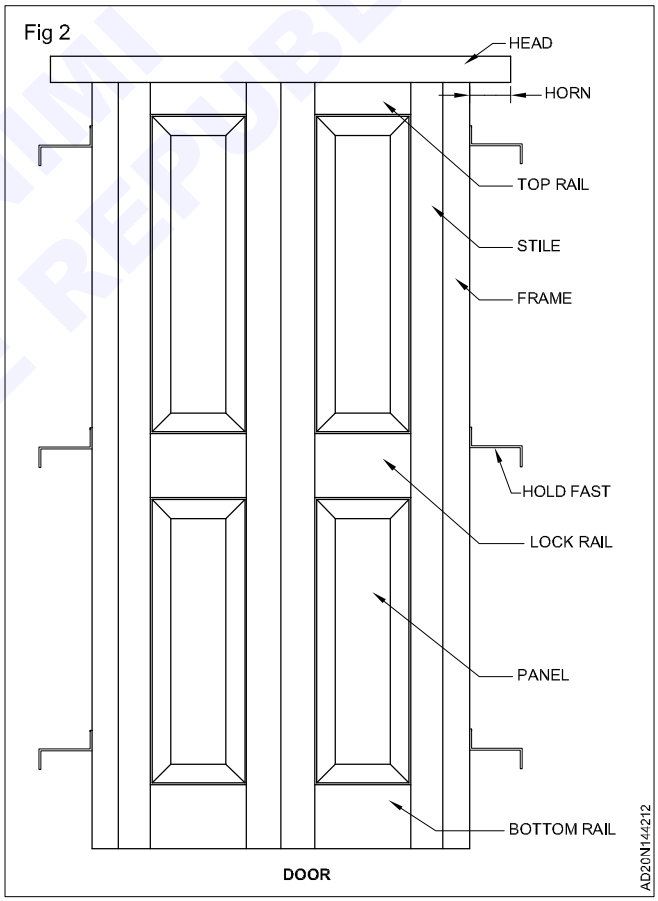
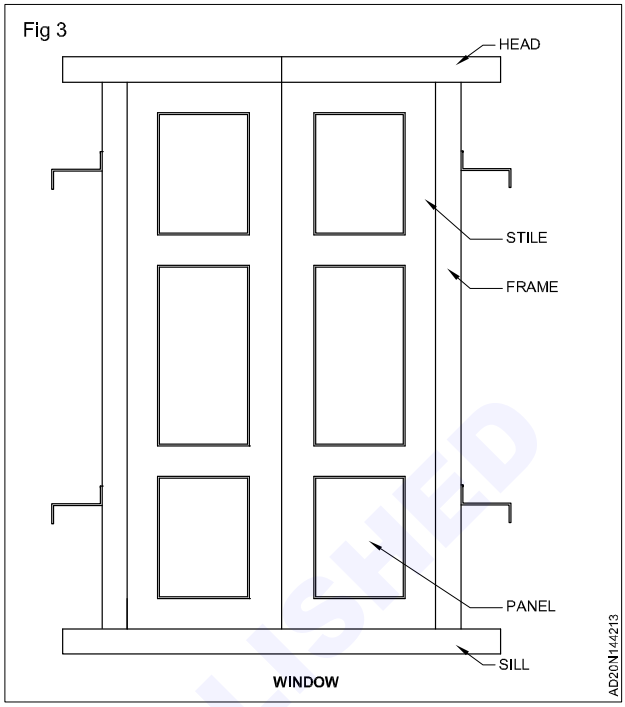


Fig 2



Sl No.	Terms	Figure
15	**Rebate:** Depression or recess made inside the door frame, to receive the door shutter.	Fig 3 
16	**Sash:** Special type of frame, made of light sections and designed to carry glass.	
17	**Louvers:** A piece of timber which is fixed is in inclined position within a frame.	
18	**Architrave:** A strip of wood, usually moulded or splayed which is fixed around the sides and head of opening	

Size of Doors: The size of door should be such that it would allow the movement of largest object and tallest person likely to use. As a rule, the height of door should not be less than 1.80M. The width of door should be such that two persons can pass through it walking shoulder to shoulder. The common widths – height relation used in India is as follows.

1 Width = 0.40 to .0.60 height

2 Height= (width +1.2) metre.

The following are the generally adopted sizes of doors for various types of buildings.

I Doors of residential building.

a External door = 1.00 x 2.00m to 1.10 x 2.00m

b Internal door = 0.90 x 2.00m to 1.00 x 2.00 m

c Doors of bathrooms and closets

= 0.70 x 2.00 to 0.8 x 2.00m

d Carriage of cars

= 2.25m (height) x 2.25m width to 2.25m (height) x 2.40 width

II Public building such as schools, hospitals, libraries, etc.

a 1.2m x 2.00m

b 1.2m x 2.10m

c 1.20m x 2.25m

Indian standard Institution recommends that the size of door frame should be derived after allowing a margin of 5mm all round an opening for convenience of fixing. The width and height of an opening is directed by no.of modules where each modules is of 100mm.

For example a designation of 8 DS 20 denotes a door opening having width equal to 8 modules (is 8x 100=800 mm) and height=20 modules (is 20 x 100 = 2000 mm) with single shutter.

The letter 'D' denotes a door opening and letter's' stands for single shutter. Similarly the designation 10DT 21 of door opening denotes.

Width of opening = 10 x 100 = 1000 mm

Height of opening = 21 x 100 = 2100 mm

D - Stands for door, T-stands for double shutter. The thickness of shutter shall be 20,25 or 30 mm depending upon size.

Door frame: A door frame is an assembly of horizontal and vertical members forming an enclosure to which door shutters are fixed. The vertical members are known as jambs, posts, while the horizontal top member connecting the posts is called the head which has horns on both sides. The size of the frame is determined by allowing a clearance of 5 mm to both the sides and top of an opening.

Door frame are made of following matrials.

1 Timber

2 Steel Section

3 Aluminum section

4 Concrete

5 Stone

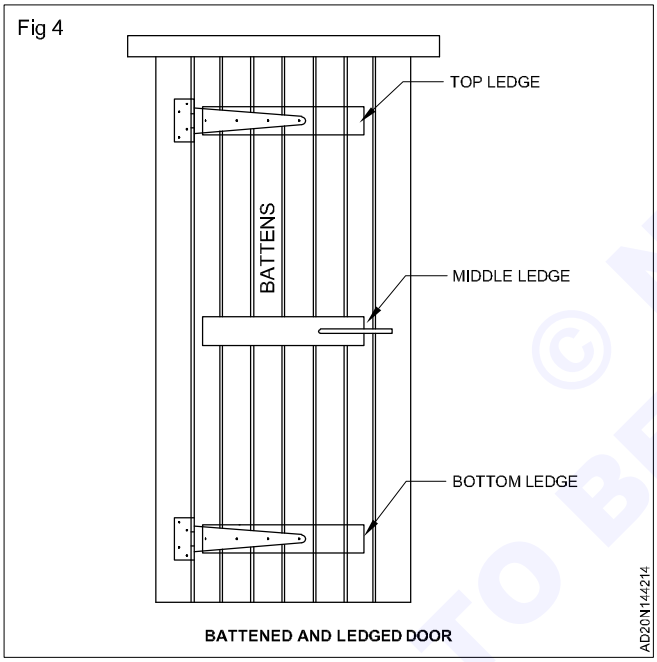
Out of these, timber frames are most commonly used. However in factories, workshops etc steel frames are used. Aluminium frames are costlier and are used only for residential buildings where more funds are available. With the increasing cost of timber, concrete frames are more popular in urban areas.

Classifications

According to arrangement of components	On the basis of method of manner of Construction	On the basis of working operation	Metal doors
Battened and ledged doors	Framed and panelled door	Revolving door	Mild steel door
Battened, ledged and braced doors	Glazed or sash door	Sliding door	Corrugated steel door
Battened, ledged and framed	Flush door	Swing door	Hollow metal door
Battened, ledged, braced and framed doors	Louvered doors	Collapsible door	Metal covered plywood door
	Wire gauged doors	Rolling steel shutter door	

Battened and ledged doors (Fig 4)

Fig 4



BATTENED AND LEDGED DOOR

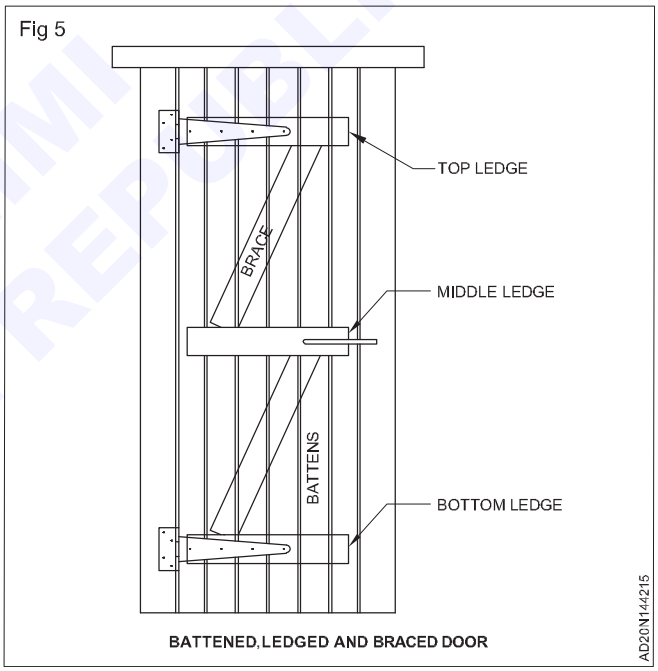
This is the simplest type doors, specially suitable for narrow opening when strength and appearance are not important. These doors are formed of vertical boards known as battens which are usually tongued and grooved and are fixed together by horizontal supports known as ledges. Battens are 10-15cm wide and 20mm-30mm thick. Ledges are generally provided at the top, middle and bottom. The door is hung to the frame by means of T-Hinge of iron.

Battened, ledged and braced doors (Fig 5)

These doors are similar to ledged doors except that diagonal members known as braces are provided as shown in figure. The braces are generally 10cm – 15 cm wide and 30 mm thick. The brace give rigidity to the door and hence doors of this types are useful for wide opening.

It should be noted that braces must slope upwards from the hanging side as they have to work in compression and not in tension.

Fig 5



BATTENED, LEDGED AND BRACED DOOR

Battened, ledged and framed doors

In this type of doors a frame work for shutters are provided to make the door stronger and better in appearance as shown in figure. Stiles are generally 10cm wide and 40mm thick. The ledges are provided as usual. The total thickness of stiles is made equal to the thickness of ledges & thickness of battens.

Battened, ledged framed and braced doors

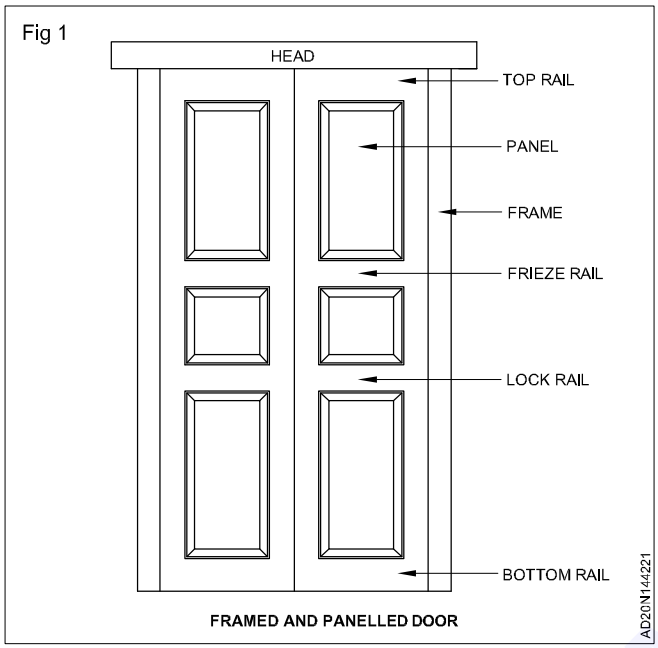
This is just similar to the battened ledged and framed doors, except that brace are introduced. This type of door is durable and stronger and hence it can be used for external use. The brace must stop upward from hanging side.

Types of doors - II

Objectives: At the end of this lesson you shall be able to

- **explain types of door according to manner of construction (framed and panelled door, glazed or sash door)**
- **explain types of door according to manner of construction (flush door)**

Framed and panelled door (Fig 1)



FRAMED AND PANELLED DOOR

These type of doors are widely used in almost all types of buildings since they are strong and give better appearance than battened doors. This door consists of frame-work in the form of vertical members called stiles and horizontal member called rails which are grooved along the inner edge of the frame to receive the panels. The panels are made from timber, plywood, block boards, A.C sheet or even glasses. Panalled doors are of various types such as.

Single panelled doors

Two panelled doors

Three panelled doors

Multiple panelled doors

Panelled doors may contain single leaf for small opening or may contain two leaves for wider openings. In double leaf door each leaf has separate frames each hinged to the corresponding jamb post of the door.

Features of framed and panelled door

The stiles are made continuous from top to bottom that is they are in single pieces.

Various rail (in top rail, bottom rail and intermediate rail) are jointed to the stiles at both the ends.

The stiles and rails are jointed by tenon and mortised joints.

The bottom and lock rail are made wider than top and frieze rails.

The entire frame is grooved on all the inside face to receive panels.

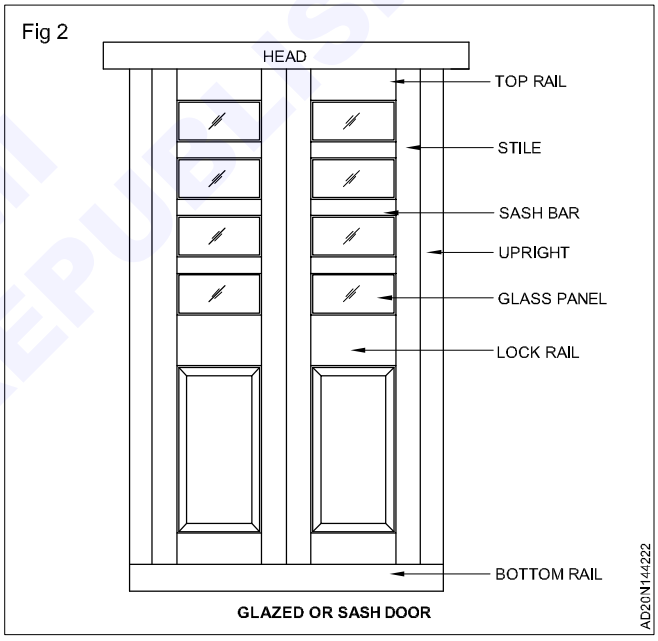
Additional timber beading is provided on one or both the sides to improve the elevation of the door.

The minimum width of the stile is kept as 100mm. The minimum width of bottom rail and top rail is kept as 150mm.

If panels are made timbers, its minimum width should be 150mm and minimum thickness should be 20mm.

However the maximum area of single panel of timber should not be more than 0.5m^2. These restrictions do not apply to panel of plywood, particles boards on hard board.

Glazed or sash door (Fig 2)



GLAZED OR SASH DOOR

Glazed or sash door are provided where additional light is required to be admitted to the room through the door or where the visibility of the interior of the room is required from the adjacent room. Such doors are commonly used in residential as well as public buildings like hospitals, schools colleges etc. The doors may be within fully glazed or they may be partially glazed and partially paneled. The glass is required into the rebate provided in the wooden sash bars and secured by rails and putty. Partially glazed doors are sometimes provided with stiles which gradually get diminished at lock rail to improve the elevation or to permit more area for the glazed panels. Such stile which decrease in width at lock level are called diminishing stile or gun stock rail or gun stock stile.

Flush Door

Flush doors are becoming popular these days because of their pleasing appearance, simplicity of construction, less cost, and greater durability. They are used both for residential as well as public and commercial buildings. These doors consist of solid or semi-solid skeleton or core covered both sides with plywood, or veneers etc. This door presents a flush and joint less surface which can be neatly polished.

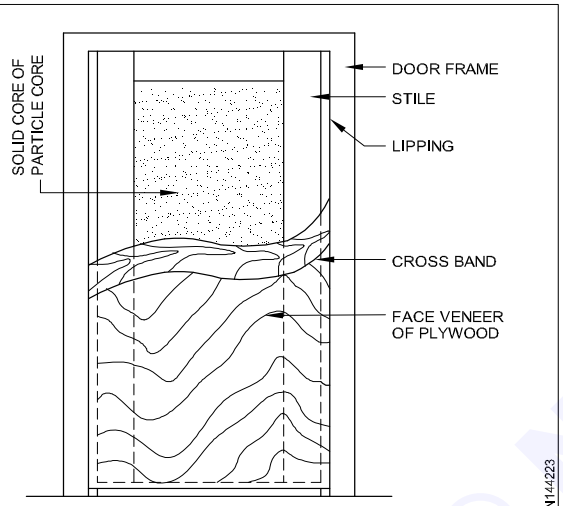
Flush doors are of two types

a Solid core or laminated core flush door

b Hollow core or celluar core flush door (framed)

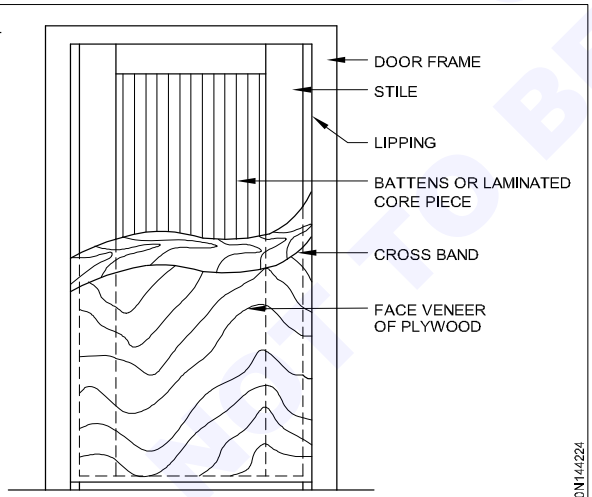
a Solid core or laminated core flush door (Figs 3 & 4)

Fig 3



SOLID CORE FLUSH DOOR

Fig 4



LAMINATED CORE FLUSH DOOR

Solid core flush door consists of framework in the form of stiles, top and bottom rails of not less than 75 mm width. The inner space of the frame is provided with block board or particle board.

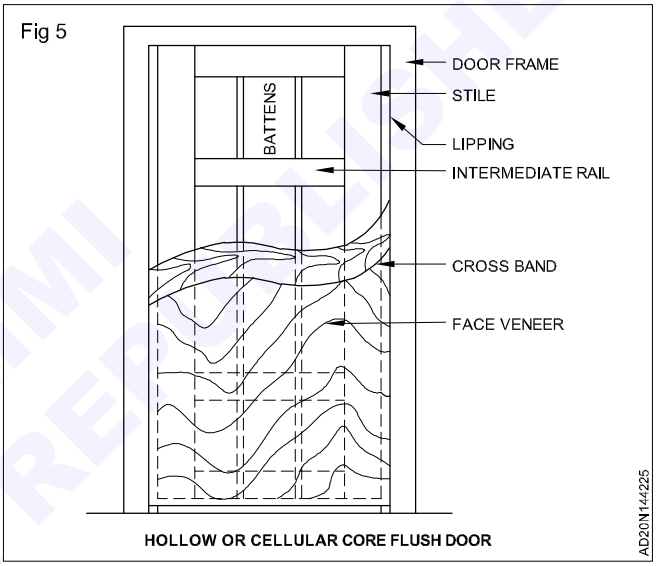
In the laminated core flush door, the wooden strips of maximum width 25mm are glued together and length of each strip is equal to the length of the laminated core. It is housed in the outer frame made of stiles, top and bottom rails of not less than 75 mm width.

In each type of core, plywood sheets are glued under pressure to the assembly of core housed in the frame on both faces. Alternatively separate cross bands and face veneers can be glued on both the faces, with the grains of core at right angles to that of the cross bands. Such doors are quiet strong but are heavy and require more materials.

b Hollow or cellular core flush door (Framed flush door) (Fig 5)

A hollow core flush door consists of frame made up of stiles, top and bottom rails and a minimum of two intermediate rails, each of minimum 75 mm width. The inner spaces of the frame is provided with equally spaced

Fig 5



HOLLOW OR CELLULAR CORE FLUSH DOOR

battens each of minimum 25 mm width, such that the area of voids is limited to 500 cm^2.

A cellular core flush door consists of frame work made of stile, top and bottom rails each of 75 mm width. The voids space is filled with equally spaced battens of wood or plywood, each of minimum 25mm width. The battens are so arranged that the voids space between the adjacent vertical and horizontal battens does not exceed 25 cm^2 in area. Total area of voids does not exceed 40% of the area of the shutter.

In both types, shutters are formed with, plywood sheets or cross bands and face veneers which are glued under pressure to both the faces of core.

Windows, ventilators and fixtures and fasteners

Objectives: At the end of this lesson you shall be able to
- **enumerate factors for selection of size, location & no. of windows in a room**
- **describe Indian standard recommendations of windows**
- **explain different types of windows and ventilators.**

Introduction

Windows: Windows are necessary for ventilation and lighting. These are usually glazed with clear or opaque glasses. As already stated, not less than 10 t0 15 percent of the floor area of a room is given to windows opening to the outside. The smaller the floor area, the larger will be the percentage.

Ventilators

Ventilators are windows of small heights and they are fixed at the top of door or window. The ventilators are provided with glass panels and steel grill is fixed in ventilator for the purpose of safety.

Windows

The selection of size, shape, location and no. of windows in a room depends upon the following factors.

1 Size of the room

2 Location of the room

3 Utility of the room

4 Direction of the wall

5 Direction of the wind

6 Climatic conditions such as humidity, temperature etc.

7 Requirement of exterior view

8 Architectural treatment to the exterior of the building.

Based on these factors the following thumb rules are in use.

1 Breath of window = 1/8 (Width of room + Height of room)

2 The total area of window opening normally varies from 10-12% of the floor areas of the room depending upon the climatic conditions.

3 The area of window opening should be at least 1 sq.m for every 30-40 cubic meter of the room volume.

4 In public buildings, the minimum area of window should be 20% of floor areas.

5 For sufficient natural light, the area of the glazed panels should at least be 8-10% of the floor area.

Indian standard recommends that the size of window frame should be derived after allowing a margin of 5 mm all round an opening for convenience of fixing. The width and height of an opening is indicated by a number of modules, where each module is of 100 mm. A designation 6ws 12 indicates a window opening with single shutter having width equal to 6 modules.

It, 6 x 100 = 600 mm

And height equal to 12 modules

It, 12 X 100 = 1200 mm

Indian standard recommendations for size of opening size of frame and size of window shutters are given below:

Sl No	Designation	Size of Opening	Size of Window frame	Size of window shutters
1	6 WS 12	600 x 1200	590 x 1190	560 x 110
2	10 WT 12	1000 x 1200	990 x1190	460 x 1100
3	12 WT 12	1200 x 1200	1190 x 1190	560 x 1100
4	6 WS 13	600 x 1300	590 x 1290	560 x 1200
5	10 WT 13	1000 x 1300	990 x 1290	460 x 1200
6	12 WT 13	1200 x 1300	1190 x 1290	560 x 1200

Types of Windows

The Common Verities of windows used in building construction are as follows:

1 Fixed Window

2 Pivoted window

3 Double hung window

4 Casement window

5 Sliding window

6 Sash window

7 Louvered window

8 Metal window

9 Bay window

10 Clerestorey window

11 Dormer window

12 Corner window

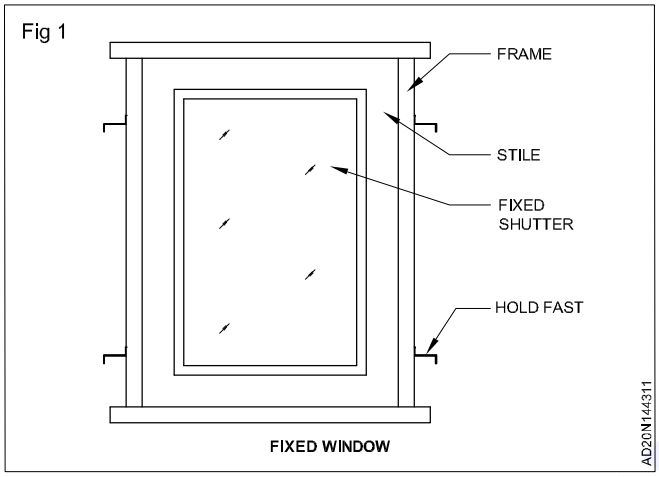
13 Gable window

14 lantern window

15 Sky lights

16 Combined windows and Ventilators.

Fixed Window (Fig 1)



These windows are provided for the only purpose of admitting light and providing vision in the room. This window may consist of a window frame to which shutters are fixed. No rebate are provided to the window frame. The shutters are fully glazed.

Pivoted window (Fig 2)

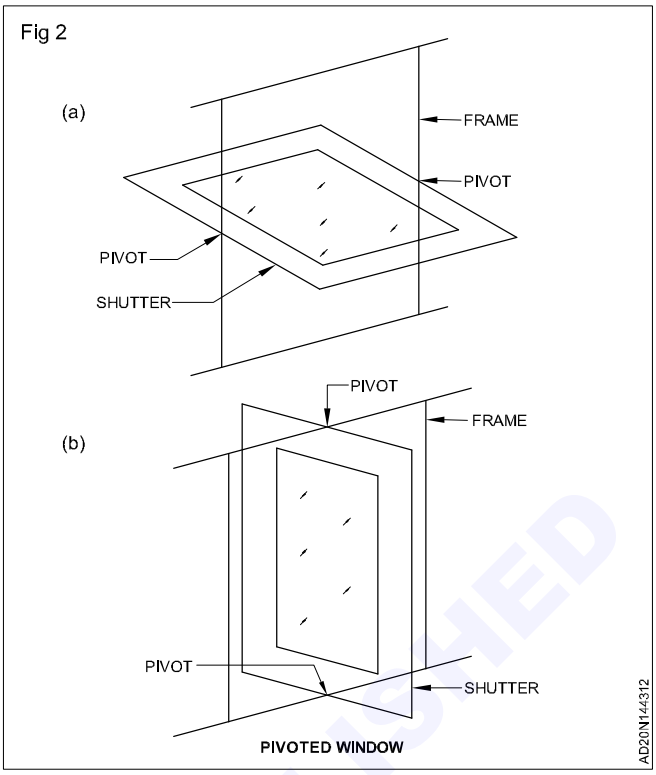
In this type of window the shutter is capable of rotating about a pivot fixed to window frame. The window frame has no rebate. The shutter can rotate horizontally or vertically depending upon the position of pivot.

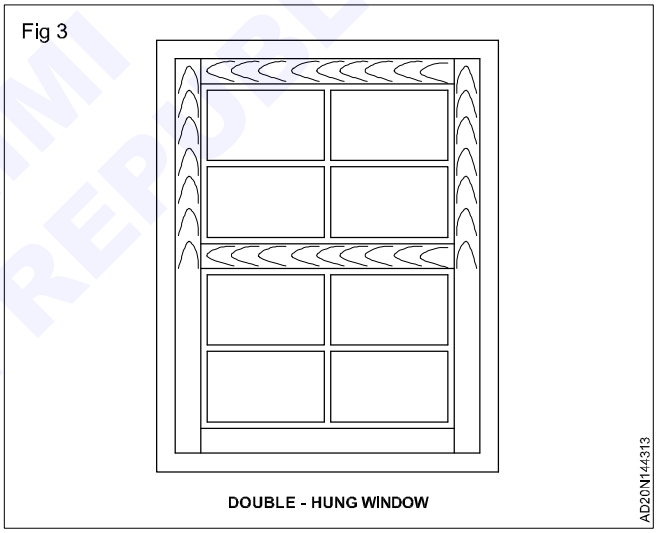
Double – hung window (Fig 3)

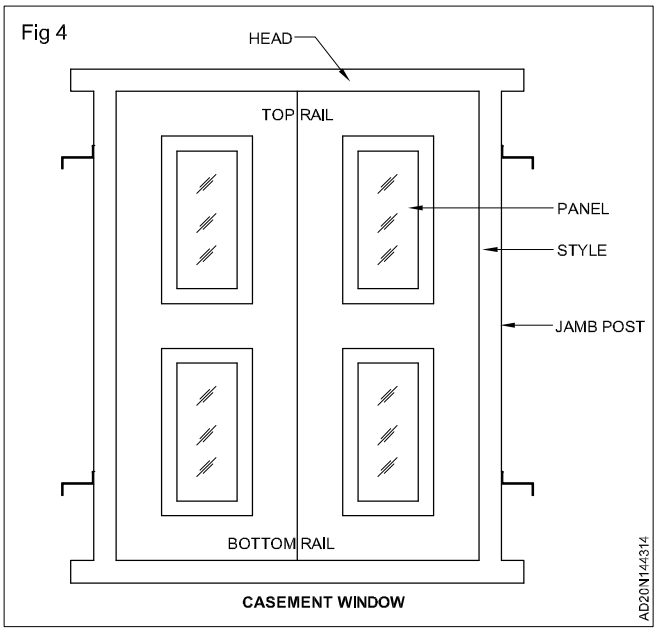
This type of window consist of a pair of shutters arranged one above the other which can slide vertically within the grooves provided in the frame. A pair of metal weights connected by chain passing over pulleys, is provided for each shutter. By this arrangement the window can be opened at top or bottom to the desired extent by pulling the metal weight suitably. Thus in this type of window, it is possible to have controlled ventilation. In addition, the shutter can also be cleaned easily.

Casement window (Fig 4)

Window where shutters open like door are called casement windows. The window has a frame which is rebated to receiving the shutters. The shutters consist of stile, top rail, bottom rail and intermediate rail, thus dividing it into panels. The panel may be glazed or unglazed or partially unglazed. In case of windows with double shutters, the outer shutter may have wire-gauged panels.







Sliding Window

In this type of window the shutters move on roller and can slide horizontally or vertically similar to sliding door.

Sash or glazed window

In this case the window shutter consists two vertical stiles, top and bottom rails. The panel space of window shutter between the stile and rail is divided by sash bars into panels of small size for fixing glass panels. The glass panels are secured in position either by putty or by fillets, known as glazing beads.

Louvered window (Venetian window) (Fig 5&6)

In this type of windows the louvers are provided as in the case of louvered doors. They allow free passage or air when close and at the same time they maintain sufficient privacy. The shutter consists of top rail, bottom rail and two stiles; which are grooved to receive the louvers. The economical angle of inclination of the louvers is 45^0 and they are generally fixed in position.

Fig 5

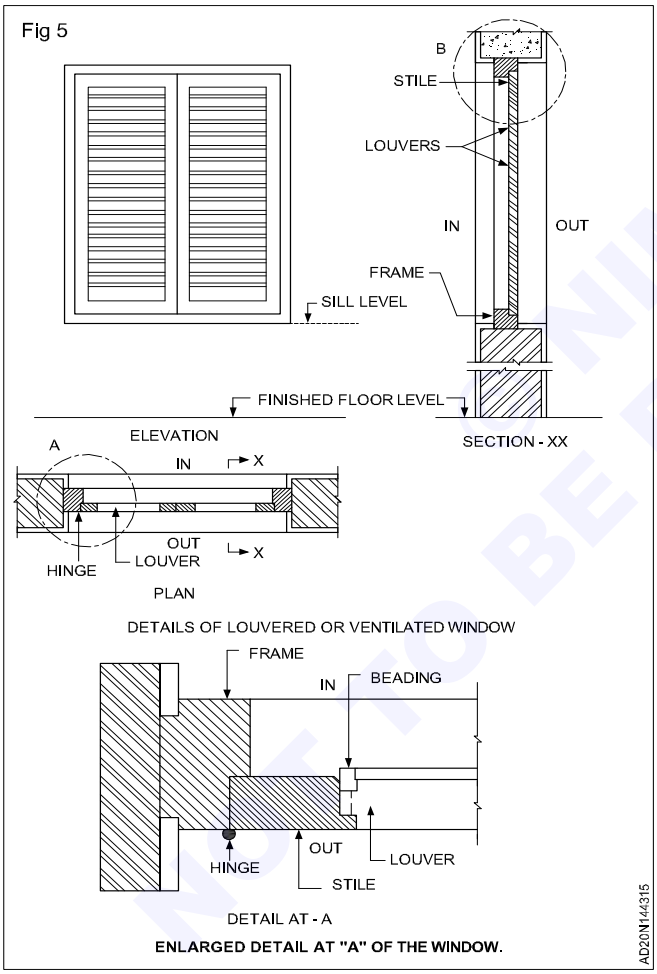
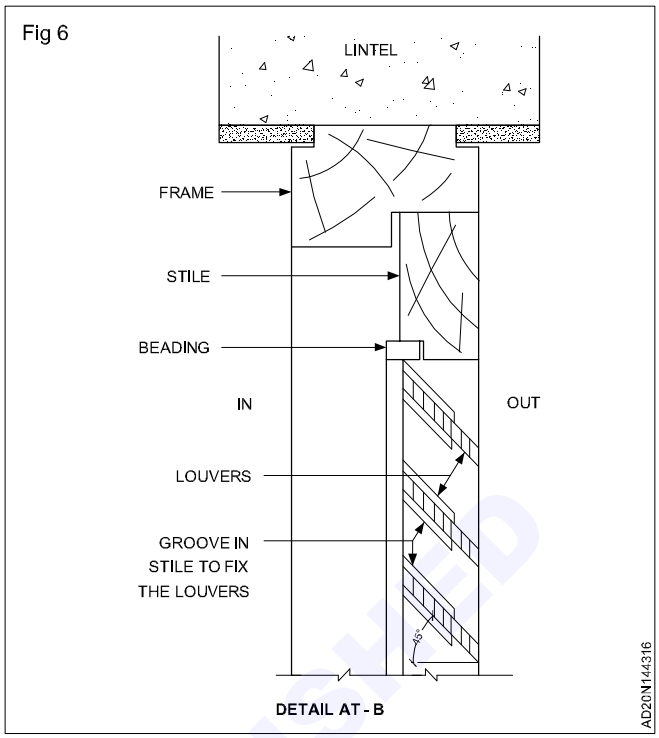


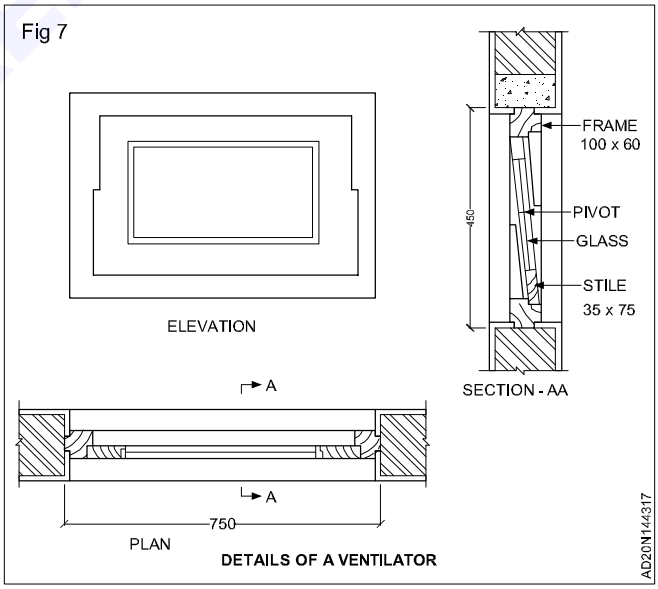
Fig 6



Ventilator

A ventilator may be defined as a narrow window of small height provided near the roof of a room to provide ventilation in the room. The shutter of the ventilator is horizontally pivoted and can be opened or closed by use of too chords, one attached to its top rail and the other to the bottom rail. (Fig 7)

Fig 7



Fixtures and fastenings

Objective: At the end of this lesson you shall be able to
- **explain types of fixtures and fastenings**
- **identify the types of joints used in doors and window.**

Introduction

Various types of fastenings are employed for connecting and maintaining the joints. The basic objects of different fastening and their important features are given below:

Fixtures and fastenings

The following types of fixtures and fastenings are required for doors, windows and ventilators.

1 Hinges

2 Bolts

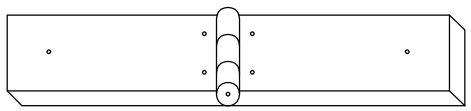
3 Handles

4 Locks.

1 Hinges: Following types of hinges are used for doors, windows and ventilators.

a Back flap hinge: These hinges are used where the shutters are thin. These are fixed on backside of the shutter and frame. (Fig 1)

Fig 1

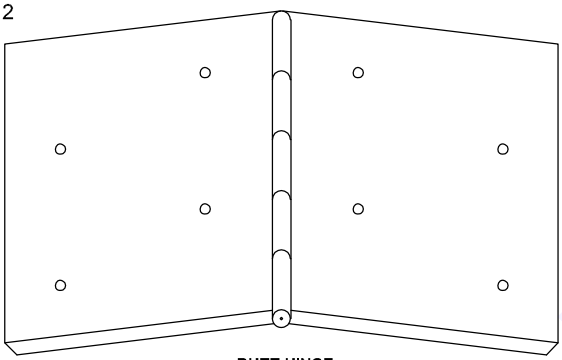


BACK FLAP HINGE

AD20N144321

b Butt Hinge: These hinges are commonly used for fixing door and window shutters to the frame. (Fig 2)

Fig 2

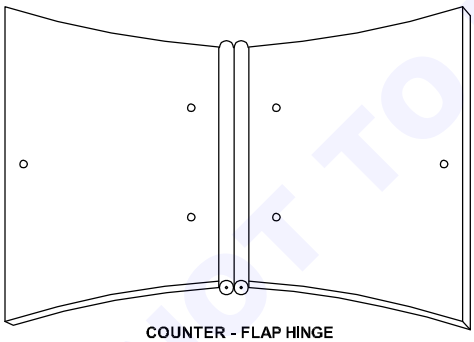


BUTT HINGE

AD20N144322

c Counter-Flap hinge: This type of hinge has three parts and two centers. Provision of this type of hinge enable the shutter to be folded back to back (Fig 3)

Fig 3

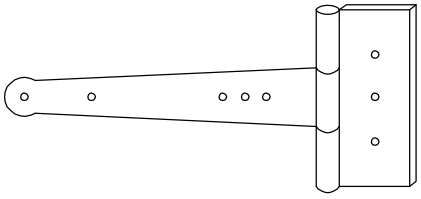


COUNTER - FLAP HINGE

AD20N144323

d Garnet hinge: This type of hinge is also known as T-hinge and is commonly used for battened, ledged and braced doors. (Fig 4)

Fig 4

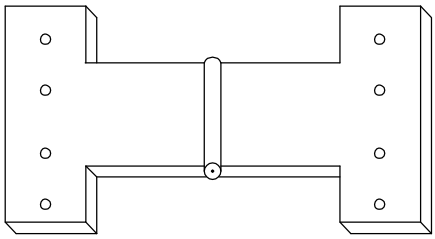


GARNET HINGE

AD20N144324

e Parliamentary Hinge: These hinges permit the door shutters, when open, the rest parallel to the wall. Hence these hinges are used where the opening is narrow and when it is required to keep the opening free from obstruction due to door shutters. (Fig 5)

Fig 5

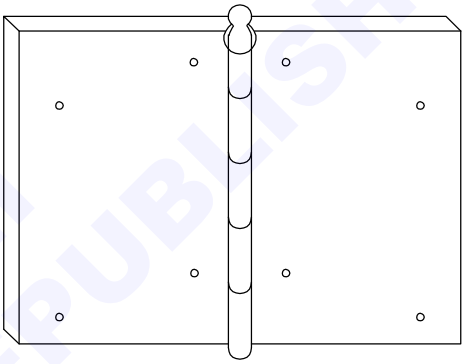


PARLIAMENTARY HINGE

AD20N144325

f Pin hinge: This is used for heavy door shutters. The center pin of the hinge can be removed and the two leaves or straps of the hinge can be fixed separately to the frame and the shutter. (Fig 6)

Fig 6

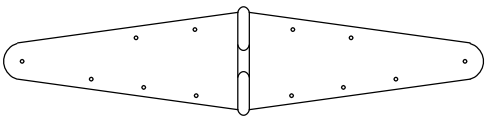


PIN HINGE

AD20N144326

g Strap hinge: It is used for ledged and braced door and for heavy doors such as for garages, stables gate etc. (Fig 7)

Fig 7

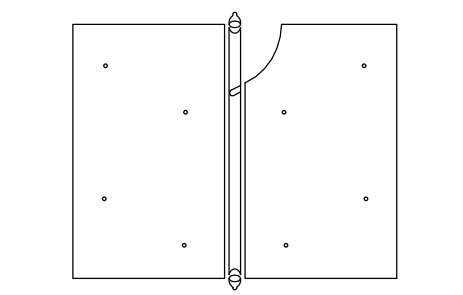


STRAP HINGE

AD20N144327

h Spring hinges: Single acting or double acting hinges are used for swinging doors, single acting hinge is used when door shutter opens only in one direction while the double acting hinge is used when shutter swings in both the directions. The door closes automatically due to spring action (Fig 8)

Fig 8

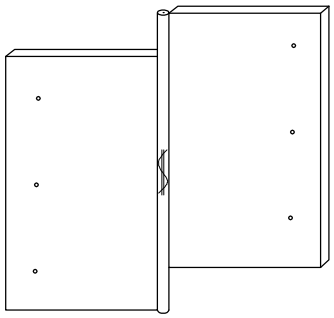


SPRING HINGE

AD20N144328

i **Rising butt hinge:** Such hinges are used for doors of rooms having carpet etc. They are used in place of ordinary butt hinges. The door is closed automatically, due to which the shutter is raised by 10 mm on being opened. (Fig 9)

Fig 9



RISING BUTT HINGE

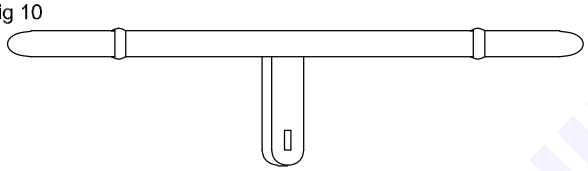
AD20N144329

Bolts

Following are the various type of bolts used for doors and windows:

a **Aldrop:** It is fixed on external doors where pad locks are to be used. (Fig 10)

Fig 10

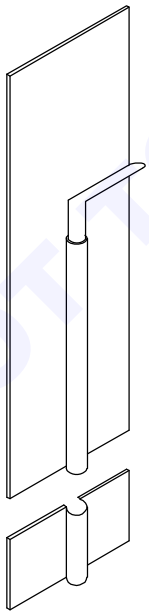


ALDROP

AD20N14432A

b **Barrel bolt:** It is used for fixing back faces of doors. The socket is fixed to the door frame while the plate is succeeded to the inside of the shutter (Fig 11)

Fig 11

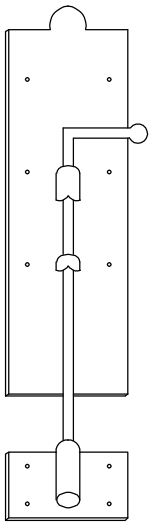


BARREL BOLT

AD20N14432B

c **Tower bolt:** This is similar to barrel bolt except that instead of barrel bolt are two or three staples (Fig 12)

Fig 12

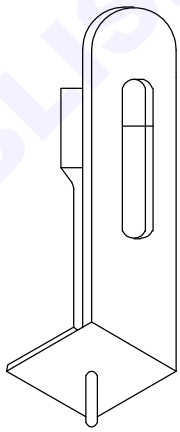


TOWER BOLT

AD20N14432C

d **Flush bolt:** This bolt is used when it is desired to keep the bolt flush with the face of the door (Fig 13)

Fig 13

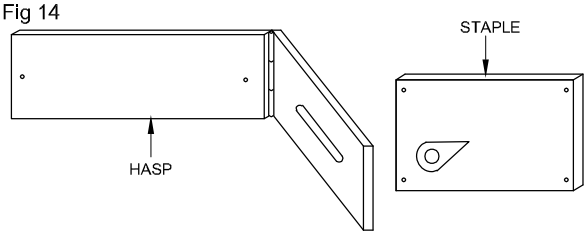


FLUSH BOLT

AD20N14432D

e **Hasp and Staple bolt:** This is used for external doors where padlock is to be used. The staple is fixed to the door frame while hasp is fixed to the shutter (Fig 14)

Fig 14



HASP AND STAPLE BOLT

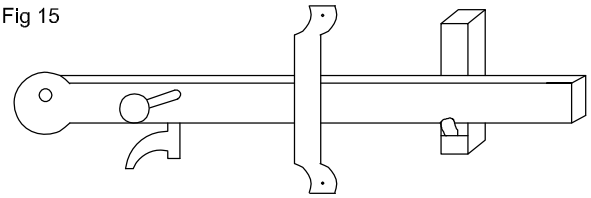
AD20N14432E

f **Latch :** This is made of iron, it consists of lever pivoted at one end. The Liver is secured in a hasp and staple. It is fixed to the inside face of the door (Fig 15)

Locks

a **Hook and Eye:** This is used for keeping the window shutter in position when the window is opened (Fig 16)

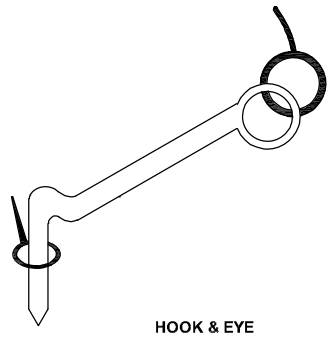
Fig 15



LATCH

AD20N14432F

Fig 16

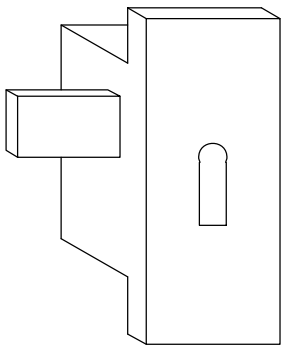


HOOK & EYE

AD20N14432G

b Cup-board lock: It is used to secure doors of minor importance (Fig 17)

Fig 17

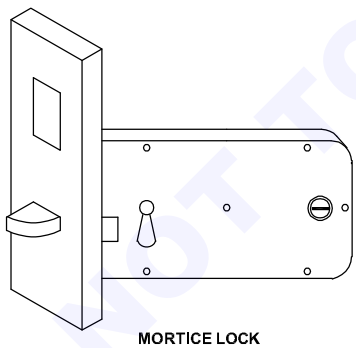


CUP - BOARD LOCK

AD20N14432H

c Mortice lock: It is fixed in mortice formed on the edge of a door (Fig 18)

Fig 18

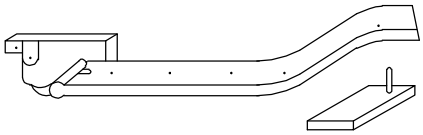


MORTICE LOCK

AD20N14432I

d Peg Stay: It is used for steel windows. The width of opening can be adjusted by holes which are provided in the peg stay (Fig 19)

Fig 19

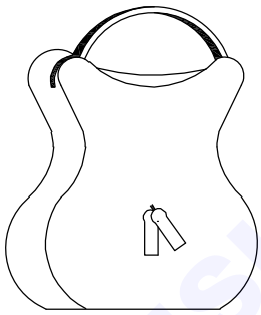


PEG STAY

AD20N14432J

e Pad lock: It is used for securing doors when all drop bolts and hasp and staple bolts are employed (Fig 20)

Fig 20

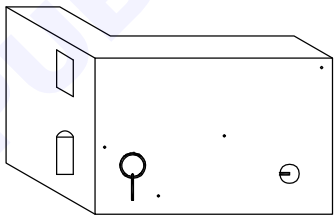


PAD LOCK

AD20N14432K

f Rim Lock: It is used for thin doors (Fig 21)

Fig 21



RIM LOCK

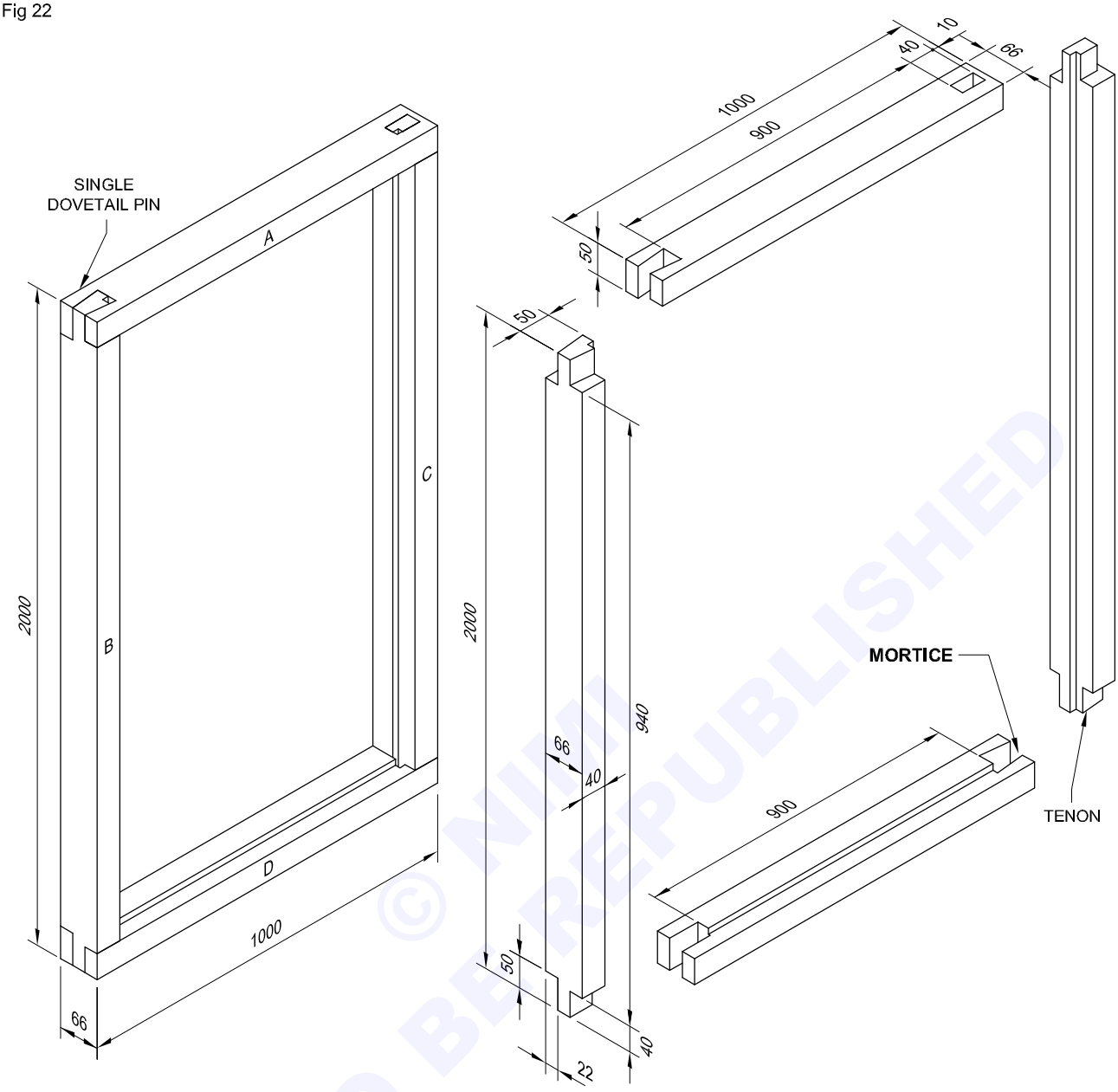
AD20N14432L

Types of joints (used in door and window) (Fig 22 & 23)

Framing joints, mortice and tenon joints are similar to bearing joints. These type of joints are used in doors and windows framing.

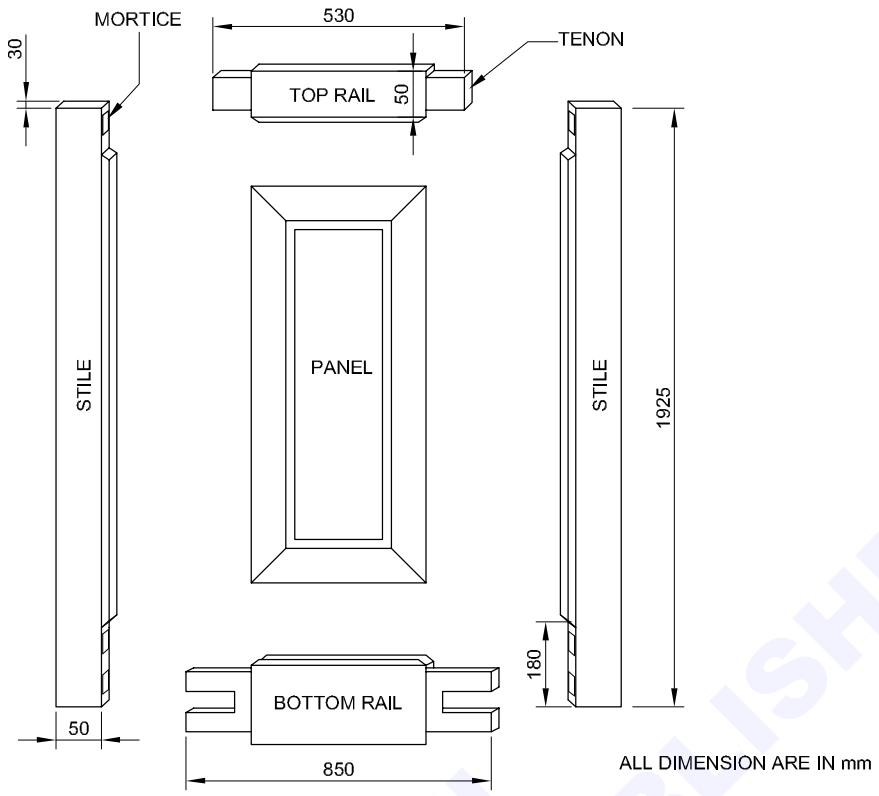
Mortising is the process of cutting rectangular recess or hole in the member of wood to receive the projection of another member while the process of forming projection at the end of timber piece to fit into the recessed or mortise hole is known as tenoning.

Fig 22



DOOR FRAME - MORTICE AND TENON JOINT

Fig 23



SINGLE PANEL DOOR SHUTTER - MORTICE AND TENON JOINT

Lintel with chajja

Objectives : At the end of this lesson you shall be able to,
- **define lintel**
- **explain bearing of lintel**
- **listout the materials used lintel**
- **classify the lintel according to material of construction.**

Introduction

A lintel can be a load bearing building component placed over an opening. The function of lintel is just the same as that of an arch or a beam. However the lintels are easy and simple in construction. Lintels are made from various materials. The lintels of RCC are widely used to span the openings for doors, windows etc. in a structure.

Definition

A Lintel is a structural horizontal member which is placed across an opening to support the portion of the structure above it.

Bearing of lintel

Bearing of lintel means the distance up to which it is inserted in the supporting wall. Bearing should be the minimum of the following three considerations.

1 150 mm or

2 The height of lintel or

3 1/10th to 1/12th span.

Materials for lintels

The common materials used in the construction of the lintel are as follows.

1 Wood or timber

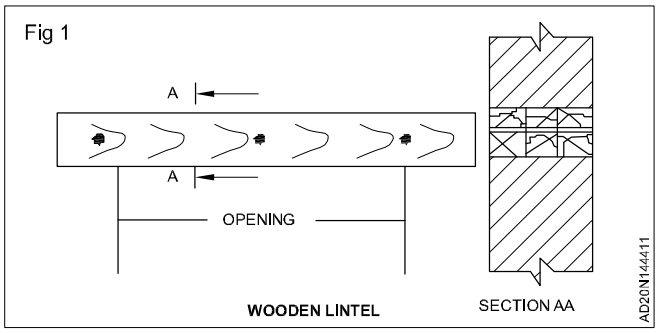
2 Stone

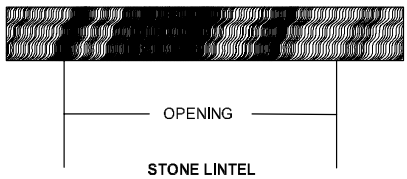
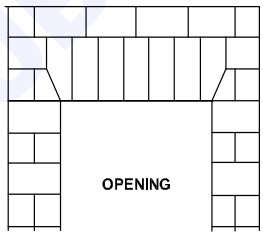
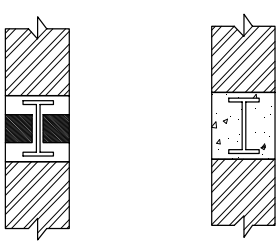
3 Brick

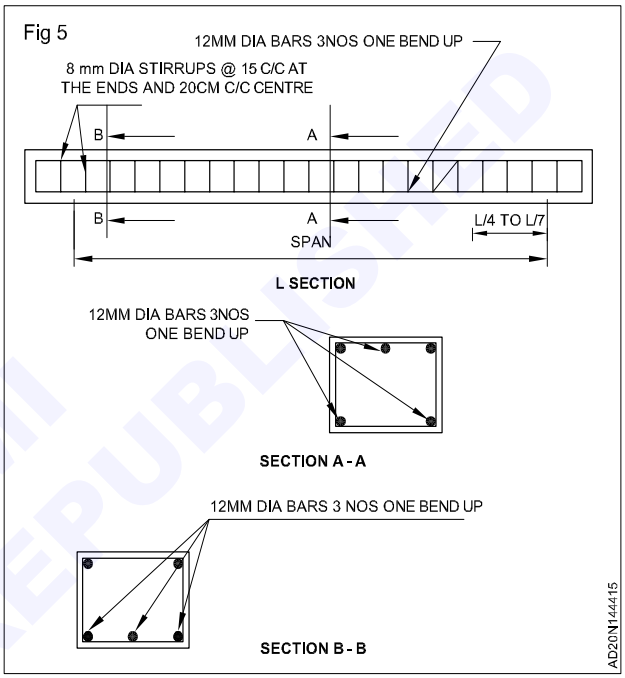
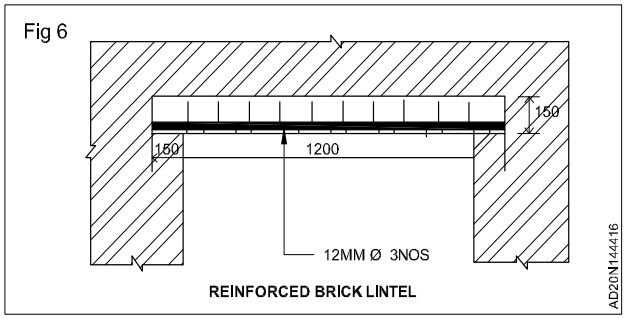
4 Steel

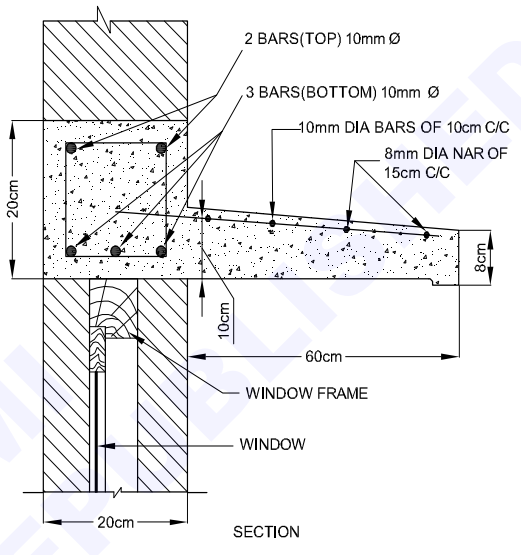
5 Reinforced cement concrete

Classification of lintels according to the material used

Name	Features	Figure
1 Wood or timber lintel. (Fig 1)	A single piece of timber or built up sections of wood can be used as a lintel. • A bearing of about 15 cm to 20 cm should be provided. • The width of lintel should be equal to the opening • The depth of lintel should be about 1/12 to 1/8 of the span with a minimum value of 80 mm. • Timber lintels one oldest types of lintels they are not commonly used now. • There are relatively costlier, structurally weak and vulnerable to fine, liable to decay	Fig 1 

Name	Features	Figure
2 Stone lintel (Fig 2)	These lintels consists of slabs of stones which it placed across the openings. **Disadvantages of stone lintels** • Stone posses low tensile resistance. • It is difficult to obtain a good stone of required depth. • Stone lintels are used where stones are abundantly available • Dressed stone lintels give good architectural appearance. • It can be used for up to 2m span of width. • It acts when subjected to vibratory loads because it is weak in tension.	Fig 2 
3 Brick lintels (Fig 3)	Brick lintels consist of bricks which are generally placed on edge. • Bricks should be well burnt, copper coloured • Free from cracks and with sharp and square edges. • This lintel have a depth equal to some multiple of brick courses. • Suitable up to a span of one meter and for greater spans reinforcement or steel angle may be provided. • Brick lintels are used only when the opening is very small (less than 1m) and loads are light. • Bricks with frogs are more suitable. Bricks are cheap and easily available material and very common in the site. So it is used for temporary structures.	Fig 3 
4 Steel lintels (Fig 4)	• Steel lintels consist of steel angles or rolled steel joists. Steel angles are used for small spans and light loading. • Rolled steel joists are used for large spans and heavy loading. • Tube separator-may be provided to keep the joists in position.	Fig 4 

Name	Features	Figure
	• R.S.J - The joists are embedded in concrete to protect steel from corrosion and fire. • Steel lintels are used at large openings and where superimposed loads are heavy. • Faster installation, light weight, can be used with combination of different materials.	
5 Reinforced cement concrete (Fig 5)	These lintels consists of reinforced cement concrete. The usual mix for concrete R.C.C lintel is 1:2:4 lintels Properties of R.C.C lintels. • Fire proof • Durable • Strong • Economical • Easy to construct • No relieving arches are necessary. The reinforcement provided depends on 1 Span of lintel 2 Width of opening 3 Total load to be supported	Fig 5 
a. Precast RCC	• Economical, Increase speed of construction • Allow sufficient time for curing before fixing.	
b. Cast in situ RCC Lintel	• Centering is prepared reinforcement is placed and concreting is done.	
6 Reinforced Brick lintel (Fig 6)	Brick lintel strengthened by the provision of mild steel. In this use first class bricks with high compressive strength. Dense cement mortar is used to embed the reinforcement. It is adopted or used in the following circumstances. • Brickwork has to bear tensile and shear stress • To increase the longitudinal bond • Brickwork supported on large settlement soil.	Fig 6 

Name	Features	Figure
	• Brickwork is supported to act as a beam or lintel over opening • When brickwork is to resist lateral loads as in retaining walls • To carry heavy compressive load • In seismic areas	
7 R.C.C. lintel with chajja or canopy (Fig 7)	• The number of main bars depends upon the load to be carried from the wall above and span of opening. • The diameter of the bar varies with the span and is adopted as follow • 6 mm ϕ bar span upto 1 m • 8 mm ϕ bar span 1 to 1.5m • 10 mm ϕ bar span 1.5 to 2 m • 12 mm ϕ bar span 2 to 3 m • The details of chajjah projection or canopy is shown in Fig. 7	Fig 7  R.C.C LINTEL WITH CHAJJAH (OR) SUNSHADE

Arches

Objectives : At the end of this lesson you shall be able to,
- **define arch**
- **state the technical terms regarding the arch**
- **identify the components of arch**
- **classify the arches.**

Introduction

It is a geometrical shaped structure placed over an opening to transfer the load coming over it. It generally consist of small wedge shaped units which are joined together with mortar.

Arches made of steel and R.C.C is built in single units without the use of wedge shaped units and they are used for bridge construction.

Definition

An arch is a structure which is constructed to span across an opening.

Technical terms:

Components of arch (Fig 1)

Intrados: Inner curve of an arch.

Soffit: Inner surface of an arch.

Extrados: Outer curve of an arch

Voussoirs: Wedge shaped units of masonry

Crown: Highest part of extrados

Key: Wedge shaped unit fixed at the highest point of arch.

Spandril: Curved triangular space formed between extrados and the horizontal line through the crown.

Skew back: Inclined splayed surface on the abutment which is Prepared to receive the arch.

Springing point: Points from which the curve of the arch springs.

Springing line: It is an imaginary line joining the springing points.

Springers: The lowest voussoir immediately adjacent to the skewback.

Abutment: End support of an arch

Pier: An intermediate support of an arch

Arcade: Row of arches.

Haunch: Lower half of the arch.

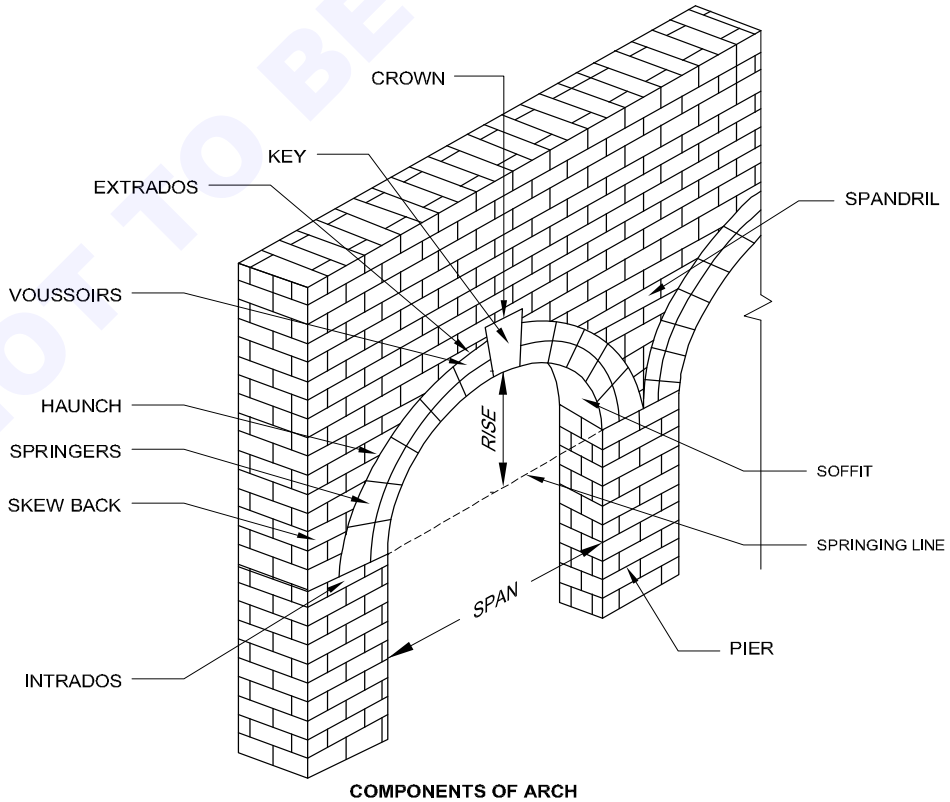
Span: Clear horizontal distance between supports

Rise: Clear vertical distance between highest point on the intrados and the springing line.

Depth: Perpendicular distance between the intrados and extrados.

Thickness : Horizontal distance measured perpendicular to the front and back faces.

Fig 1



COMPONENTS OF ARCH

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Classification of arches

Arches

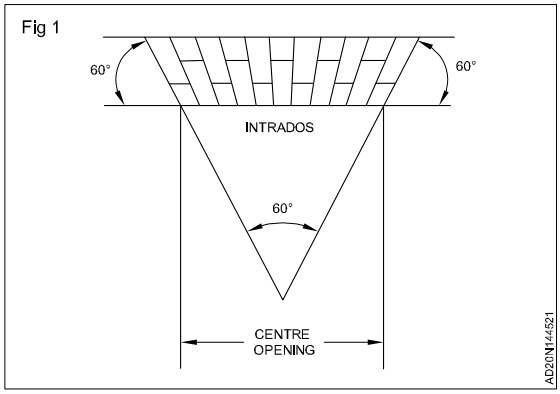
According to shape	According to number of centers	According to materials used	According to workmanship
1. Flat arch	1. One centered arch	1. Brick arch	1. Rough arch
2. Segmental arch	2. Two centered arch	2. Stone arch	2. Rough cut
3. Semi-circular arch	3. Three centered arch	3. Concrete arch	3. Gauged arch
4. Bull's eye arch	4. Four centered arch	4. Purpose made	
5. Semi elliptical arch	5. Five centered arches		
6. Inverted arch			
7. Pointed arch			
8. Relieving arch			
9. Horse-shoe arch			
10.Stilted arch			
11.Venetian arch			
12.Florentine arch			
13.Ogee arch			
14.Tudor arch			
15.Drop arch.			

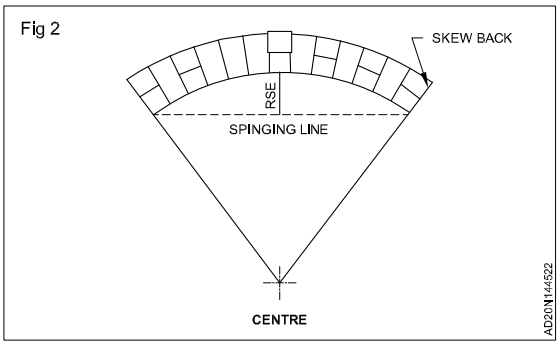
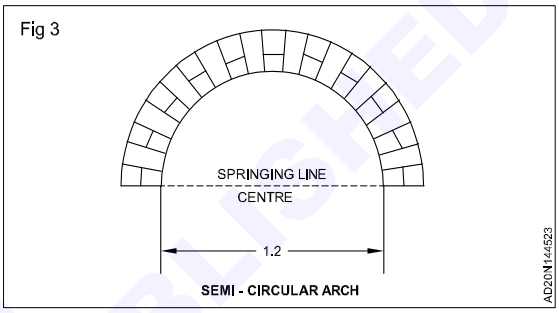
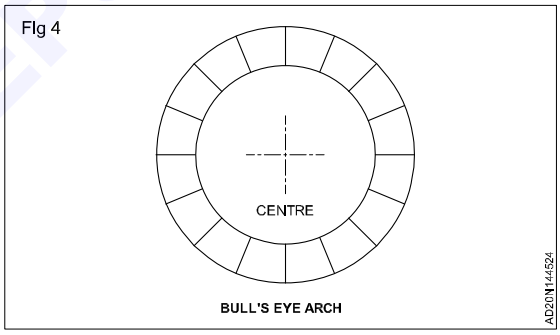
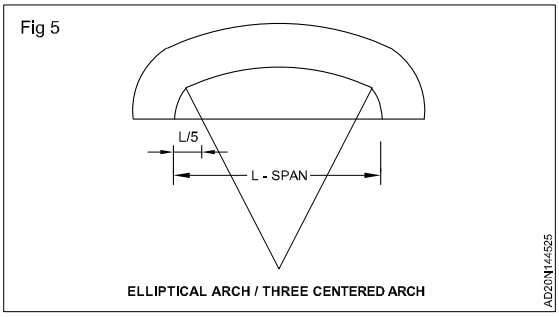
Arches according to shape

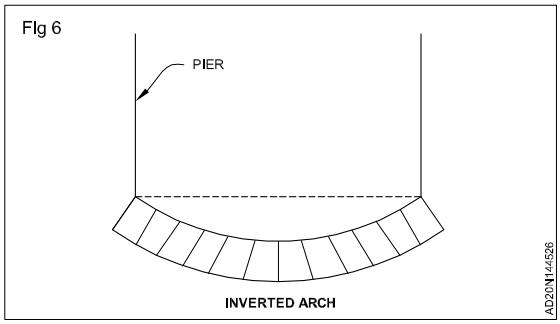
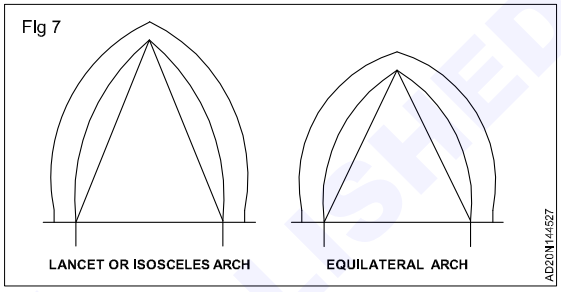
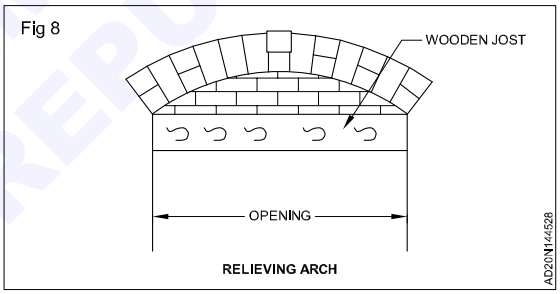
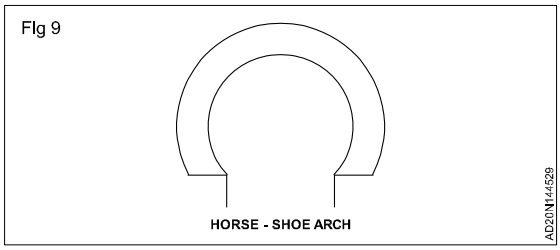
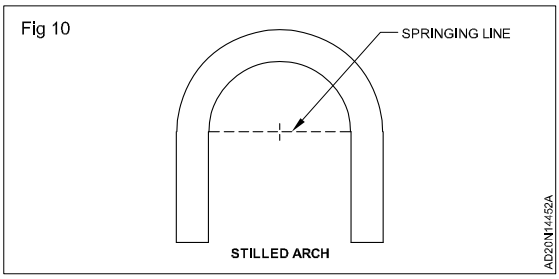
Objectives : At the end of this lesson you shall be able to,
- **classify arches according to shape**
- **state the technical terms regarding the arch**
- **classify the arches.**

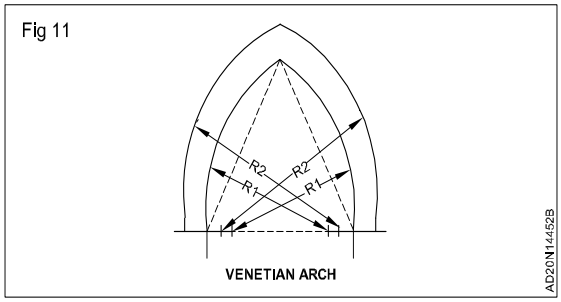
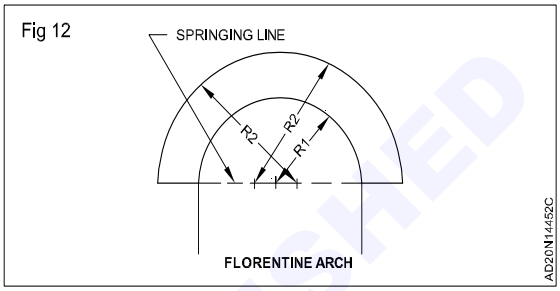
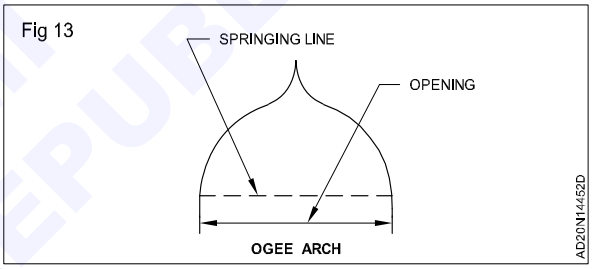
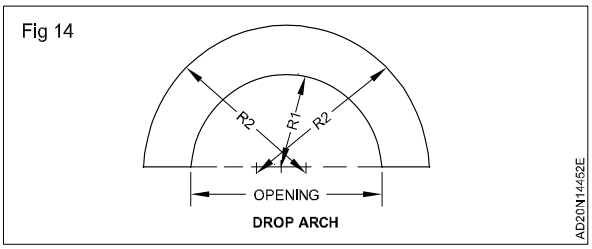
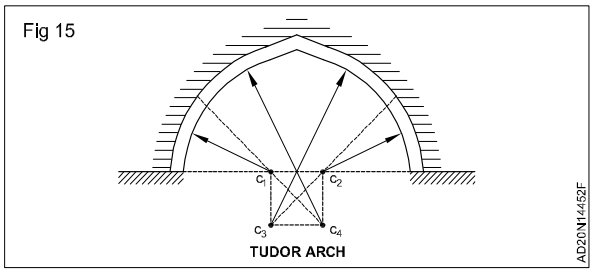
According to shape ,the arches are classified as follows.

Classification of arches according to shapes

Name of arch	Features	Figure
1 Flat arch (Fig 1)	• Shape flat and skewback forms 60 degree with horizontal. • Depth equal to course of masonry. • Slight rise of about 10mm to 15mm per meter length of masonry opening. • Max.span upto 1.5m • Used for light loading and very easy to construct. • Used for doors and windows.	Fig 1 

Name of arch	Features	Figure
2 Segmental arch (Fig 2)	• Centre of arch is below springing line. • Thrust transferred to the abutment in an inclined direction • This types of arch commonly used because skilled labour is not necessary	Fig 2 
3 Semi-circular (Fig 3)	• Centre of arch lies on the springing line • Skewback is horizontal. • Thrust transferred to the abutment in vertical direction. • Gives aesthetic appearance as well as strong structure • Used in bridges and aqueducts • Simple arches were constructed in Large structure at ancient times	Fig 3 
4 Bull's eye arch (Fig 4)	• One center only. • Used for circular windows • Also known as full circle arch • Very attractive appearance and decorative	Flg 4 
5 Semi -elliptical (Fig 5)	• More than one center arch (Three or five) • Used for Large span openings and river bridges	Fig 5 

Name of arch	Features	Figure
6 Inverted arch (Fig 6)	• Constructed between piers to increase the bearing power of soil. • Rise is 1/5 to 1/10 of span. • Built in ½ brick rings. • It provides as foundation for walls	
7 Pointed arch (Fig 7)	• Two curves meeting at the apex of a triangle. Two types are • Equilateral arch and • Lancet or isosceles arch. • Used to direct weight on the load bearing columns at sharp angle allowing for much taller vaults	
8 Relieving arch (Fig 8)	• Constructed over a wooden joist or flat arch. • It relieves the joist or flat arch from carrying load.	
9 Horse shoe arch (Fig 9)	• Shape include more than a semicircle. • Centre of arch lies above springing line	
10 Stilted arch (Fig 10)	• Semi circular portion attached at the top of two vertical portions. • Springing line passes through the top of vertical portions. • Used for Large and high openings	

Name of arch	Features	Figure
11 Venetian arch (Fig 11)	• Depth at crown is more than that at the springing line. • Have four centers.	Fig 11 
12 Florentine arch (Fig 12)	• Similar to venetian arch except that the intrados has a Semi circular shape.	Fig 12 
13 Ogee arch (Fig 13)	• Consist of three centers and with reverse (Ogee) curve.	Fig 13 
14 Drop arch (Fig 14)	• Consist of two centers	Fig 14 
15 Tudor arch (Fig 15)	• Consist of four centers. • This is a pointed arch of four centers.	Fig 15 

Arches according to number of centers

Objectives : At the end of this lesson you shall be able to,
- **classify arches according to number of centers.**

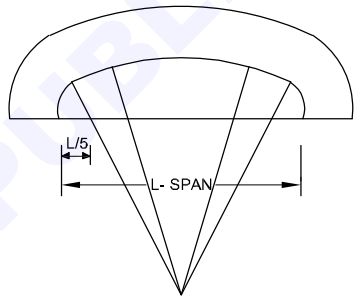
According to number of centers ,the arches are classified as follows

Classification of arches according to number of centers

Name of arch	Description	Example
1 one- centered arch	This type of arches have only one center	Flat, Segmental, Circular, Horse shoe, Stilted, Etc.
2 Two- centered arch	This type of arches have two centers	Pointed arches ie, Equilateral pointed and isosceles pointed arch (Lancet and Drop).
3 Three-centered arch	This type of arches has three centers	Three centered semi-elliptical arch, Florentine arch, Ogee arch.
4 Four-centered arch	This type of arches has four centers	Venetian, Tudor.
5 Five-centered	This type of arches has five centers	Five centered semi elliptical arch.

We can make this type of arch with more number of centers. (Fig 1)

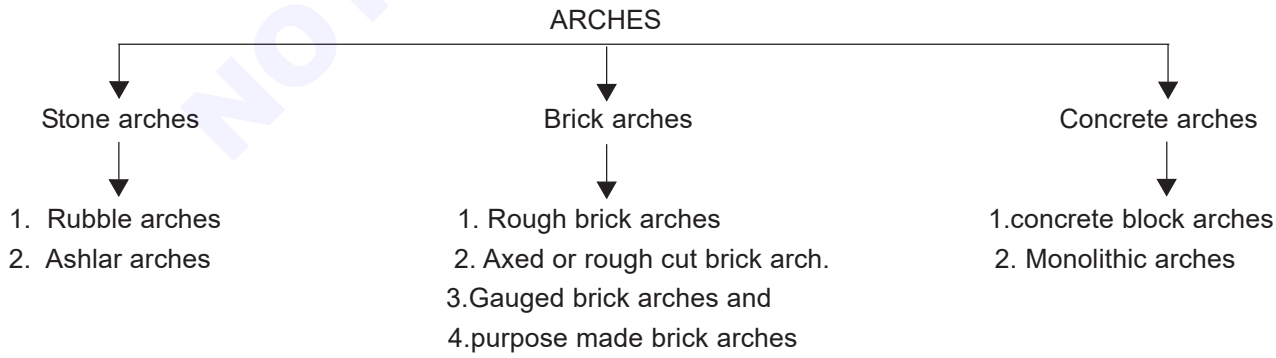
Fig 1



FIVE CENTERED SEMI ELLIPTICAL ARCH

Arches according to material of construction & workmanship

Objectives : At the end of this lesson you shall be able to
- **classify arches according to material of construction & workmanship**
- **state the features of arches according to material of construction**
- **state the features of arches according to workmanship.**



Classification of arches according to materials of construction

Name	Type of materials	Description
Stone arch	1 In ashlar masonry 2 In rubble masonry	• Constructed from wedge shaped units. • Stones should be laid with their natural bedding plane. • Weak and used for inferior work. • Span limited to 1m or so
Brick arch	1 With ordinary bricks 2 With purpose made brick 3 With soft brick	• Joints are made wedge shaped. • Not suitable for exposed brick work. • Good quality arch work. • Soft bricks are cut,sawn and rubbed to desired shape.
Concrete arch	1 With precast concrete blocks 2 Monolithic concrete	• Similar to stone arches in ashlar masonry. • Constructed from cast in -situ concrete and are suitable for long spans.

Classification of arch according to workmanship

Sl.No.	Name	Description
1	Rough arch	• Using ordinary uncut bricks • Bricks are rectangular shape and mortar joints are wider at extrados than at the intrados. • Rough arch is used where appearance is secondary importance, the arch surface is plastered.
2	Axed or rough cut arch	• The bricks used are wedge shaped by means of an axe • The thickness of mortar joints various 3 mm to 6 mm.
3	Gauged arch	• The bricks used are wedge shaped by means of a wire saw, the bricks are cut finely. • The mortar joints are 1.5mm to 0.75 mm.

Introduction of CAD

Objectives : At the end of this lesson you shall be able to
- **define the computer and CAD**
- **describe history of computer.**

Introduction

Computer are increasingly becoming a part of everyday life. Computer calculates our electricity and telephone bill, useful applications in the field of medicine and medication, assists various business organization system to keep their accounts and other basic jobs up to date. It also provides the facility of playing games and surfing over the internet so as to gain information on different filed.

Definition

Computer are an electronic devices which are used to perform arithmetic and logic operation at a very high speed. The application of computers in different fields and areas are successful and economically justified.

AutoCAD

AutoCAD is the leading computer-aided design and drafting (CAD) program in the world. Since its original introduction in November, 1982, AutoCAD has grown in sales and functionality to become the standard PC-based CAD program. Over the years, AutoCAD has kept pace with developments in the computer industry. The program has grown from its original command line driven DOS-based roots to become a fully compatible windows application.

Enlarging or reducing diagrams : CADD allows you to enlarge or reduce diagrams in a convenient manner. To enlarge or reduce diagrams, you need to select the objects and enter a scale factor. The scale factor determines by how much the diagrams are to be reduced or enlarged.

There are two main categories of computer software:

- **System software**
- **Application program**

The system software manages the internal operations of the computer. The application programs are tools that help you accomplish your work, such as CADD.

CAD hardware

The following are the main hardware components of CAD

- System unit
  - Central processing unit.
  - Memory.
  - Hard disk, CD-ROM pen drive.
- External storage devices.
- Monitor.
- Printers and plotters.
- Keyboard.
- Digitizer, puck and mouse.

System unit

The system unit is the computer that is used for all data processing. The main components of the system units are the central processing unit (CPU) and memory. In mainframe and minicomputers CPU and memory are usefully separate compartments that house thousands of devices. In today's PCs, however, they all fit in a small box commonly known as a desktop computer. Most desktop computers today come equipped with a hard disk, and CD-ROM. Let us have a look at the components of a system unit:

- Central processing unit.
- Memory.
- Hard disk, CD-ROM.

External storage devices

There are a number of external storage devices available such as magnetic tapes, zip drives and removable hard disks. They are commonly used to keep backup copies of electronic files for safekeeping.

The new option for data storage is the removable hard disk. You can remove the entire hard disk from your computer and use it on another computer. This approach is commonly used when you need to work on different computers and you want the same information to be available instantly.

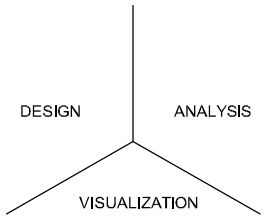
Computer Aided Design & Drafting (CADD): It is simply, design and drafting with the aid of a computer. Design is creating a real product from an idea. Drafting is the production of the drawings that are used to document a design. CAD can be used to create 2D or 3D computer models. A CAD drawing is a file that consists of numeric data in binary form that will be saved onto a disk.

Traditional drafting is repetitious and can be inaccurate. It may be faster to create a simple "rough" sketch by hand but larger more complex drawings with repetitive operations are drawn more efficiently using CAD.

Learning to use a CAD system is similar to learning a new language. It is necessary to begin with the basic alphabet and learn how to use it correctly and effectively through practice. This will require learning some new concepts and skills as well as learning a different vocabulary.

In general, a Computer Aided Design (CAD) package has three components: a) Design, b) Analysis, and c) Visualization, as shown in the sketch. A brief description of these components are follows as Fig 1

Fig 1



COMPONENTS OF COMPUTER AIDED DESIGN

The monitor (Fig 2)

Fig 2

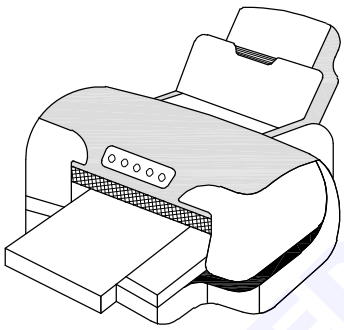
The monitor is the computer screen and is used to display information. A good monitor is very important for CADD in order to display fine graphics. A colour monitor is essential because many CADD drawing techniques are based on colours. Monitors are available in various sizes ranging from 13" to 30" or more. It should have high refresh rate.

The main factor that determines the quality of a monitor is the resolution. The term resolution refers to sharpness of an image displayed on the screen. Resolution is measured by the number of picture elements (pixels) that a screen can display. The more pixels and the closer they are the sharper the image. Typically, a flat panel monitor with a resolution of 1920 x 1080 or higher is recommended The monitor should have an aspect ratio of 16:9 so that it can display 1080P contents.

Printers and plotters (Fig 3)

CADD drawings are printed using fine-quality printers and plotters. Drawings are neat and clean and as accurate as the naked eye can see. You can print drawings at as much as 1200-dpi (dots per inch) accuracy. This means 1200 dots are printed in every inch. All the text dimensions and other graphics are printed highly accurate, neat and crisp. You can print drawings with a lot of variations; for example, drawings can be printed with different sizes, line types, text fonts and colours.

Fig 3

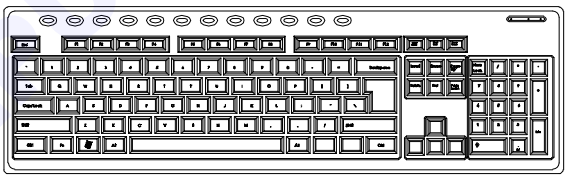


PRINTER

There are a variety of printers and plotters available in the computer industry. They work on different principles and their prices very significantly. There are many types of pen plotters, ink-jet printers, laser printers and plotters, electrostatic printers, etc.

Key board (Fig 4)

Fig 4



KEYBOARD

Key board: This is an input devices. Which contains keys to feed information in to the computer.

Type writer key: Used for letters, numbers and punctuation symbol.

Function Keys: F1 to F12 performs depend on the software use.

Cursor control keys: To move the cursor to the left, right, up, or down.

Page up and down key: To move the preceding page and to move the text page.

Home key: To the top of the Document.

End key: To end of the Document.

Num lock key: Numeric 0-9, pressing any of them, a number gets displayed on the screen.

Caps lock key: By pressing, type letters will appear in the small or capital.

Shift key: To appear the upper symbol, if hold down this key.

Ctrl & Alt key: Often used in combination with other keys to carry out special actions. By pressing Ctrl, Alt & delete

keys simultaneously, the machine automatically restart.

Enter key: In alert PC that finish given instruction to execute the Instructions.

Tab key: Move the cursor along the line to a preset point and also to move from one option to another in a menu.

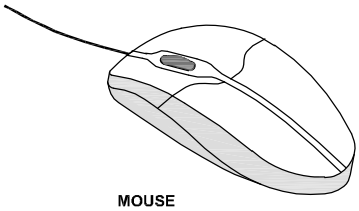
ESC key: To cancel or to ignore the entry or command that just Entered.

Delete key: Erase the character to the place to the right side of the Blinking cursor.

Back space key: Erase the character to the left side of the blinking curser, also it moves the cursor back.

Digitizer, puck and mouse (Fig 5)

Fig 5



MOUSE

AD20N154615

The digitizer (also known as a graphic tablet) and the puck are the data input devices most commonly used in CADD systems. These devices allow you to enter point locations on the screen and to make selections from the menus. As the puck is moved over the surface of the digitizer, it moves the indicator (cursor) on the screen relatively. To enter a point, you need to position the cursor at the appropriate position on the screen and then press the "Enter" button on the puck.

Digitizers are available in many sizes and styles. A number of commands are printed on the digitizer surface. To enter a command, place the puck over the desired command and press the "Enter" button. The selected command is instantly entered. The puck buttons are configured to perform many other tasks. For example, one button is used to make selections, another to enter the data, another to return to the previous menu and another to cancel the last command.

A mouse is another pointing device that can be used with CADD. Like the puck, the mouse allows you to control the position of the cursor on the screen by rolling it across a flat surface, but it does not require a digitizer. Some programs support working with a mouse only, while others support both the mouse and the digitizer. A mouse is much cheaper than a digitizer or puck, but provides only limited data entry options.

CADD software

A CADD program contains hundreds of functions that enable you to accomplish specific drawing tasks. A task may involve drawing an object, editing and existing drawing, displaying a view of the drawing, printing or saving it, or controlling any other operation of the computer. The functions contain a number of commands that enable you to specify exactly what you want to do and how you want to do it.

The functions are organized into modules that provide easy access to all the commands. The program is divided into modules such as draw, edit, data output, function control, data storage and management. A program may also have a number of specialized functions such as layers, database and 3D. Let s have a look at the CADD modules.

- Draw.
- Edit.
- Data output.
- System control.
- Data storage and management.
- Special features.

Draw : The draw module provides access to all the drawing functions of CADD. Whenever you need to draw something this group of functions is used. The draw module enables you to draw lines, arcs, circles, ellipses, text, dimensions, symbols, borders and many other drawing components.

Draw is CADD s most frequently used module because all drawing work is accomplished using it.

Edit : The edit module lets you change existing drawing elements and manipulate them in a number of ways. You can move, copy or erase drawing components. You can enlarge or reduce the sizes of diagrams or change the colour and line type of drawing components. You can also change the size and style of text and dimensions, as well as edit a dimension to show different units of measurement. A good CADD program is designed to change the appearance of all drawing elements created with CADD.

The edit functions also act as convenient drawing-aid tools. They enable you to join missing corners of lines, trim drawing components along a line, stretch them to fit a new shape, etc. The list of editing capabilities goes on and on. The edit functions make CADD a dynamic drawing tool.

Data output : The data output module enables you to display drawings on the screen and then print them on paper. There are two separate sets of functions that help accomplish this:

- View-display functions.
- Print/plot functions.

The view-display functions allow you to display different views of a drawing on the screen. These functions are used quite often, because every time you need to draw something or edit something, you need to focus on that portion of the drawing. With the help of view-display functions, you can zoom in on a specific portion of the drawing.

The print and plot functions allow you to print drawings using a printer or a plotter. You can control many aspects of printing and plotting. You can print the same drawing in different sizes by applying the appropriate scale factor. You can plot the drawings with specific colours, pen thickness, and line types.

Data storage and management : The data storage and management module allows you to store and manage drawing data. Through the use of the functions in this module, you can store drawings as files on the hard disk. You can manage the files in directories and sub-directories, and move, copy or delete them as needed.

CADD data management functions also let you translate drawings created by other CADD programs. These functions convert drawing data to a generic format that can be read by any CADD program. Data exchange format (DXF) is one of the common data translation formats used by CADD program. There are a number of data exchange formats available.

System control : The system control module (also known as system defaults) allows you to control how CADD works. CADD programs are designed for a broad range of professionals, including architects, designers, engineers and surveyors. With the help of system control functions, you can set the working environment of CADD to suit your needs.

Example: You can set the type of units that you will be using, the accuracy of the units, a style for dimensions and text, colours, layers, line type in a drawing, etc. Additionally, you can customize screen menus, the display of colours on the screen, resolution of the screen, size, the speed of the cursor, etc.

Special features : CADD programs usually offer a number of special features that make working with CADD easier and allow you to automate many drawing tasks. For example, you can create layers in a drawing that allow you to segregate drawing components. You can develop spreadsheets and databases that can be used to create many types of project reports. You can create three-dimensional (3D) drawings, such as isometrics and perspectives, with the help of 3D functions. You can also accomplish many other automated tasks with the help of macros.

CADD user interface

CADD user interface provides the environment and the tools that allow you and the computer to communicate. Each CADD program establishes an environment that best suits its purpose. The goal is to make working with CADD efficient. Most programs use a Graphic User Interface (GUI) to communicate with the user. The GUI provides visual aids for quick data entry. You are given tools to select functions, enter textual or mathematical data, locate points in the drawing window, select objects in the drawing window, etc.

Graphical user interface (GUI)

Objectives : At the end of this lesson you shall be able to
- **describe graphical interface of auto cad**
- **explain key board function keys.**

Introduction : Note that AutoCAD automatically assigns generic name, Drawing X, as new drawings are created. In our example, Auto CAD opened the graphics window using the default system units and assigned the drawing. (Fig 1, 2, 3)

Graphical user interface (GUI) OF Auto CAD

Fig 1

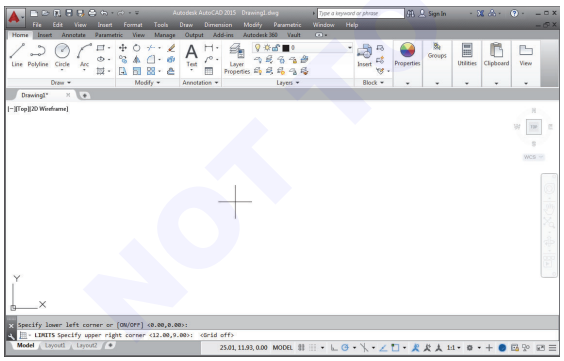


Fig 2

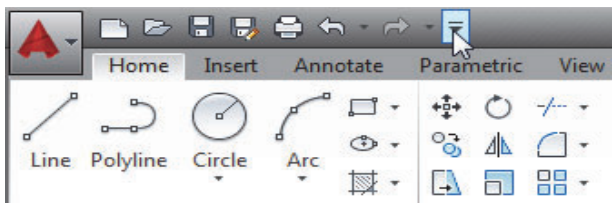


Fig 3

Quick access toolbar

1 Click on one of the following icons for quick access to commands QNEW, OPEN, SAVE, PLOT, and UNDO/ REDO. (Fig 4)

Fig 4

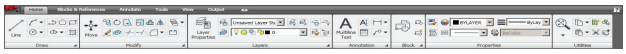
Right-click the quick toolbar and click customize quick access toolbar. The customize user interface dialog opens and displays the list of commands available.

Drag commands you want to add from the command list pane in the customize user interface dialog box to the quick access toolbar.

Info center : Quickly search for a variety of information sources, access product updates and announcements, and save topics with info center.

Ribbon : The ribbon provides a single, compact placement for operations that are relevant to the current workspace. It eliminates the need to display multiple toolbars, reducing clutter in the application window. The ribbon maximizes the area available for work using a single compact interface. (Fig 5)

Fig 5



The ribbon can be displayed horizontally, vertically, or as a floating palette. The horizontal ribbon is displayed at the top of the drawing window by default when you create or open a drawing.

You can create your own panels to display on the ribbon; you can also modify the commands and controls on existing ribbon panels.

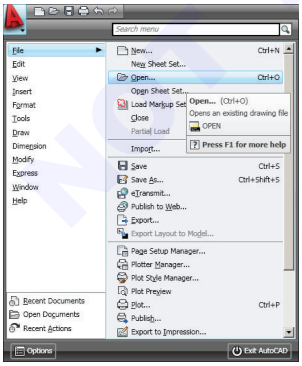
Menu browser

1 Click on the a icon in the upper left corner of the drawing area.

2 Click the desired pull down menu.

3 Click on the command to be executed from the pulldown. (Fig 6)

Fig 6



Workspaces

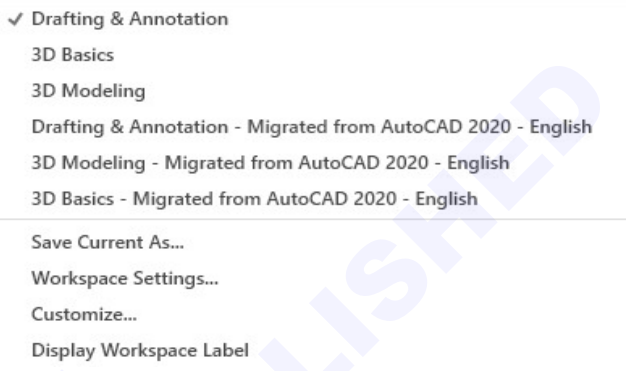
You can switch between the workspaces from the menu browser.

1 Click the workspace switching icon in the lower left corner of the screen. (Fig 7)

Fig 7

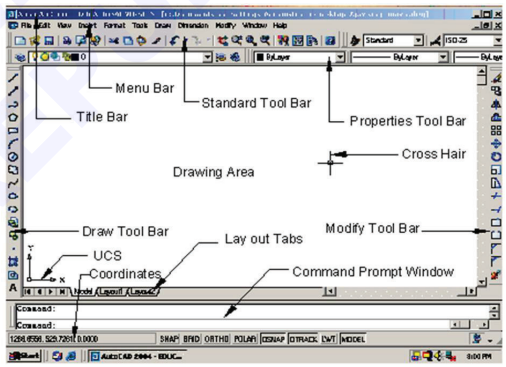
2 Click on one of the following workspace options. (Fig 8)

Fig 8



Auto CAD classic workspace (Fig 9)

Fig 9



Title bar: This shows the name of drawing which is currently used.

Menu bar: This menu bar help us quicker way to access the general controls and setting for AutoCAD. The main commands and functions are available in this menu bar it has the following facilities.

1 It gives a command that requires key board or drawing input.

2 It displays additional menus choice with > symbol, in this menu called cascading menus.

3 It displays a dialogue box that contains settings which have changing options.

Standard tool bar: This tool bar contains the standard functions of commands which is used for getting information's and modifications.

Properties tool bar: This tool bar have the properties of the entity such as thickness of line, colour, layer type of line etc. We can change the properties of the entity by using this tool bar.

Draw tool bar: This tool bar contains the group of drawing commands such as line, arc, circle etc. (Fig 10)

Modify tool bar: This tool bars are used to do the modifications in the entities such as erase, trim etc.

Draw area: This is a black space to draw the drawings. This area has formed as grids, we can increase or decrease the area by using boundary limit command.

UCS: UCS (user coordinate system is an indication to the use of for which plane the drawing is drawn. We can change any plane according to our wish to draw the drawing in views.

Command prompt window: This window is used to give commands by typing in key board.

Cross hair: This is the pointer used to draw, select and to locate.

Layout tabs: These tabs are used to select the particular lay out of the drawing.

Function tabs: Below the command prompt window drawing function tabes are available. These tabs show us the position of grid, other, o snap etc. The functional keys are used for effective function of the drawing.

Key board function keys

There are some function keys in the keyboard for quick access to certain commands. These keys are pressed for the following purposes.

Key	Function defined
F1	Online help.
F2	Toggles between command window on and off.
F3	Toggles between OSNAP on and off.
F4	Toggles between Tablet on and off.
F5	Switches among isoplanes top, right and left.
F6	Toggles between coordinates on and off.
F7	Toggles between grid on and off.
F8	Toggles between ortho mode on and off.
F9	Toggles between snap mode on and off.
F10	Toggles between polar tracking on and off.
F11	Toggles between objects snap tracking on and off.
F12	Save as.

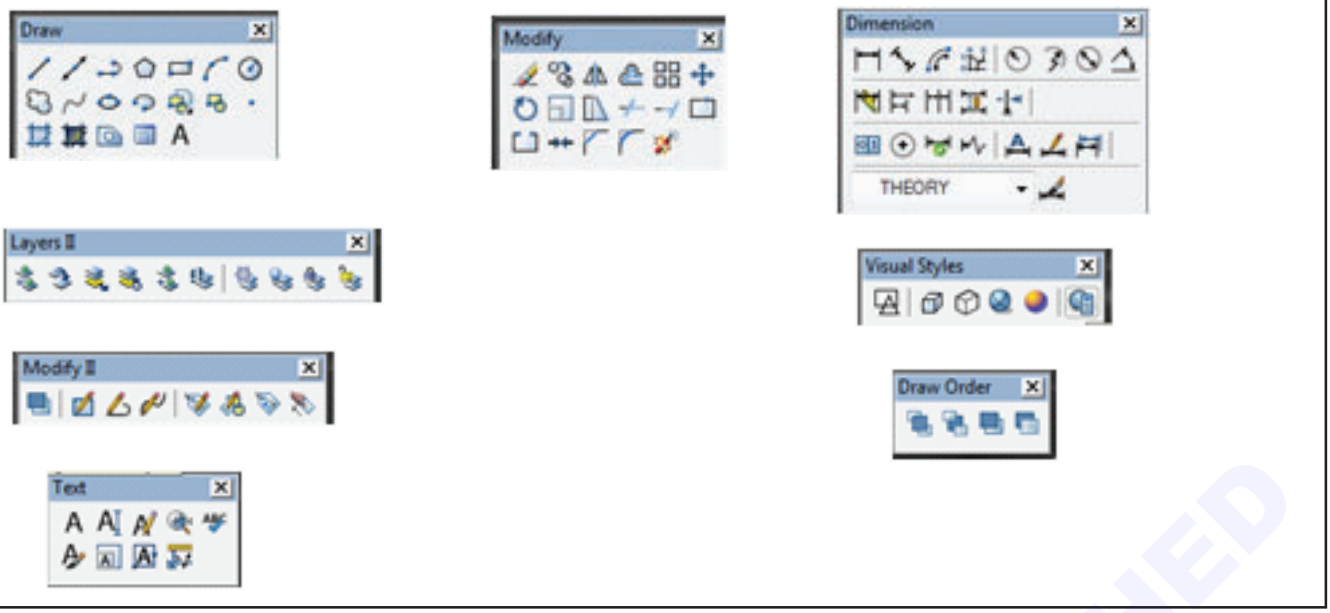
You can disable the group selection quickly by pressing FUNCTION KEYS (Ctrl + Key) combination to quickly toggle some of the modes and invoke some of the commands.

Function keys used in Auto CAD

Key strokes	Function defined
Ctrl+Z	Undo
Ctrl+C	Copy clip
Ctrl+E	Isoplane top/right /left
Ctrl+G	Grid ON/OFF
Ctrl+L	Ortho ON/OFF
Ctrl+O	OPEN command
Ctrl+S	QSAVE command
Ctrl+U	Polar tracking ON/OFF
Ctrl+Y	Redo
Ctrl+2	ADCENTER command
Ctrl+F6	Switch between open drawings
Ctrl+B	Snap ON/OFF
Ctrl+D	Coordinate display ON/OFF
Ctrl+F	Osnap ON/OFF
Ctrl+K	HYPERLINK command
Ctrl+N	NEW drawing
Ctrl+P	PRINT command
Ctrl+T	Tablet on/off
Ctrl+V	Paste
Ctrl+X	Cut
Ctrl+2	Object properties window on/off
Ctrl+6	DBCONNECT command
Ctrl + Tab	Switch between open Drawings.

The functionality of these Ctrl + Key combination depends on the settings done on the User Preferences tab on the option dialog box.

Fig 10



Example:

That is to say Ctrl+ C works for COPYCLIP command, if the check box is cleared, Ctrl + C works for the CANCEL command.

Text edit keys

The following accelerator keys, which are effective within the Multilane Text Editor, dialog box.

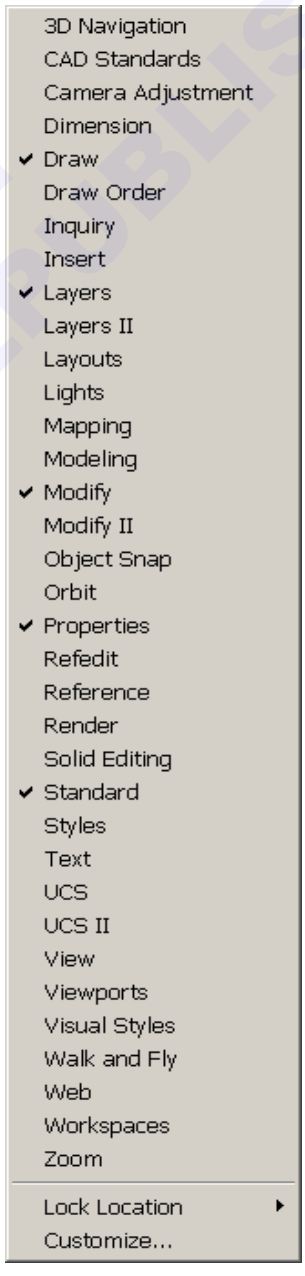
Key strokes	Function defined
Ctrl+A	Select all text in the multiline text editor.
Ctrl+B	Applies or removes bold format for selected text.
Ctrl+C	Copies selected text to the clip board.
Ctrl+I	Applies or removes italic format for selected text.
Ctrl+Shift+L	Converts selected text to lower case.
Ctrl+Shift+U	Converts selected text to upper case.
Ctrl+U	Applies or removes underline format for selected text
Ctrl+V	Pastes Clipboard contents to cursor location
Ctrl+X	Cuts selected text to the clipboard
Ctrl+SPACE	Removes character formatting in selected text.

Loading toolbars.

Right- clicking on an icon in any toolbar.

This will show a list of all available toolbars. (Fig 11)

Fig 11



Method of installation

Objectives : At the end of this lesson you shall be able to
- **introduction of cad installation**
- **system requirements serial number and production**
- **installing of CAD.**

Introduction of CAD Installation : Auto CAD installation provides information, how to prepare and then how to install. If the product is never installed before, one should familiarize with the installation process. It should be done before installing and in beginning. Before installing one should aware of the minimum requirements to install and run the product.

System requirements for AutoCAD 2022 (Windows)

Operating System	64-bit Microsoft® Windows® 11 and Windows 10
Processor	**Basic:** 2.5–2.9 GHz processor **Recommended:**3+ GHz processor
Memory	**Basic:** 8 GB **Recommended:** 16 GB
Display resolution	**Conventional Displays:**1920 x 1080 with True Color **High Resolution & 4K Displays:** Resolutions up to 3840 x 2160 supported on Windows 10 (with capable display card)
Display Card	**Basic:** 1 GB GPU with 29 GB/s Bandwidth and DirectX 11 compliant Recommended: 4 GB GPU with 106 GB/s Bandwidth and DirectX 12 compliant
Disk Space	10.0 GB
Network	See Autodesk Network License Manager for Windows
Pointing Device	MS-Mouse compliant
.NET Framework	.NET Framework version 4.8 or later

It should be reviewed about the system requirements, administration permission, locating serial number and product key, closing all numbering applications, completing the tasks and now it is reedy for installing auto cad.

Serial number and product key.

Whatever auto cad install, which is prompter for the per sons serial number and the product key in the product. And the user information page. This can be done by installing the product in trial mode. The serial number and the product key are located on the out side of the product packing or in the auto desk. The serial is consists of in three digit pre fix followed by the product key consists of fine characters.

The information entered is permanently retained with the product. This information cannot changed later with out uninstalling . To review this product information later and the mars menu bar click auto cad about auto cad. In the about dialog box, click product, information.

The Auto CAD installation wizard contains all installation related material in one place from the installation wizard one can select installation register product and customize the install.

Basic Commands - I

Objectives : At the end of this lesson you shall be able to
- **draw circle & arc**
- **draw ellipse & polygon.**

Introduction

AutoCAD allows you to have across to a large number of commands, a general rule is that you use 20% of the commands 80% of the time. In other words, most of the commands you will use while using Auto cad are taught in level1.

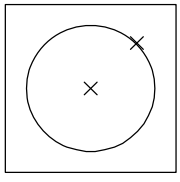
The important thing to remember is that AutoCAD will expect you give it information in a very particular order. It is very important to be in the habit of looking at the command line.

Circles

Circle command (Fig 1,2, & 3)

1	Choose	Draw, circle. (or)
2	Click	The Circle icon. (or)
3	Type	Circle at the command prompt.

Fig 1



CIRCLE COMMAND

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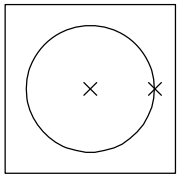
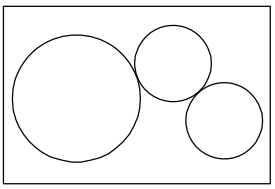
Fig 2



CIRCLE COMMAND

AD20N154622

Fig 3



CIRCLE COMMAND

AD20N154623

4	Type	One of the following options: 3P/2P/TTR/<<center point>>:
		(or)
5	Pick	A center point
6	Type	A radius or diameter.
		(or)
7	Pick	A radius or diameter Diameter/<<radius>>:

TIPS

- To create circles that are the same size, press ENTER when asked for the circle radius.
- When selecting a circle with a pick box, be sure to select the circumference of the circle.

The command line tells you what information AutoCAD requires to continue.

Your first drawing alignment will be to use the drawing commands in conjunction with the co-ordinate system it is very important to understand how to give the program accurate information. You will use the following commands.

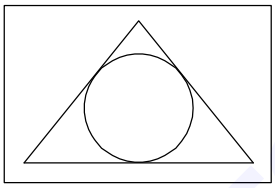
Drawing arcs and circles

CADD provides many ways to draw arcs and circles. There are a number of advanced techniques available for drawing arcs and circles, which can simplify many geometrical drawing problems. You can draw an arc by specifying circumference and radius, radius and rotation angle, chord length and radius, etc.

Arc command (Fig 4&5)

1	Choose	Draw, arc.
		(or)
2	Click	The Arc icon. 
		(or)
3	Type	Arc at the command prompt command: ARC
4	Draw	One of the arcs.

Fig 4



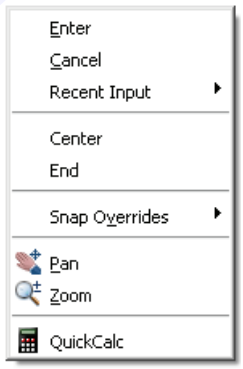
CIRCLE COMMAND

AD20N154624

TIPS

- Except for 3 point arcs, arcs are drawn in a counter clock wise direction.
- While in the arc command, press the right mouse button to select the following options for arcs:

Fig 5



Arc examples (Fig 6)

3 point arc
Start, center, chord length
Start, center, end
Start, end, radius
Start, center, included angle
Start, end direction

Drawing ellipses and elliptical arcs

Ellipses are much easier to draw with CADD than on a drawing board. On a drawing board, you need to find the right size template or draw a series of arcs individually to draw an ellipse. With CADD, all you need to do is specify the size of the ellipse.

The following are two basic methods for drawing ellipses:

- Length and width.
- Axis and rotation angle.

Ellipse:

Creates an ellipse or an elliptical arc:

1	**Choose**	Draw, Ellipse.
		(or)
2	**Choose**	The ellipse or partial ellipse icon
		(or) 

3 **Type** Ellipse at the command prompt
Command: ellipse

4 **Type** One of the following options:

Arc/Center/Isocircle/<Axis endpoint1>:

Ellipse options

Axis endpoint 1: Defines the first axis by two specified endpoints. The angle of the first axis determines the angle of the ellipse. The first axis can define either the major or the minor axis of the ellipse.

Ellipses options

Axis end point 2: <Other axis distance>/Rotation: Specify a point or enter a distance

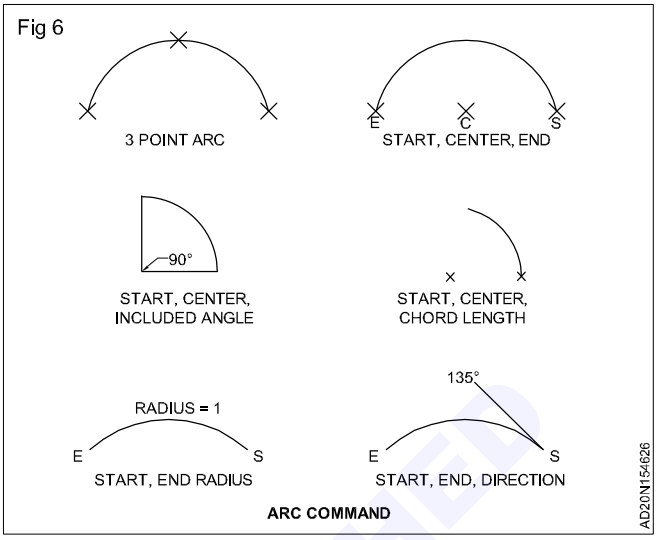
Arc: Creates an elliptical arc. The angle of the first axis determines the angle of the elliptical arc. The first axis can define either the major or the minor axis of the elliptical arc.

Center : Creates the ellipse by a specified center point.

Isocircle : Creates an isometric circle in the current isometric drawing plane.

Rotation : The major axis is now treated as the diameter of a circle that will be rotated a specified amount around the axis. You enter an angle between 0 and 89.4 degrees.

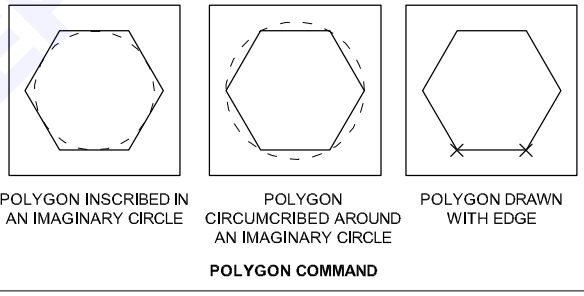
Fig 6



Polygon (Fig 7)

1	Choose	Draw, ploygon.
		(or)
2	Click	The polygonicon.
		(or)
3	Type	Polygon at the command prompt.
4	Type	The number of sides for the polygon (3-1024).
5	Pick	The center of the polygon. Edge/ <Center of polygon>: pick.
		(or)
6	Type	E to define the polygon by two edges.
		(or)
7	Type	I or C to place the polygon in side or outside of an imaginary circle. Inscribed in circle/ circum scribed about circle (I/C)

Fig 7



Basic commands - II

Objective : At the end of this lesson you shall be able to
- **express move, copy, offset, rotate, trim, on, fillet, array, straiten, lemgthen.**

The previous lesson dealt with drawing commands. This lesson will introduce some common modifying commands. In AutoCAD, you may actually use modifying commands more often than drawing commands. Now that you know the basics, here's some more commands to add to your collection. Three commands, Trim, Extend and Offset are used often in 2D AutoCAD work.

Command	Keystroke	Location	Result
Rectangle	RECTANGLE/REC	Home>Draw>Rectangle	Draws a rectangle after you enter one coner and then the second.
Trim	TRIM/TR	Home>Modify>Trim	Trims objects to a selected cutting edge.
Extend	EXTEND/EX	Home>Modify>Extend	Extends objects to a selected boundary edge.
Offset	OFFSET/O	Home>Modify>Offset	Offsets an object (parallel) by a set distance.

Object snaps	OSNAP/OS/F3	Tools>Object Snap Settings	Brings up the OSNAP dialog box.
Move	Move/M	Home>Modify>Move	Moves an object or objects.
Copy	Copy/CP	Home>Modify>Copy	Copies object(s) once or multiple times.
Stretch	Stretch/S	Home>Modify>Stretch	Stretches an object after you have selected a portion of it.
Mirror	Mirror/MI	Home>Modify>Mirror	Creates a mirror image of an object or se lection set.
Rotate	Rotate/RO	Home>Modify>Rotate	Rotates objects to a certain angle.
Fillet	Fillet/F	Home>Modify>Fillet	Creates a round corner between two lines.
Chamfer	Chamfer/CHA	Home>Modify>Chamfer	Creates an angled corner between two lines
Array	Array/AR	Home>Modify>Array	Creates a repeating pattern of the selected objects.

Move command (Fig 1 & 2)

Fig 1

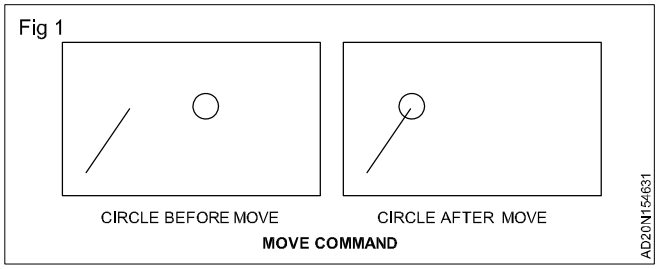
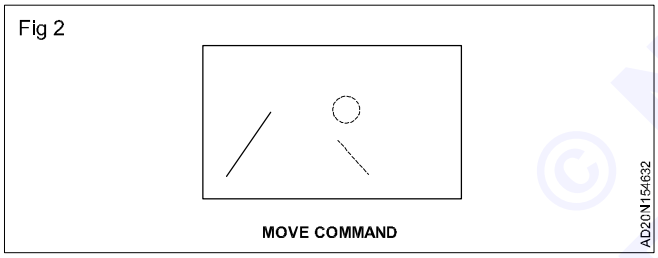


Fig 2



1	Choose	Modify, Move. Or
2	Click	The Move icon or
3	Type	Move at the command prompt command: MOVE or M
4	Pick	Objects to move select objects (select)
5	Pick	A point to move from base point of displacement: (Pick point)
6	Pick	A point to move to second point of displanement: (pick point)

TIP : To move an object a specified distance, type a distance at the second point of displacement prompt:@1<0

Moving drawing objects : CADD allows you to move drawing objects within a drawing in a convenient manner. Unlike on a drawing board, you don't need to first erase and then redraw in a new place. You can simply rearrange the existing drawing objects, as you like. This is a very useful tool for analyzing design alternatives and making quick adjustments to drawings.

Previous selection

Places selected objects in the previous selection set

1	Choose	Modify, move.
		(or)
2	Click	The move icon.
		(or
3	Type	Move at the command prompt.
		Command: Move or M
4	Pick	Objects to move.
		Select objects : (P)

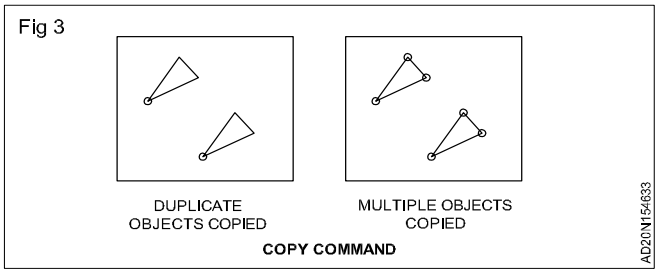
Previous selection set highlighted

TIP

AutoCAD requires that objects be selected in order to be processed. The Select Objects prompt occurs after many commands, including the SELECT command itself.

Copying drawing objects (Fig 3)

Fig 3



CADD allows you to make quick and easy copies of existing drawing objects. You can copy individual drawing objects or the entire drawing all at once. You can even make multiple copies of drawing objects within seconds.

Using the copy function is quite similar to the way the move function is used. First, you need to select objects using any of the methods described earlier. Then you need to indicate a base point and a relocation (or destination) point. The copied objects are placed according to the relocation point..

Making multiple copies in a rectangular fashion

There are separate functions available in CADD that allow you to make multiple copies in a linear or rectangular fashion (commonly known as a rectangular array). You can make hundreds of copies within seconds. You don't need to enter a base point and a destination point. You just need to select the objects, specify how many rows and columns you need and the distance between them.

Copy command

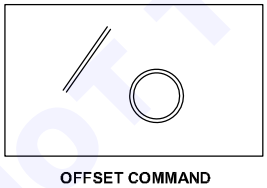
1	Choose	Modify, copy. 
		(or)
2	Click	The copy icon
		(or)
3	Type	Copy at the command prompt. (or) CO
4	Pick	Objects to copy.
		Select objects: (select)
5	Pick	A point to move from.
		Base point or displacement /multiple: (pick point).
6	Pick	A point to copy to.
		Second point of displacement: (Pick point)
		(or)
7	Type	A point to copy to.
		Second point of displacement: @1<0

TIP

To copy many objects in the same copy command, type M for Multiple at the "Base point or displacement/Multiple" option.

Offset command (Fig 4)

Fig 4



OFFSET COMMAND

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Offset distance

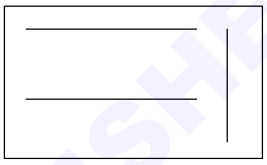
To offset a specified distance:

1	Choose	Modify, Offset. 
		(or)
2	Choose	The offset icon.
		(or)
3	Type	OFFSET at the command prompt. Command: OFFSET or O
4	Type	The distance to offset. Offset distance or <Through point>: (number)
5	Pick	The object to offset. Select object to offset: (select object)
6	Pick	A side to offset object to. Side to off set: (pick side)
7	Pick	Another object to offset
		Select object to offset: (Pick side)
		(or)
8	Press	Enter to end the command.

Offsetting objects by specifying a distance

Offset through point (Fig 5)

Fig 5



OFFSET COMMAND

AD20N154635

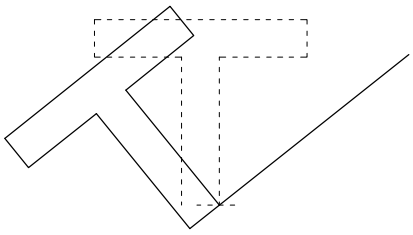
To offset through point

1	Type	Offset at the command prompt
		Command: Offset
2	Type	T to specify a through point
		Offset distance or <Through point>: (T)
3	Pick	A point to offset through (HINT: use object snaps) Select object to offset: (pick) through point: (select object)

Offset through a point

Rotate (Fig 6)

Fig 6



ROTATE COMMAND

AD20N154636

1	Choose	Modify, rotate
		(or) 
2	Click	The modify icon.
		(or)
3	Type	Rotate at the command prompt Command: Rotate (or) RO
4	Pick	Objects to rotate: Select objects: (select)

5	Pick	A pivot point to rotate around Base point: (point)
6	Type	A rotation angle<Rotation angle>/Reference: (number) (or)
7	Pick	A rotation angle<Rotation angle>/Reference: (point)

Rotating the drawings

CADD drawing allows you to rotate selected drawing objects to a specified angle. To rotate, you need to select the drawing objects, enter a reference point (or base point) and the rotation angle. The base point acts as a pivot point around which the objects are rotated. The rotation angle determines by how much the objects will be rotated and in which direction.

Reference angle rotation

A positive angle causes counterclockwise rotation, and a negative angle produces clockwise rotation. If you respond to the last prompt with r, you can specify the current rotation and the new rotation you want. AutoCAD prompts

1	Type	R for a rotation angle<Rotation angle>/Reference: (R)
2	Choose	An existing rotation angle Rotation angle: (number or points)
3	Choose	A new rotation angle New angle: (number or points)

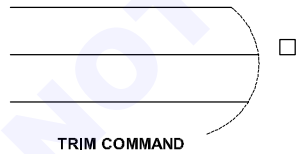
TIP (Fig 7)

You can show AutoCAD the reference angle (by pointing to the two endpoints of a line to be rotated), and then specify the new angle. You can specify the new angle by pointing or by dragging the object.

Trim

The trim command allows you to trim objects in a drawing so they end precisely at a cutting edge defined by one or more other objects in the drawing.

Fig 7



TRIM COMMAND

AD20N154637

1	Choose	Modify, trim (or)
2	Click	The trim icon. (or)
3	Type	Trim at the command prompt Command: trim (or) TR Select cutting edge(s)
4	Pick	The cutting edge to extend to Select objects: (select)
5	Press	Enter to accept the cutting edge Select objects: (press enter)
6	Pick	Objects to trim <Select object to trim>/Project/Edge/Undo: Select an object, enter an option, press enter
7	Press	ENTER when you are done choosing objects Select object to trim/Undo: (press enter)

TIP: Hold the shift key to interactively extend instead of trim.

Cutting drawing objects along an edge

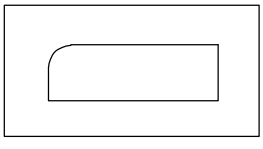
CADD allows you to erase drawing objects along a selected edge (this technique is often called trimming).When you use this function, you are prompted to select the drawing object that is to be used as the cutting edge and then select the objects that are to be erased along that edge.

Making sharp and rounded corners

CADD allows you to make fine corners of any two lines or arcs. This technique, often called filleting, is the quickest way to join the missing corners of lines and arcs. With this function active, to make a corner all you need to do is select the lines or arcs that have missing corners. CAD automatically extends or shortens the selected objects to form a corner. You can also specify whether you want a sharp corner or a rounded corner.

Fillet (Fig 8)

Fig 8



FILLET COMMAND

AD20N154638

1	Choose	Modify, fillet. (or)
2	Click	The fillet icon. (or)
3	Type	FILLET at the command prompt. Command: FILLET (or) F
4	Pick	First object to fillet. Polyline/radius/trim<Select two objects>: Select first object.

5	Pick	Second object to fillet. Select second object: select second object. (or)
6	Type	One of the following options:
	P	Fillets a nentire Polyline
	R	Sets the filletradius.
	T	Sets the trimmode (trim cuts the fil let corner and no trim keeps the fillet corner).

TIP

You can also fillet PARALLEL lines as well as PLINES with LINES

Type a radius of Zero (0) to create a clean 90 degree corner.

Chamfer

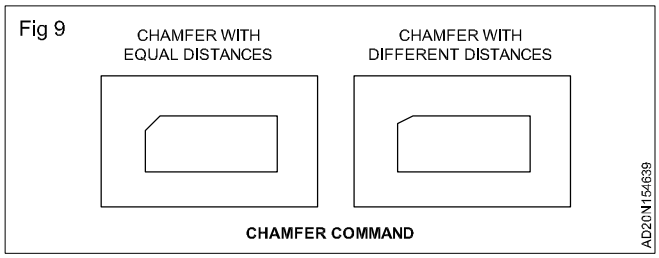
1	Choose	Modify,chamfer. (or)
2	Click	The chamfer icon. (or)
3	Type	CHAMFER at the command prompt. Command: Chamfer (or) CHA
4	Pick	First object to chamfer. Polyline/ distance/angle/trim/ method<Select first line>: select first object.
5	Pick	Second object to chamfer. Select second object: select second object. (or)
6	Type	One of the following options:
	P	Chamfers entire Polyline.
	D	Sets chamfer distances.
	A	Uses a distance and angle method in stead of two distances.
	T	Sets the trim mode
	M	Sets the method to distance or angle.

Chamfer with equal distances (Fig 9)

Chamfer with different distances

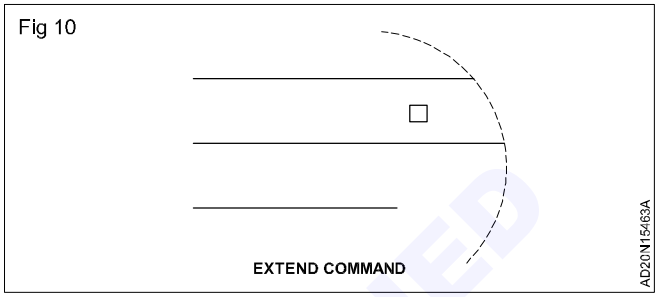
Making chamfered corners : CADD allows you to make a chamfered corner between two lines. It works quite like the fillet command. When you enter the chamfer command, you are prompted to select the lines that are to be chamfered and enter a chamfer distance. The chamfer distance determines the size of the chamfer.

Fig 9



EXTEND (Fig 10)

Fig 10



1	Choose	Modify, extend, (or)
2	Click	The extend icon. (or)
3	Type	EXTEND at the command prompt command: EXTEND (or) EX Select boundary edge (s)...
4	Pick	The BOUNDARY edge to extend to select objects: (select)
5	Press	ENTR to accept the boundary edge select objects: (press enter)
6	Pick	The object to extend <Select object to extend> / Project/ edge/ undo: Select an object, enter an option, or press enter: (select)
7	Press	ENTER when you are done choos ing objects.

Lines extended to an arc (Arc is boundary edge)

TIP

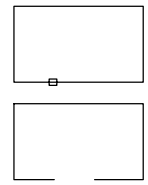
- Use the object selection option FENCE to choose mul tiple objects.

Extending drawing objects to an edge : CADD allows you to extend lines to a selected drawing object. Often you need to extend lines to construct a drawing and to fix any graphical errors. To extend lines, you need to select an edge to which the lines should extend and then select the lines to be extended.

Dividing an object into equal parts : CADD allows you place dividing marks on a drawing object such as a line, arc, ellipse or spline. To use this command, you need to select an object and specify how many divisions are required. This function places markers at equal distances on the drawing object.

Break (Fig 11 & 12)

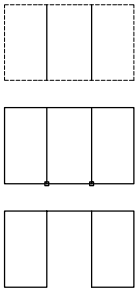
Fig 11



BREAK COMMAND

AD20N15463B

Fig 12



BREAK COMMAND

AD20N15463C

1	Choose	Modify, break. (or)
2	Click	The break icon. (or)
3	Type	BREAK at the command prompt. Command: BREAK
4	Pick	Object to break. Select object: (select one object)
5	Pick	A second break point. Enter second point: (point)
6	Type	F to choose a different break point Enter second point (or F for first point): (F)
7	Pick	The first break point on the object Enter first point: (point)
8	Pick	A second break point

TIP

You can also type coordinates instead of picking a break point. Enter second point (or F for first point): @3'<0

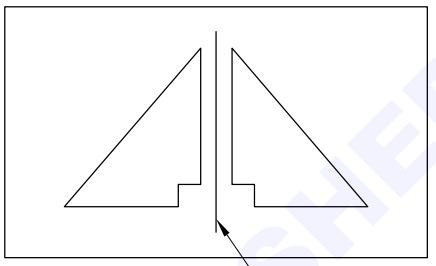
If you break a circle, it changes to an arc by deleting the portion from the first point to the second, going counterclockwise.

Breaking a polyline with nonzero width will cause the ends to be cut square.

Mirror command (Fig 13)

1	Choose	Modify, mirror. (or)
2	Click	The mirror icon (or)
3	Type	MIRROR at the command prompt. Command: MIRROR (or) MI
4	Pick	Objects to mirror. Select objects: (Se lect)
5	Pick	First point of mirror line: (point)
6	Pick	Second point: (Point)
7	Type	Yes to delete the original objects and No to keep them. Delete old objects? Y or N

Fig 13



MIRROR COMMAND

AD20N15463D

Mirroring drawings

CADD allows you to create mirror images of drawings. This capability is very useful when you want to draw something that is symmetrical on both sides. You need to draw only one half of the drawing; the rest of the drawing can be completed using the mirror function. To make a mirror image, you need to select the objects to be mirrored and indicate a mirror axis. The mirror axis is an imaginary line along which the diagram is mirrored.

Array

Rectangular array

To draw rectangular array

1	Choose	Modify, array. (or)
2	Click	The array icon. Or
3	Type	ARRAY at the command prompt.(or) AR Command: ARRAY objects to array. Select
4	Pick	Objects to array. Select Objects: (select)
5	Type	The number of rows top to bottom. Number of rows (----) <1>: (number)
6	Type	The number of columns left to right. Number of columns (III) <1>: (num ber)
7	Type	The unit cell distance between items in each row. Distance between rows: (+number=up, number = down)

8	Type	The unit cell distance between items in each column. Distance between columns: (+ number = right, - number = left)

Creating an array of objects (Fig 14&15)

The array command in AutoCAD is used to make multiple copies of objects. Although you can use the copy command to duplicate objects, the array command is more flexible and precise. One advantage of using the array command is that it allows you to copy objects in a defined angle and exact number of copies. Therefore, you can create array in various pattern. For example, you can show multiple objects in a row, column, or irregular pattern such as a spiral. Let's look at a few examples below:

Fig 14

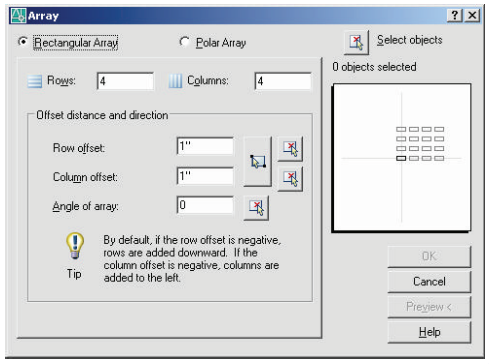
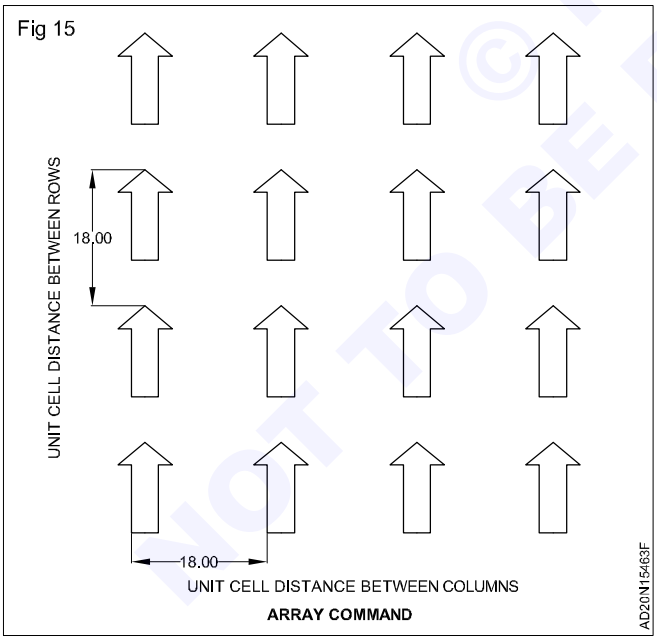


Fig 15



Polar array (Fig 16&17)

To draw a polar array:

1	Choose	Modify, array. (or)
2	Click	The array icon. (or)
3	Type	Array at the command prompt. Command: Array
4	Pick	Objects to array. Select Objects: (select)
5	Type	P to draw a polar array. Rectangular or Polar array (R/P):P
6	Pick	A center point for the array. Center point of array. Pick point
7	Type	The total number of items in the array. Number of items: number
8	Type	The number of degrees to rotate the objects. Degrees to fill (+=CCW, -+CW) <360>: Number
9	Type	Yes No to rotate objects. Rotate objects as they are copied? <y> Y or N

Fig 16

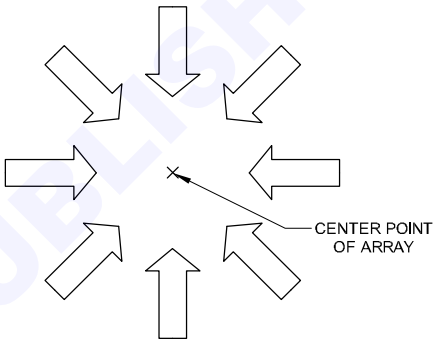
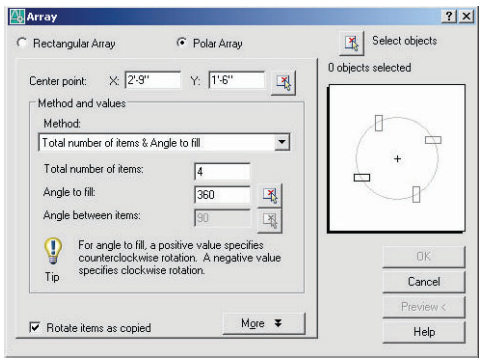


Fig 17



Stretch

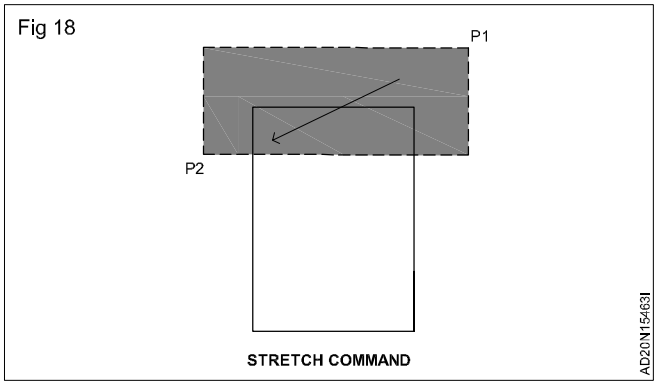
1	Choose	Modify, stretch (or)
2	Click	The stretch icon.
3	Type	STRETCH (or) S at the command prompt. Command: STRETCH select objects to stretch by window.
4	Type	C to choose CROSSING window Select objects: C
5	Pick	A first corner to stretch. First corner: (point)

6 Pick The opposite corner to window the ob jects to stretch.
Other corner: (point)

7 Press ENTER to accept objects to stretch

8 Pick A base point to stretch from Base point: (point)

Stretching diagrams (Fig 18)



CADD allows you to quickly change the size of diagrams by stretching lines, arcs, splines, etc. This function is very helpful to make quick alterations to drawings. To use the stretch function, you need to select the drawing objects to be stretched and specify the distance and direction of stretching.

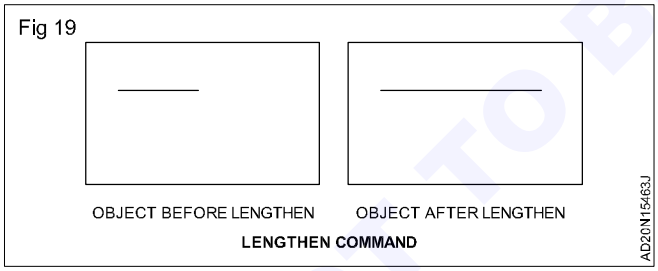
9 Pick A point to stretch to New point: (point)

10 Type A distance to stretch. New point: @ 1<0

TIP

The Stretch command must use a CROSSING window or a CROSSING POLYGON window.

Lengthen (Fig 19)



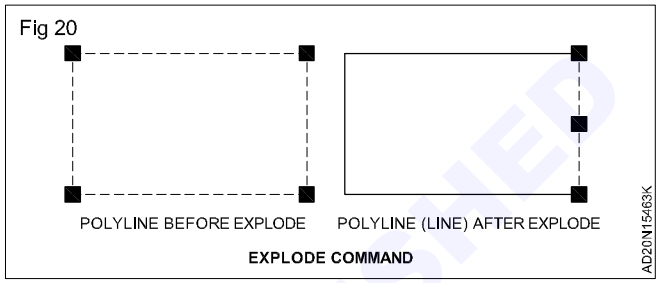
1 Choose Modify, lengthen.

(or)

2 Type Lemgthen at the command prompt.
Command:_ lengthen (Fig 19)
Select an object or [DElta/Percent/Total/
Enter delta length or [Angle]<0.0000>:2
Select an object to change or [Undo]: pick object

Object before lengthen
Object after lengthen

Explode command (Fig 20)



1 Choose Modify, explode.

(or)

2 Pick The explode icon.

3 Type X (or) EXPLODE at the command prompt.
Command: EXPLODE (Fig 20)

(or)

4 Pick The object to explode. Select objects: (pick)

4.3 OOPS commands

Reinserts the last erased set of objects or block even if it was not the last command issued. Otherwise oops acts like UNDO.

1 Type OOPS at the command prompt to rein sert erased objects
Command: OOPS

Other CAD commands

Objectives : At the end of this lesson you shall be able to
- **draw points, rectangle, polyline, spline, multllines, construction line**
- **draw adding patterns to drawings.**

Introduction

Drawing multiple parallel lines

CADD allows you draw parallel lines simultaneously just by indicating a starting point and an end point. These lines can be used to draw something with heavy lines or double lines. For example, they can be used to draw the walls of a building plan, roads of a site map, or for any other presentation that requires parallel lines.

Most programs allow you to define a style for multiple parallel lines. You can specify how many parallel lines you need, at what distance and if they are to be filled with a pattern or solid fill.

A number of add-on programs use multiple lines to represent specific drawing features. For example, an architectural program has a special function called "wall". When you use this option, it automatically draws parallel lines representing walls or specified style and thickness.

Drawing flexible curves

CADD allows you to draw flexible curves (often called splines) that can be used to draw almost any shape. They can be used to create the smooth curves of a sculpture, contours of a landscape plan or roads and boundaries of a map.

To draw a flexible curve, you need to indicate the points through which the curve will pass. A uniform curve is drawn passing through the indicated points. The sharpness of the curves, the roughness of the lines and the thickness can be controlled through the use of related commands.

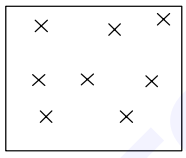
Adding hatch patterns to drawings

The look of CAD drawings can be enhanced with the hatch patterns available in CAD. The patterns can be used to emphasize portions of the drawing and to represent various materials, finishes, and spaces. Several ready-made patterns are available in CAD that can be instantly added to drawings.

Hatch patterns are quite easy to draw. You don't need to draw each element of a pattern one by one. You just need to specify an area where the pattern is to be drawn by selecting all the drawing objects that surround the area. The selected objects must enclose the area completely, like a closed polygon. When the area is enclosed, a list of available patterns is displayed. Select a pattern, and the specified area is filled.

Point command (Fig 1)

Fig 1



POINT COMMAND

AD20N154641

1 Choose Draw, point, single or multiple point

(or)

2 Click The point icon

(or)

3 Type Point at the command prompt
Command: Point

4 Pick A point on the drawing

Point (point)

Point styles (Fig 2)

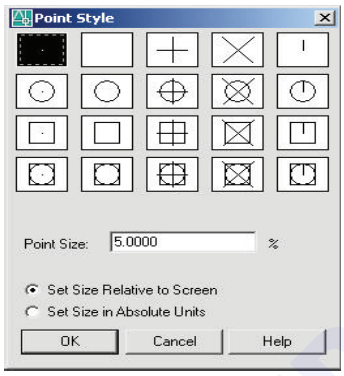
Changes the appearance of points and point sizes.

1 Choose Format, Point Style...

(or)

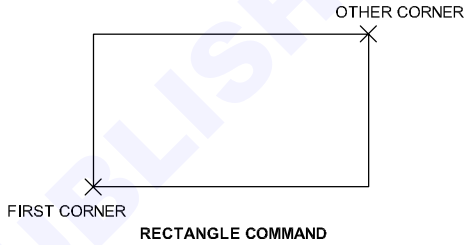
2 Type DDP type at the command prompt.
Command: DDP type (or) PTTYPE

Fig 2



Rectangle (Fig 3)

Fig 3



1 Choose Draw, rectangle.

(or)

2 Click The rectangle icon

(or)

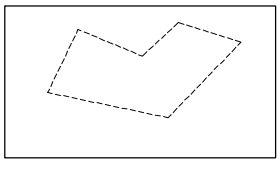
3 Type Rectangle at the command prompt
Command: REC

4 Pick first corner

5 Pick other corner or type coordinates (i.e. @ 4,2)

Pline command (Fig 4)

Fig 4



PLINE

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A polyline is a connected sequence of line segments created as a single object. You can create straight line segments, arc segments, or a combination of the two.

1 Choose Draw, polyline.

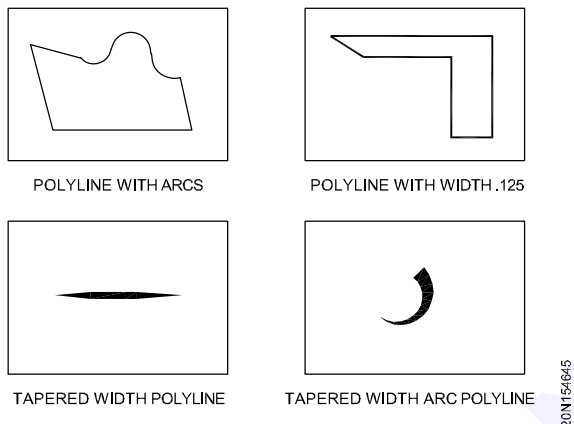
(or)

2 Pick The pline icon.

3	Type	PLINE at the command prompt Com mand: PLINE or PL
4	Pick	A point on the drawing to start the polyline
		Form point: (select)
5	Type	One of the following options Arc/Close/ Halfwidth/Length/Undo/Width/<endpoint of line>:
		(or)
6	Pick	A point to continue drawing Arc/Close/ Halfwidth/Length/Undo/Width/<endpoint of line>: (pick point)

PLINE options (Fig 5)

Fig 5



Arc : Toggles to arc mode and you receive the following: Angle/CEnter/CLose/Direction/Halfwidth/Line/Radius/ Second Pt/Undo/Width/<enter of arc>:

Close : Closes a polyline as it does in the line command.

Halfwidth : Specifies the halfwidth of the next polyline segments. Can be tapered.

Length : Specifies the length to be added to the polyline in the current direction.

Undo : Undoes the previous pline segment as with the line command.

Width : Specifies the width of the next polyline segments. Can be tapered.

Polyline with arcs

Polyline with width 125

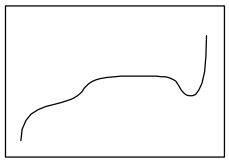
Tapered width polyling

Tapered width arc polyline

Convert pline to spline (Fig 6)

1	Draw	A Pline
2	Type	PEDIT to edit the polyline as a spline.

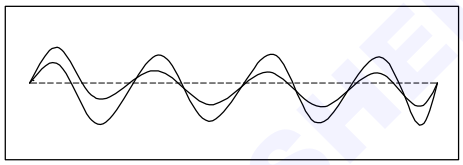
Fig 6



3	Choose	Draw, Spline
4	Type	Object at the command prompt.
5	Click	Once on the polyline to turn it into a spline.

Spline (Fig 7)

Fig 7

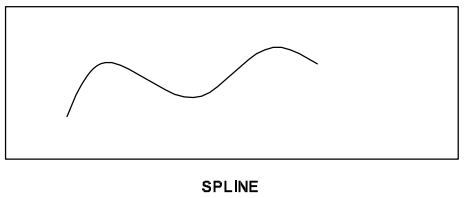


The spline command creates a particular type of spline known as a non uniform rational B-spline (NURBS) curve. A NURBS curve produces a smooth curve between control points.

1	Choose	Draws, spline.
		(or)
2	Click	The spline icon
		(or)
3	Type	Spline at the command prompt Command: Spline (or) SPL
4	Pick	A start point for the spline Object /<En ter first point> (pick point)
5	Pick	Points until you are done drawing splines Enter point: (pick points)
6	Press	Enter or close to complete the spline
7	Pick	Starting tangent point for the spline En ter start tangent (pick point)
8	Pick	Ending tangent point for the spline
		Enter end tangent (pick point)

Spline options (Fig 8 & 9)

Fig 8



Object: Convers 2D or 3D spline-fit polylines to equiva lent splines

Points: Points that defines the spline

Close: Closes a spline

Fit Tolerance: Allows you to set a tolerance value that creates a smooth spline.

TIP: Refer to AutoCAD online help topic for more information on spline options.

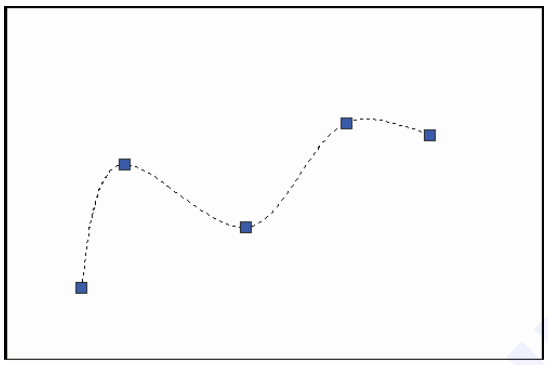
Editing splines

1. Choose Modify, Object, Spline.

TIP

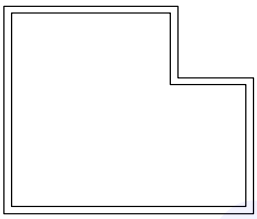
Drawings containing splines use less memory and disk space than those containing spline-fit polylines of similar shape.

Fig 9



Multilines (Fig 10)

Fig 10



MLINE Command

1	Choode	Draw, multiline.
		(or)
2	Type	MLINE at the command prompt Com mand: MLINE
3	Pick	A point to start the multiline.
		Justification/Scale/Style/<From point>: pick point
4	Pick	A second point to continue the multiline. <To point>: Pick point
5	Pick	The next point to continue drawing Multilines. Undo/<To point>: pick point
6	Press	ENTER to end the multiline
		Close/Undo/<To point>: press enter
		(or)
7	Type	C to close the multiline back to the first point. Close/Undo/<To point:C

Multiline styles (Fig 11&12)

1	Choose	Format, multiline style.
2	Type	Mlstyle at the command prompt.
		Command: Mlstyle
3	Rename	The existing style called STANDARD to your new style.
4	Choose	Element properties to change the ap pearance of the Multilines.
5	Choose	ADD to create the new multiline.

Fig 11

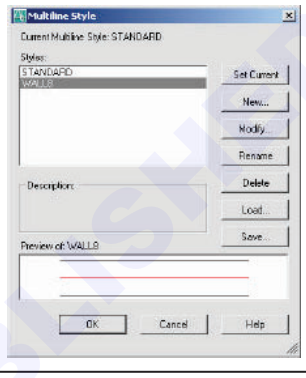
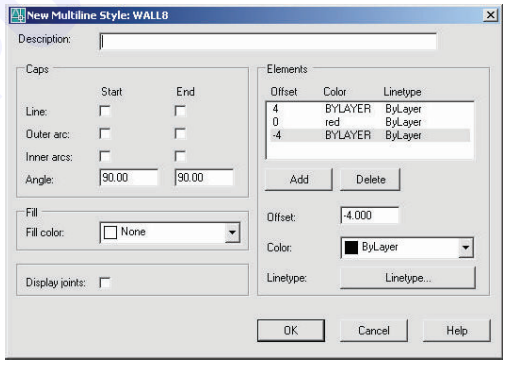
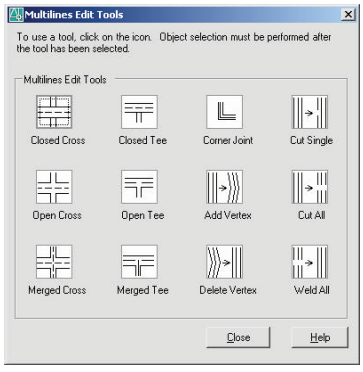


Fig 12



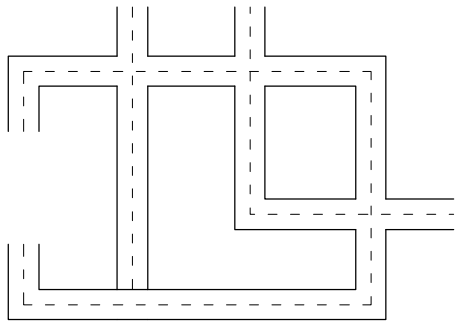
Editing multilines (Fig 13&14)

Fig 13



1	Choose	Modify, Multiline
		(or)
2	Type	MLEDIT at the command prompt Command: MLEDIT
3	Choose	from one of the mledit options

Fig 14



MULTILINES

AD20N1546E

Construction line

Creates an infinite line.

1 Choose — Draw, Construction Line

(or)

2 Choose — the XLINE icon.

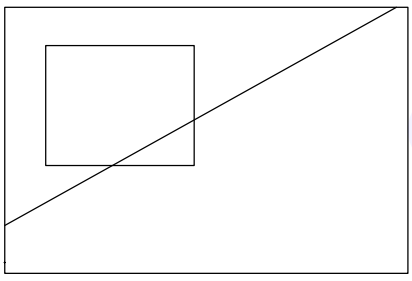
(or)

3 Type — XLINE at the command prompt. Com mand: XLINE

Specify a point or [Hor/Ver/Ang/Bisect/ Offset]

XLINE options (Fig 15 & 16)

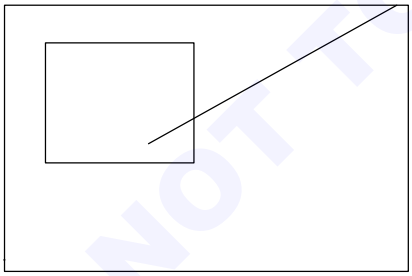
Fig 15



XLINE

AD20N1546F

Fig 16



XLINE

AD20N1546G

HOR: Creates a horizontal xline passing through a specified point

VER: Creates a vertical xline passing through a specified point

ANG: Creates an xline at a specified angle.

BISECT: Creates an xline that passes through the selected angle vertex and bisects the angle between the first and second line

OFFSET: Creates an xline parallel to another object.

Ray command

Creates an infinite line in one direction

1 Choose — Draw, ray

(or)

2 Type — Ray at the command prompt. Command: Ray specify a point: (pick through point)

Hatch command

1 Choose — Draw, hatch...

(or)

2 Click — The hatch icon.

(or)

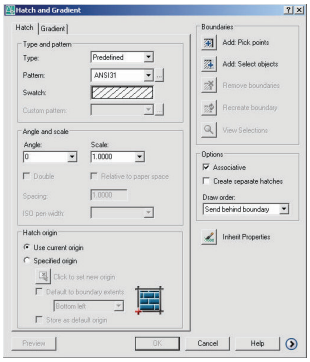
3 Type — HATCH at the command prompt Command: HATCH (or) H

Hatch options (Fig 17)

Pattern type: Sets the current pattern type by using AutoCAD's Predefined patterns or user defined patterns.

Pattern properties: Sets the current pattern, scale, angle, and spacing, Controls if hatch is double spaced or exploded.

Fig 17



Pick points: Constructs a boundary from existing objects that form an enclosed area.

Select objects: Selects specific objects for hatching. The boundary hatch dialog box disappears and AutoCAD prompts for object selection.

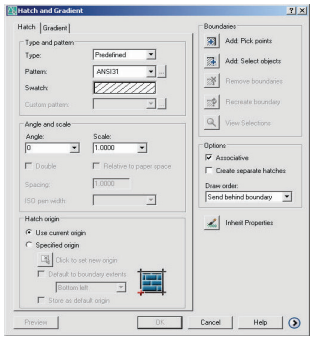
Inherit properties: Applies the properties of an existing associative hatch to the current pattern type and pattern properties options.

Preview hatch: Displays the hatching before applying it. AutoCAD removes the dialog box and hatches the selected areas.

Associative: Controls associative hatching.

Apply: Crates the crosshatching in the boundary. (Fig 18)

Fig 18

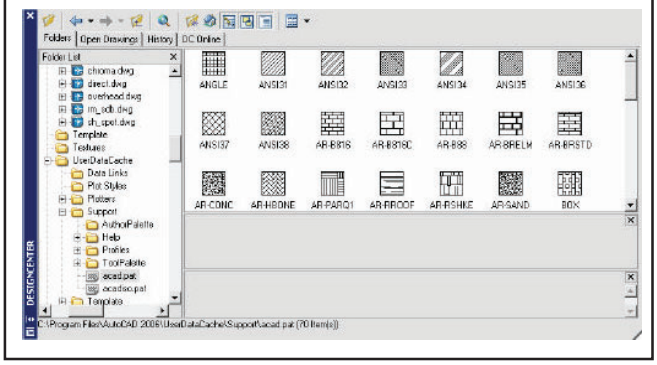


Annotative hatch

Hatching from the design center (Fig 19)

1 Choose: A cross hatch pattern from the following AutoCAD directly\AutoCADxxxx\Support\acad.pat or \AutoCADxxxx\Backup

Fig 19



2 Drag: and drop a pattern into a drawing.

TIP

Be sure the HPSCALE is set before dropping a hatch pattern into a drawing.

CAD basics

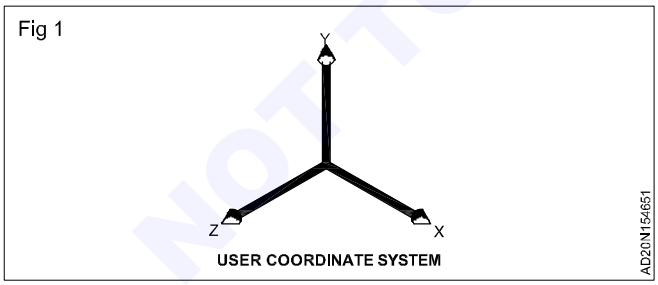
Objectives : At the end of this lesson you shall be able to

- **explain user co-ordinate system**
- **enumerate Auto CAD commands**
- **express line & erase commands.**

The CAD Database and the user coordinate system

Designs and drawings created in a CAD system are usually defined and stored using sets of points in what is called world space. In most CAD systems, the world space is defined using a three-dimensional Cartesian coordinate system. Three mutually perpendicular axes, usually referred to as the X-, Y-, and Z-axes, define this system. The intersection of the three coordinate axes forms a point called the origin. Any point in world space can then be defined as the distance from the origin in the X-, Y- and Z- directions. In most CAD systems, the directions of the arrows shown on the axes identify the positive sides of the coordinates. (Fig 1)

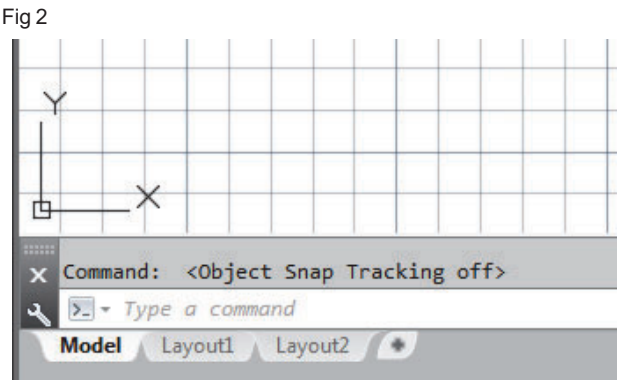
Fig 1



A CAD file, which is the electric version of the design, contains data that describes the entities created in the CAD system. Information such as the coordinate values in world space for all endpoints, center points, etc., along with the descriptions of the types of entities are all stored in the file. Knowing that AutoCAD stores designs by keeping coordinate data helps us understand the inputs required to create entities.

The icon near the bottom left corner of the default AutoCAD graphics window shows the positive X-direction and positive Y-direction of the coordinate system that is active. In AutoCAD, the coordinate system that is used to create entities is called the user coordinate system (UCS). By default, the user coordinate system is aligned to the world coordinate system (WCS). The world coordinate system is a coordinate system used by AutoCAD as the basis for defining all objects and other coordinate systems defined by the users. We can think of the origin of the world coordinate system as a fixed point being used as a reference for all measurements. The default orientation of the Z-axis can be considered as positive values in front of the monitor and negative values inside the monitor. (Fig 2)

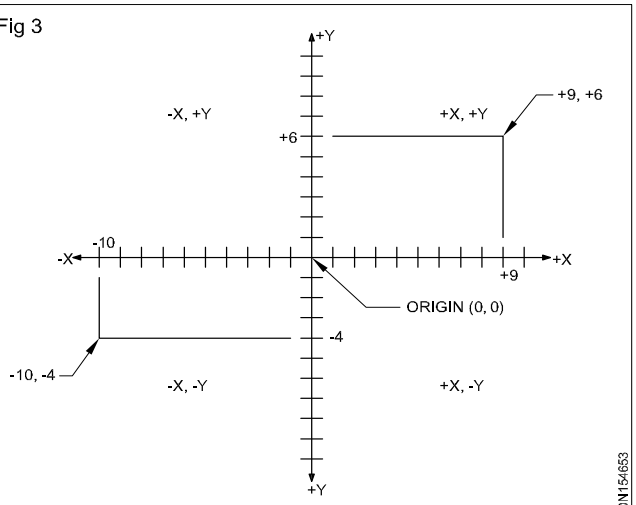
Fig 2



AutoCAD uses points to determine where an object is located. There is an origin where it begins counting from. This point is (0,0). Every object is located in relation to the origin. If you were to draw a line straight out to the right from the origin, this would be considered the positive X-axis. If you were to draw a line straight up, this would

be the positive Y-axis. The picture above shows a point located at (9,6). This means that the point is 9 units over in the X-axis and 6 units up in the Y-axis. When you are working with points, X always comes first. The other point shown is (-10-4). This means that the point is 10 units in the negative X-axis (left) and 4 units in the negative Yaxis(down) (Fig 3)

Fig 3



USER COORDINATE SYSTEM

A line has two points, a start point and an end point. AutoCAD works with the points to display the line on the screen. Move your cursor over the picture above and you will see line drawn from the absolute points of (-10-4) to (9,6).

Most of the time you will not have an indication of where the origin is. You may need to draw a line from the endpoint of an existing line. To do this you use relative points. These work the same way, but you have to add the @ symbol (shift+2) to tell AutoCAD that this next point is relative from the last point entered.

To review

Absolute points are exact points on the drawing space.

Relative points are relative to an object on the drawing space.

its simple system, but mastering it is the key to working with AutoCAD and is explained in more detail further below. In order to work effectively with AutoCAD, you have to work with this system. Until you are comfortable and familiar with it, learning AutoCAD will be more of a chore. My experience in teaching is that the better a student is with coordinates, the faster they will learn.

Entering points in AutoCAD

You can enter points directly on the command line using three different systems. The one you use will depend on which is more applicable for the situation. The first assignment will get you used to this. The three systems are as follows.

Absolute co-ordinates: Using this method, you enter the points as they relate to the origin of the WCS. To enter a point just enter in the exact point as X,Y.

Relative co-ordinates : This allows you to enter points in relation to the first point you have entered. After you've entered one point, the next would be entered as @ X,Y. This means that AutoCAD will draw a line from the first point to another point X units over and Y units up relative to the previous point.

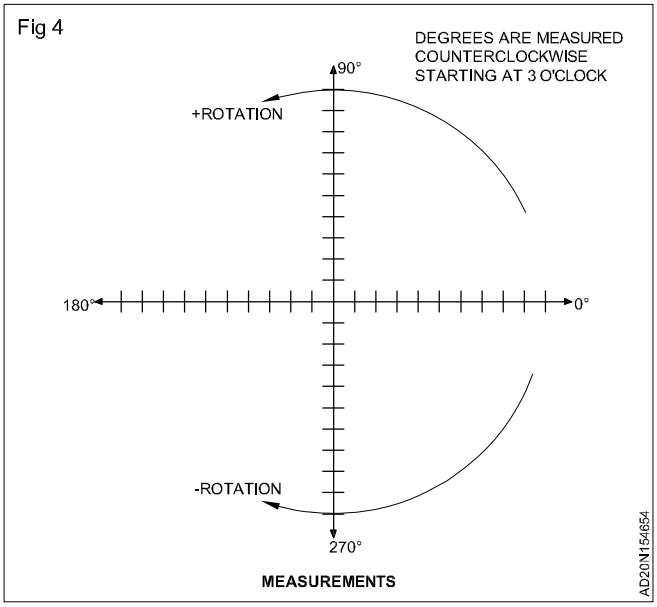
Polar co-ordinates: You would use this system if you know that you want to draw a line a certain distance at a particular angle. You would enter this as @ D<A. In this case, D is the distance and A is the angle. Example: @10<90 will draw a line 10 units straight up from the first point.

The three ways of entering coordinates shown above are the ONIY way AutoCAD accepts keyboard input. First decide which style you need to use, and then enter as shown. Remember that X is always before Y (alphabetical). Don't forget the '@' symbol when you are entering relative points. Any typing error or omission will give you results you don't want. If you make a mistake and need to see what you typed, Press F2 to bring up the text screen and check your typing. (press F2 to get back to your drawing)

Key terms

Term	Description
Absolute coordinates	Distance measured from a fixed reference point.
Aperture	Effective diameter of the cursor on the screen.
Cartesian coordinates	A rectangular system of measurement to locate points in the drawing area.
Object snaps	A method for indicating point locations using existing drawing objects as a reference.
Origin point	The 0,0 location of the coordinate system.
Polar coordinates	A system to locate of the coordinate system.
Prototype drawing	A template drawing that has a last location of the cursor.
Relative coordinates	Distance measured from the last location of the cursor
User-defined co-ordinates System	A mode of measurement that allows the user to set up a customized coordinate system.

Angular measurement (Fig 4)



AutoCAD measures angles in a particular way also. Look at the diagram below and then place your mouse on it to see how this is

Degrees are measured counterclockwise starting at 3 O'CLOCK

When drawing lines at an angle, you have to begin measuring the angle from 0 degrees, Which is at the 3 O'clock position. If you drew a line at 90 degrees, it would go straight up. The example above (When you move your mouse over it) shows a line drawn at+300 degrees (270+30), or-60 degrees.

Your might not always have an obvious reference point for 0 degrees. Look at the example below and place your mouse on the image to find out the angle in question.

In this example, you are given information about the lines, but not the angle AutoCAD needs to draw the line from the start point. What you are given though, is (a) the knowledge that 0°is at the 3 o'clock position (b) the knowledge that180° is at the 9 o'clock position and (c) the angle between 180° and the line you want to draw is 150°. With this information, you can figure out what angle you need. Here is a fool-proof way of getting the angle you need (Fig 5)

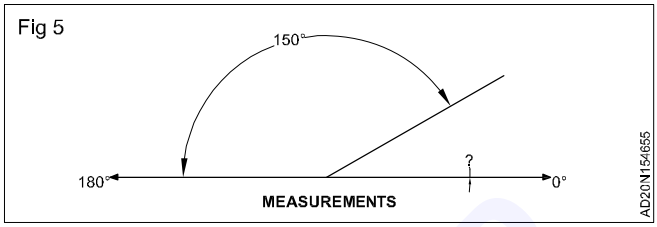
1 Start at the 0° position and measure counter-closkwise (+) to 180°

2 From 180°, measure clockwise 150°(-)

3 Consider that you just went+180-150 and use that as an equation:+180-150=30

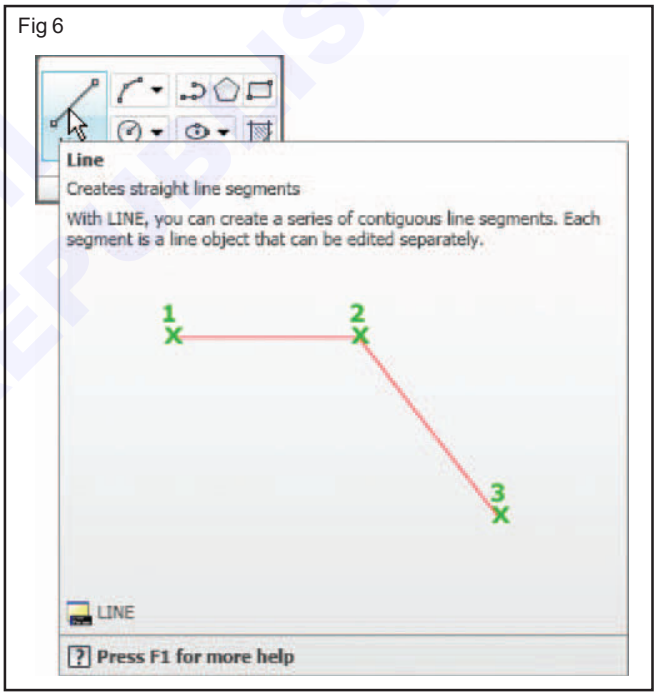
4 Now you can draw your line using polar coordinates (discussed below)

There are many ways to do things in most windows programs. AutoCAD is no exception. Everyone will develop a way that works best for him or her. In this course, we will primarily be working with the keystroke commands. The reason for this is because they will work in most AutoCAD versions (including DOS versions), and in some other CAD programs. The icons work well, but as you will see, icons can be placed anywhere on the screen and can be difficult to find quickly. You may be working on another employee's computer that is set up differently than what you're used to. The pulldown menus will access almost all commands, but are a slower way of doing things. Icons in AutoCAD 2010 are found on the ribbon, divided into panels-just click on the appropriate tab to open thepanel you need.



Example: If you want to draw a line, you can do it a few ways:

At the command line type: LINE (or) L and press the ENTER key. (Fig 6)



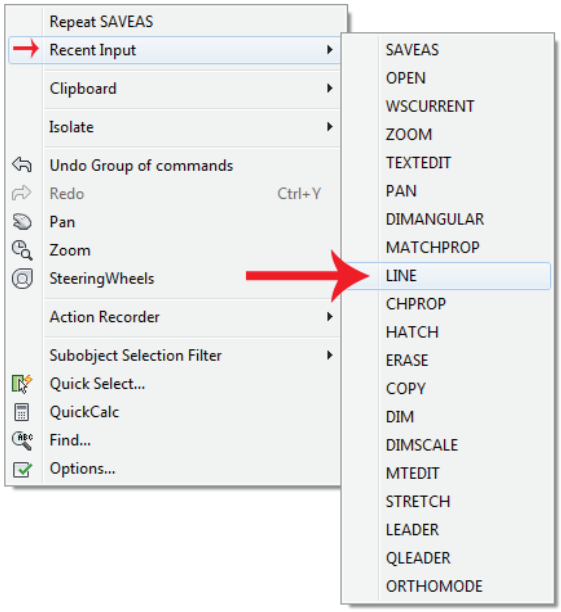
Select the line icon from the DRAW Panel.

Another way is to Right-Click on the drawing space and choose "Recent Input" from the menu. This will give a list of the most recent command that you have used. (Fig 7)

All three approaches will do the same thing: prepare AutoCAD to draw a line where you tell it.

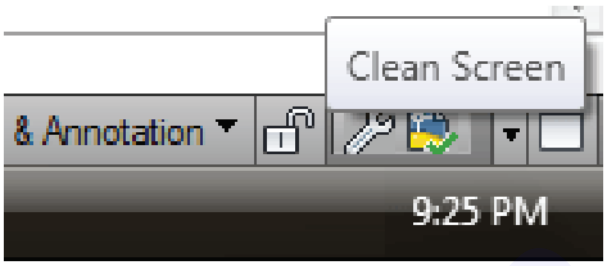
AutoCAD is a popular program because it can be customized to suit an individual's needs. The toolbars are a good example of this. You can have the toolbars you use most often on the screen all the time. You can easily make them go away so that you have more drawing space. You can also customize them so you have the most common commands on one toolbar. For example, the dimensioning toolbar is one that you will not want taking up space on your screen while drawing, but is very handy when you're dimensioning your drawing.

Fig 7



To remove the ribbon and have the most drawing space available, click on the "Clean Screen" icon in the bottom right corner of the screen (or press CTRL+O[letter O]. To go back the to the standard display, click again on the same icon. (Fig 8)

Fig 8



Symbol	Command	Purpose
	Erase	Delete object
	Move	Move object one place to other place
	Copy	Create one or more copies of object
	Stretch	Stertch, shorte, or move object
	Trim	Shorten object using other object
	Extend	Lengthen object using object
	Mirror	Creates a mirror image of objects.
	Rotate	Rotate objects around a specified point.
	Offset	Create a new object at a specified distance from an existing object or through a specified point.
	Array	Each object in an array can be manipulated independently.

Auto CAD Drawing Commands

Symbol	Command	Major option	Toolbar button	Draw men
	Line	Start, End Point	Line	Line
	Mline	Justification, Scale Style	None	Multiline
	Pline	Vertices	Polyline	Polyline
	Polygon	Number of sides, Inscribed / Circumscribed	Polygon	Polygon
	Rectangle	Two Corner	Rectangle	Rectangle
	Arc	Various methods of definition	Arc	Arc, submenu for definition methods
	Circle	Three point, two point, Tangent	Circle	Circle submenu for definition methods
	Donut	Inside, Outside Diameters	None	Donut
	Spline	Convert polyline or Create new	Spline	Spline
	Ellipse	Arc, center, axis	Ellipse	Ellipse, submenu for denifition methods
	Revcloud	Arc Length	Revcloud	Revision cloud

Knowledge of short cut key board commands

Objective : At the end of this lesson you shall be able to
- **describe the features of key board commands in detail.**

Manage screen

Ctrl + o(zero)	Clean screen	Ctrl + 6	DB connect manager
Ctrl + 1	Property palette	Ctrl + 7	Markup set manager palette
Ctrl + 2	Design center palette	Ctrl + 8	Quick calc
Ctrl + 3	Tool palette	Ctrl + 9	Command line
Ctrl + 4	Sheet set palette		

Toggle features and commands (Fig 1 & 2)

Fig 1

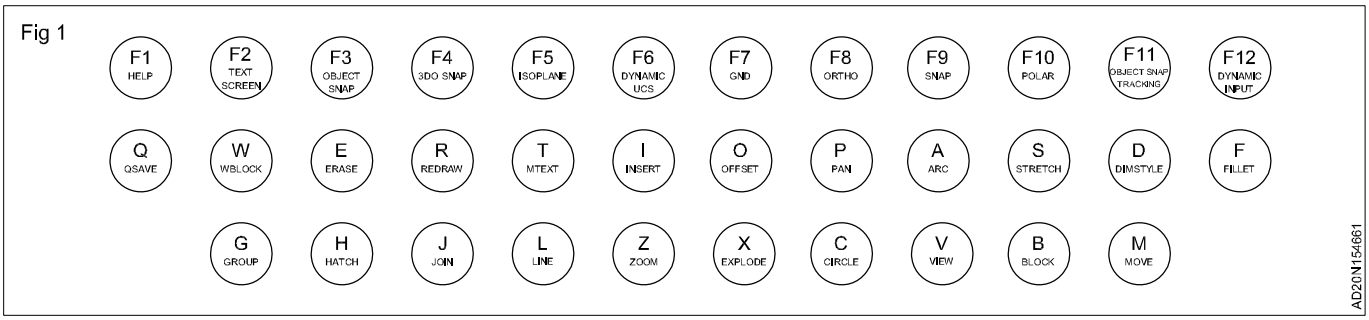
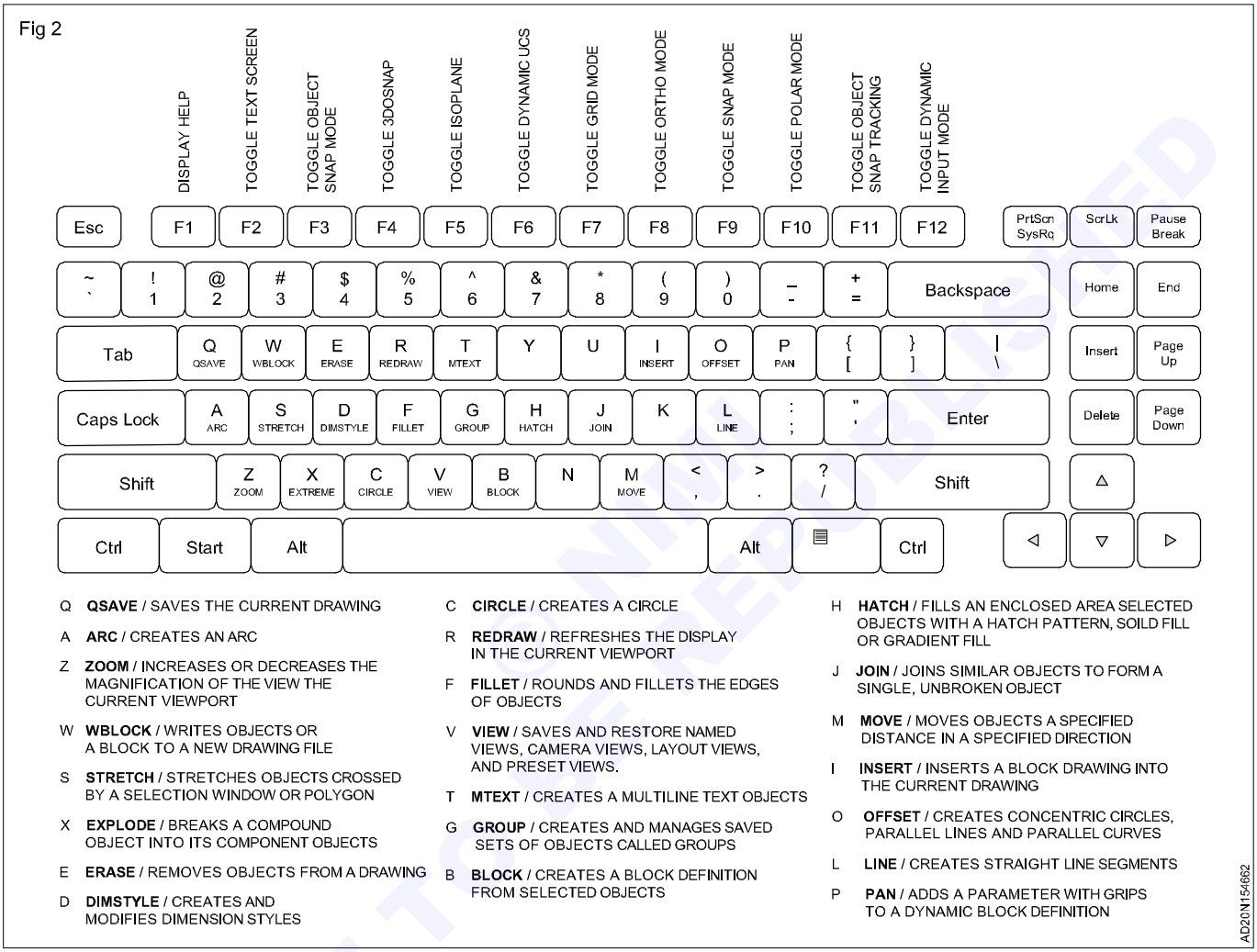


Fig 2



Manage Drawings

Ctrl + n	New drawing
Ctrl + s	Save drawing
Ctrl +o	Open drawing
Ctrl + p	Plot dialog box
Ctrl + Tab	Switch to next
Ctrl+shift+Tab	Switch to previous drawing
Ctrl +page up	_Switch to next Tab in current drawing
Ctrl + Q	Exit
Ctrl + a	Select all objects

A

A	Arc/Creates an arc.
AA	_AREA / Calculates the area and Perimeter of objects or of defined areas.
ADC	ADCENTER / Manages and inserts Content such as blocks, xrefs, and hatch patterns.
AL	ALIGN/Aligns objects with other objects in 2D and 3D
AP	_APPLOAD / Load Application.
AR	_ARRAY / Creates multiple copies of objects in a pattern.
ARR	_ACTRECORD / Starts the Action Recorder.
ARM	_ACTUSERMESSAGE / Insert a user message into an action macro.

ARU _ACTUSERINPUR / Pauses for user input In an action macro.

ARS _ACTSTOP / Stops the Action Recorder and provides the option of saving the recorded actions to an action macro file.

ATI _ATTIPEDIT / Change the textual content of am attribute within a block.

ATT _ATTDEF / Redefines a block and updates associated attributes.

ATE _ATTEDIR / changes attribute information in a block

B

B _BLOCK / Creates a block definition from selected objects.

BC _BCLOSE / Closes the Block Editor.

BE _BEDLT / Opens the block definition In the Block Editor.

BH _HATCH / Fills an enclosed area or selected objects with a hatch pattern, solid fill, or gradient fill.

BO _BOUNDARY / Creates a region or a poly line from an enclosed area.

BR _BREAK / Breaks the selected object between two points.

BS _BSAVE / Saves the current block definition.

BVS _BVSTATE / Creates , sets, or deletes a visibility state in a dynamic block.

C

C _CIRCLE /Creates a circle.

CAM _CAMERA /Sets a camera and target location to create and save a 3D perspective view of objects.

CBAR _CONSTRAINTBAR / A toolbar-like UI element that displays the available geometric constraints on an object.

CH _PROPERTIES / Control Properties of existing objects.

CHA _CHAMFER / Bevels the edges of objects.

CHK _CHECKSTANDARDS / Checks the current drawing for standards violations.

CLI _COLOR / Sets the color for new objects.

CO _ COPY / Copies objects a specified Distance in a specified direction

CT _CTABLESTYLE / Sets the name of the current table style.

CUBE _NAVVCUBE / Controls the visibility and display properties of the View Cube tool.

CYL _CYLINDER / Creates a 3D solid cylinder.

D

D _DIMSTYLE / Creates and modifies dimension styles.

DAN _DIMANGULAR / Creates an angular dimension

DAR _DIMARC / Creates an arc length dimension.

DBA -DIMBASELINE / Creates a linear, angular, or ordinate dimension from the baseline of the previous or selected dimension.

DBC _DBCONNECT / Provides an interface to external database tables.

DCE _DIMCENTER / Creates the center mark or the center lines of circles and arcs.

DCO _DIMCONTINUE / Creates a dimension that starts from an extension line of a previously created dimension

DCON _DIMCONSTRAINT / Applies dimension that starts from an extension line of a previously created dimension.

DCON _DIMCONSTRAIN / Applies dimensional constraints to selected objects or points on objects.

DDA - DIMDISASSOCIATE / Removes associatively from selected dimensions.

DDI _DIMDIAMETER / Creates a diameter dimension for a circle or an arc.

DED _DIMEDIT / Edits dimension text and extension lines.

DI _DIST / Measures the distance and angle between two points.

DIV _DIVIDE / Creates evenly spaced point objects or blocks along the length or perimeter of an object.

DJL _DIMJOGLINE / Adds or removes a jog line on a linear or aligned dimension.

DJO _DIMJOGGED / Creates jogged dimensions for circles and arcs.

DL _DATALINK / The Data link dialog box is displayed.

DLU _DATALINK /Updates data to or from an established external data link.

DO _DONUT /Creates a filled circle or a wide ring.

DOR _DIMORDINATE / Creates ordinate dimensions.

DOV _DIMOVERRIDE /Controls overrides of system variables used in selected dimensions.

DR _DRAWORDER / Changes the draw order of images and other objects.

DRA _DIMRASSOCIATE / Associates or re -associates selected dimensions to objects or points on objects,

DRM -DRAWINGRECOVERY / Displays a list of drawing files that can be recovered after a program or system failure.

DS _DSETTINGS / Sets grid and snap, polar and object snap tracking, object snap modes, Dynamic input, and Quick properties.

DT _TEXT/Creates a single-line text object.

DV _DVIEW / Defines parallel projection or perspective views by using a camera and target.

DX _DATAEXTRACTION / Extracts drawing data and merges data from an external source to a data extraction table or external file.

E- F

E _ERASE / Removes objects from a drawing.

ED _DDEDIT / Edits single-line text, dimension text, attribute definitions, and feature control frames.

EL _ELLIPSE / Creates an ellipse or an elliptical arc.

EPDF _EXPORTPDF / Exports drawing to PDF

ER _EXTERNALREFERENCES / Opens the External References palette

EX _EXTEND / Extends objects to meet the edges of other objects.

EXIT _QUIT / Exits the program.

EXP -EXPORT / Saves the objects in a drawing o a different file format.

EXT _EXTRUDE / extends the dimensions of a 2D object or 3D face into 3D space.

F fillet / Rounds and fillets the edges of objects.

FI _FILTER / Creates a list of requirements that an object must meet to be included in a selection set.

FS _FSMODE / Creates a selection set of all objects that touch the selected object.

FSHOT _FLATSHOT / Creates a 2 D representation of all 3D objects based on the current view.

G-H

G _GROUP / Creates and manages saved sets of objects called groups.

GCON _GEOCONSTRAINT / Applies of persists geometric relationships between objects or points on objects.

GD _GRADIENT / Fills an enclosed area or selected objects with a gradient fill.

GEO _GEOGRAPHICLOCATION / Specifies the geographic location information for a drawing file.

H _HATCH / Fills an enclosed area or selected objects with a hatch pattern, solid fill, or gradient fill.

HE _HATCHEDIT / Modifies an existing hatch or fill.

HI _HIDE/Regenerates a 3D wireframe model with hidden lines suppressed.

I-K

I _INSERT / Inserts a block or drawing into the current drawing.

IAD _IMAGEADJUST / Controls the image display of the brightness, contrast, and fade values of images.

IAT -IMAGEATTACH / Inserts a reference to an image file.

ICL _IMAGECLIP / Crops the display of a selected image to a specified boundary.

ID _ID / Displays the UCS coordinate values of a specified location.

IM _IMAGE / Displays the External References palette.

IMP _IMPORT / Imports files of different formats into the current drawing

IN _INTERSECT / Creates a 3D solid, surface, or 2D region from overlapping solids surfaces, or regions.

INF _INTERFERE / Creates a temporary 3D solid from the interferences between two sets of selected 3D solids.

IO _INSERTOBJ / Inserts a linked or embedded object.

J _JOIN / Joins similar objects to form a single, unbroken object,

JOG _DIMJOGGED / Creates jogged dimensions for circles and arcs.

L-M

L _LINE / Creates straight line segments.

LA _LAYER / Manages layers and layer properties.

LAS _LAYERSTATE / Saves, restores, and manages named layer states.

LE _QLEADER / Creates a leader and leader annotation.

LEN _LENGTHEN / Changes the length of objects and the included angle of arcs.

LESS _MESHSMOOTH;ESS /Decreases the level of smoothness for mesh objects by one level.

LI _LIST / Displays property data for selected objects.

LO -LAYOUT / Creates and modifies drawing layout tabs.

LT _LINETYPE / Loads, sets, and modifies line types.

LTS _LTSCALE / Changes the scale factor of line types for all objects in a drawing.

LW _LWELGHT / Sets the current line weight, display options, and line weight units.

M _MOVE / Moves objects a specified distance in a specified direction.

MA -MATCHPROP / Applies the properties of a selected object to other objects.

MAI _MATERIALS / Shows or hides the Materials window.

ME _MEASURE / Creates point objects or blocks at measured intervals along the length or perimeter of an object.

MEA _MEASUREGEOM / Measures the distance, radius, angle, area, and volume of selected objects or sequence of points.

MI -MIRROR / Creates a mirrored copy of selected objects.

ML -MLINE / Creates multiple parallel lines.

MLA _MLEADERALIGN / Aligns and spaces selected multilayer objects.

MLC _MLEADERCOLLECT / organizes selected multileaders that contain blocks into rows or columns, and displays the result with a single leader.

MLD _MLEADER / Creates a multileader object.

MLE _MLEADEREDIT / Adds leader lines to, or removes leader lines from, a multileader object.

MLS _MLEADERSTYLE / Creates and modifies multileader styles.

MO _PROPERTIES / Controls properties of existing objects.

MORE _MESHSMOOTHMORE / Increases the level of smoothness for mesh objects by one level.

MS _MSPACE/ Switches from paper space to a model space viewport.

MSM _MARKUP / Opens the markup set manager.

MT _MTEXT / Creates a multiline text object.

MV _MVIEW / Creates and controls layout view ports

N-O

NORTH _GEOGRAPHICLOCATION / Specifies the geographic location information for a drawing file.

NSHOT _NEWSHOT / Creates a named view with motion that is played back when viewed with Show motion.

NVIEW _NEW VIEW / Creates a named view with no motion.

O _OFFSET / Creates concentric circles, parallel lines, and parallel curves.

OP _OPTIONS / Customizes the program settings.

ORBIT _3DORBIT / Rotates the view in 3D space, but constrained to horizontal and vertical orbit only.

OS _OSNAP / Sets running object snap modes.

P

P _PAN / Adds a parameter with grips to a dynamic block definition.

PA _PASTESPEC/Pastes objects from the Clipboard into the current drawing and controls the format of the data.

PAR _PARAMETERS / Controls the associative parameters used in the drawing.

PARAM_PARAMETER / Adds a parameter with grips to a dynamic block definition.

PATCH _SURFPATCH / Creates a new surface by fitting a cap over a surface edge that forms a closed loop

PC _POINTCLOUD / Provides options to create and attach point cloud files.

PCATTACH _POINTCLOUDATTACH / Inserts an indexed point cloud file into the current drawing.

PCINDEX _POINTCLOUDINDEX / Creates an indexed point cloud (PCG or ISD)file from a scan file.

PE _PEDIT/ Edits poly lines and 3D polygon meshes.

PL _PLINE/Creates a 2D poly line.

PO _POINT / Creates a point object.

POFF -HIDEPALETTES /Hides currently displayed palettes (including the command line)

POL _POLYGON / Creates an equilateral closed poly line.

PON _SHOWPALETTES / Restores the display of hidden palettes

PR _PROPERTIES / Displays properties palette.

PRE _PREVIEW / Displays the drawing as it will be plotted.

PRINT _PLOT/Plots a drawing to a plotter, printer, or file.

PS _PSPACE/Switches from a model space viewport to paper space.

PSOLID_POLYSOLID / Creates a 3D wall -like poly solid.

PTW _PUBLISHTOWEB / Creates HTML pages that include images or selected drawings

PU _PURGE / Removes unused items, such as block definitions and layers, from the drawing

PYR _PYRAMID / Creates a 3D solid solid pyramid.

Q

QC _QUICKCALC / Opens the Quick calc calculator.

QCUI _OUICKCUI / Displays the customize User Interface editor in a collapsed state.

QP _QUICKPROPERTIES / Displays open drawing and layouts in drawing in preview images.

QSAVE _QSAVE / Saves the current drawing.

QVD _QVDRAWING / Displays open drawings and layouts in drawing using preview images.

QVDC _QVDRAWINGCLOSE / Closes preview images of open drawings and lay outs in a drawing.

QVL _QVLAYOUT / Displays preview images of model spaces and layouts in a drawing.

QVLC _QVLAYOUTCLOSE / Closes preview images of model space and layouts in the current drawing.

R

R _REDRAW /Refreshes the display in the current viewport.

RA _REDRAWALL / Refreshes the display in all viewports.

RC _RENDERCROP / Renders a specified rectangular area, called a crop window, within a viewport.

RE _REGEN / Regenerates the entire drawing from the current viewport.

REA _REGENALL / Regenerates the drawing and refreshes all viewports.

REC _RECTANG / Creates a rectangular poly line.

REG _REGION / Converts an object that encloses an area into a region object.

REN _RENAME / Changes the names assigned to items such as layers and dimension styles.

REV _REVOLVE / Creates a 3D solid or surface by sweeping a 2D object around an axis

RO _ROTATE / Rotates objects around a base point.

RP _RENDERPRESETS / Specifies render presets, reusable rendering parameters, for rendering an image.

RPR _RPREF / Displays or hides the Advanced render settings palette for access to advance rendering settings.

RP _RENDER/ Creates a photorealistic or realistically shaded image of a 3D solid or surface model.

RW _REDERWIN / Displays the Render window without starting a rendering operation.

S

S _STRETCH / Stretches objects crossed by a selection window or polygon.

SC _SCALE / Enlarges or reduces selected objects, keeping the proportions of the object the same after scaling.

SCR _SCRIPT /Executes a sequence of commands from a script file

SEC _SECTION / Uses the intersection of a plane and solids, surfaces, or mesh to create a region.

SET _SETVAR / Lists or changes the values of system Variables.

SHA _SHADEMODE / Starts the VSCURRENT command.

SL _SLICE / Creates new 3D solids and surfaces by slicing, or dividing, existing objects.

SN _SNAP / Restricts cursor movement to specified intervals.

SO _SOLID / Creates solid-filled triangles and quadrilaterals.

SP _SPELL / Checks spelling in a drawing

SPE _SPLINEDIT / Edits a spine or spline-fit poly line.

SPL _SPLINE / Creates a smooth curve that passes through or near specified points.

SPLANE_SECTIONPLANE / Creates a section object that acts as a cutting plane through 3D objects.

SPLAY _SEQUENCEPLAY / Play s named views in one category

SPLIT _MESHSPLIT / Splits a mesh face into two faces.

SPE _SPLINEDIT / Edits a spline or spline-fit poly line.

SSM _SHEETSET / Opens the sheet set Manager.

ST _STYLE / Creates. Modifies. Or specifies text styles.

STA _STANDARDS / Manages the association of standards files with drawings.

SU _SUBTRACT / Combines selected 3D solids, surfaces, or 2D regions by subtraction.

T

T _MTEXT / Creates a multiline text object.

TA _TABLET / Calibrates, configures, and turns on and off an attached digitizing tablet.

TB _TABLE / Creates an empty table object.

TEDIT _TEXTEDIT / Edits a dimensional constraint, dimension, or text object.

TH _THICKNESS / Sets the default 3D thickness property when creating 2D geometric objects.

TI _TILEMODE / Controls whether paper space can be accessed.

TO _TOOLBAR / Displays, hides , and customizes toolbars.

TOL _TOLERANCE / Creates geometric tolerances contained in a feature control frame.

TOR _TORUS / Creates a donut-shaped 3D solid

TP _TOOLPALETTES / Opens the Tool palettes window.

TR _TRIM / Trims objects to meet the edges of other objects.

TS _TABLESTYLE / Creates modifies, or specifies table styles.

U-W

UC _UCSMAN / Manages defined user coordinate systems.

UN _UNITS / Controls coordinate and angle display formats and precision.

UNHIDE _UNISOLATEOBJECTS / Displays UNIOLATE objects previously hidden with the ISOLATEOBJECTS or HIDEOBJECTS command.

UNI _UNION / Unions two solid or two region objects.

V _VIEW / Saves and restores named views, camera views , layout views, and preset views.

VGO _VIEWGO / Restores a named view.

VP _DVPOINT / Sets the 3D viewing direction.

VPLAY _VIEWPLAY / Plays the animation associated to a named view.

VS _VSCURRENT / Sets the visual style in the current viewport.

VSM _VISUALSTYLES / Creates and modifies visual styles and applies a visual style to a viewport.

W _WEDGE / Creates a 3D solid wedge.

WHEEL _NAVSWHEEL / Displays a wheel that contains a collection of view navigation tools.

X-Z

X _EXPLODE / Breaks a compound object into its component objects.

XA _XATTAC H / Inserts a DWG file as an external reference (xref).

XB _XBIND / Binds one or more definitions of named objects in an xref to the current drawing.

XC _XCLIP / Crops the display of a selected external reference or block reference to a specified boundary.

XL _XLINE/Creates a line of infinite length

XR _XREF / Starts the EXTERNALREFERENCES command.

Z _ZOOM / Increases or decreases the magnification of the view in the current viewport.

ZEBRA _ANLYSISZEBRA / Projects stripes onto a 3D model to analyze surface continuity.

ZIP _ETRANSMIT / Creates a self -extracting or Zipped Transmittal package.

Factors considered in architectural design

Objectives: At the end of this lesson you shall be able to
- **define design elements.**

Definition

Design elements are the basic units of any visual design which form its structure and convey visual messages.

Elements of design

Creating floor plans is a process of allocating interior space to meet funcitonal needs. Designing elevations involves combining the elements of design to create functional and attractive building exteriors. The elements of design like point, line, plane, figure, form and space, color, light, materials and texture are applied to the creation of elevations.

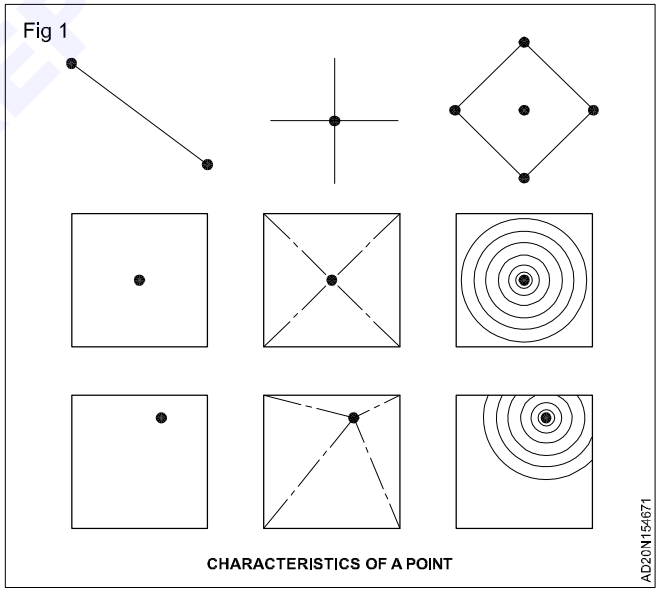
Point

A point has no dimension or magnitude but its importance and denotes its position in space. The size of points makes change with respect to its background. Point may be 'point of attraction' or a focus point in the field of architecture.

As shown in Fig 1 a point can serve to mark

- The two ends of a line.
- The intersection of two lines.
- The meeting of lines at the corner of a plane or volume and the centre of a field or environment.

Fig 1



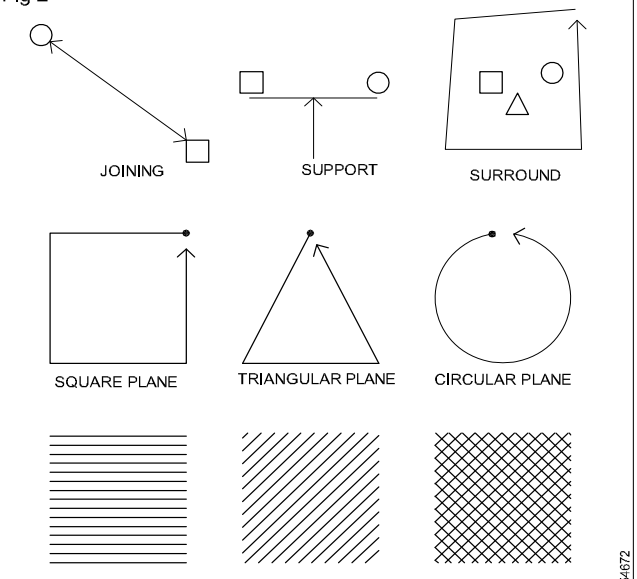
CHARACTERISTICS OF A POINT

Line : The lines of an elevation tend to create either a horizontal or vertical emphasis. The major horizontal lines of an elevation are ground line, eave line and ridge line. (Fig 2)

Lines should be consistent. The lines of an elevation should appear to flow together as one integrated line pattern. The lines of component parts of an elevation should relate each other, and the overall shape should reflect the basic shape of the building.

- Vertical lines communicates feeling of loftiness and spirituality
- Horizontal lines suggests a feeling of rest and calmness
- Diagonal lines represents feelings movement or direction lines objects in diagonal position are unstable
- Curved lines means soft, shallow, com**fort.**

Fig 2



A line can serve to

1 Join, link, support, surround, or intersect other visual elements,

2 Describe the edges of and give shapes to planes, and

3 Articulate the surfaces of planes.

Plane

Plane is a two dimensional elements composed of numbers of lines adjacent to each other. It has length and breadth but no thickness. It may be straight or curved, horizontal or vertical in appearance of the plane. (Fig 3)

Fig 3

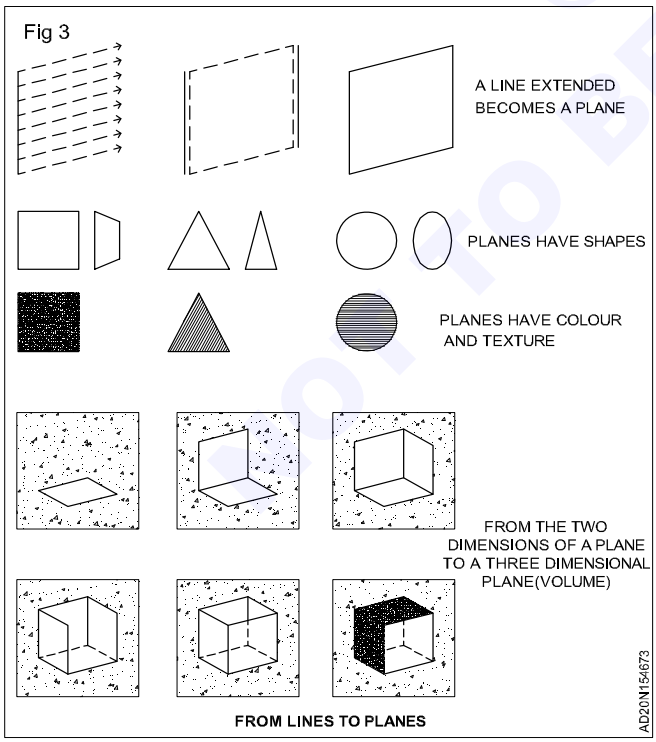


Figure : Figure is also a two dimensional elements formed by the enclosure of the space by line or number of lines. It may or may not have depth as a third dimension.(Fig 4)

Fig 4

Form are three dimensional

Lines combine to produce form and create the geometrical shape of an elevation. Elevation shapes should be balanced. Formal balance is used extensively in colonical and period styles of architecture. Informal balance is more widely used in contemporary residential architecture.

In addition to the elements of design, the basic architectural style of a building needs to be considered when designing elevations. Doors, windows should be part of a continuous pattern of the elevation and should not appear to exist alone. (Fig 5 & 6)

Fig 5

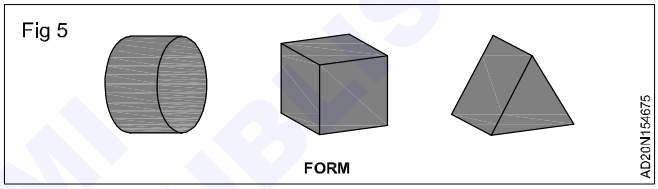
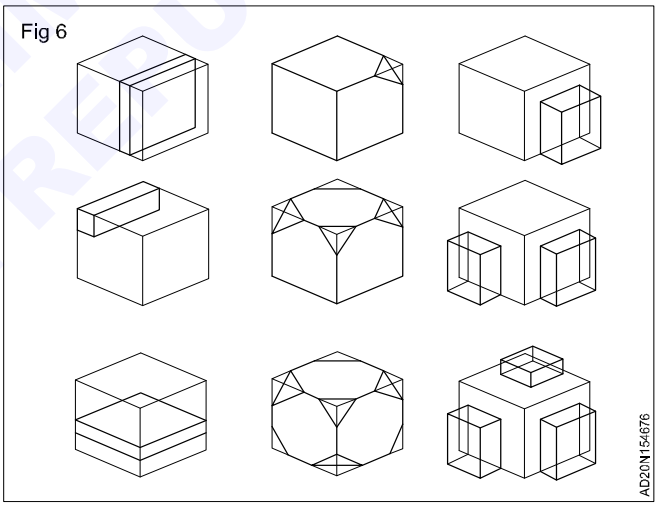


Fig 6



Light and colour

An elevation that is composed of all light areas or all dark areas tends to be uninteresting and neutral. Some balancing of light, shade and color is desirable in most elevation. Shadow patterns can be created by depressing specific areas, using over hangings, texturing and varying colors. Door and window trim, columns, battens and overhangs are used to create most shadows.(Fig 7 & 8)

Texture

Texture is defined as a feel of the surface of an object. It is everywhere from every material and object, whether it was manmade or natural. Texture gives us a sense of individuality on the material and a design will help emphasize and create a feel. Texture describes emotions and thoughts of a design, rough edges tell as anger or masculinity and smooth surface's is the opposite. (Fig 9 & 10)

Fig 7

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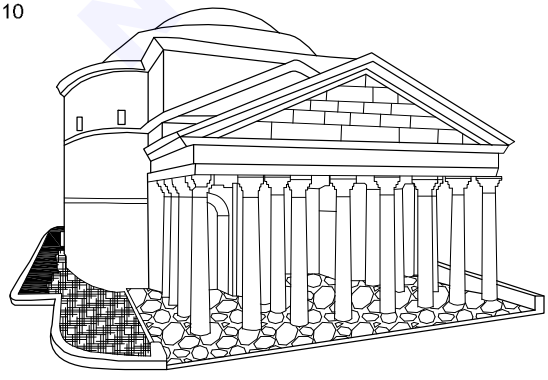
Fig 8

Fig 9

Fig 10



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Space

In a picture, the shapes that the artist has placed are considered positive space and the space around the shapes are negative space, Design what you don't add can be just as important a what you do. By learing space around it's better able to isolate and concentrate on it without distraction. (Fig 11)

Fig 11

Colours

You cannot see colour without light. When white light passes through a prism, it diffracts into seven colours forming a band known as spectrum. It is like the rainbow in the sky. This band is also known as vibgyor (v-violet, i-indigo, b-blue, g-green, y-yellow, o-orange,r-red). A colour is only a sensation, it is not in an object.

Elements of colour

The intensity of colour depends on the amount of energy contained within the wavelength, colour has three virtues.

1 Hue
2 Chroma
3 Value

Hue

Hue is determined by the wavelength because each wavelength produces a definite colour on retina of the eye. The largest wavelength creating the red colour and the shortest wavelength creating violet colour.

Chroma

Chroma is determined by the intensity of the colour. If colour has more intensity, it means the colour has more chroma.

Value

The value of a colour refers to its darkness or lightness. By adding white, a colour is lightened and by adding black, a colour is darkened.

So by adding white to a colour, we obtain a lighter colour, a tint. (Fig 12)

And by adding black to a colour, we obtain a darker colour, a shade (Fig 12)

Eg. Pink is a tint of red, and brown is a shade of red.

The term tone refers to a range of tints and shades of a colour (Fig 13).

Fig 12

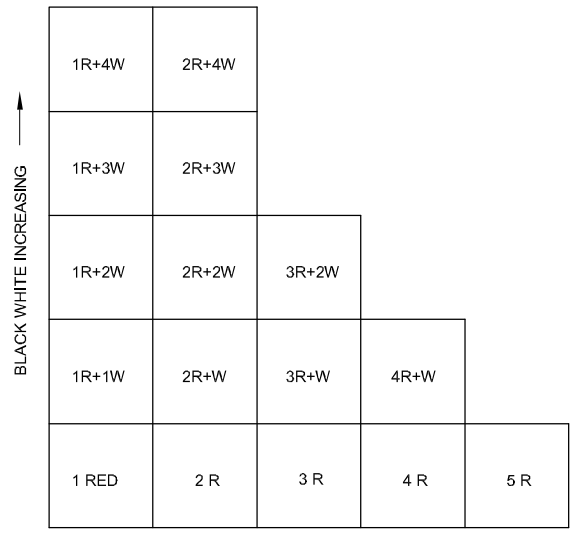


Fig 13

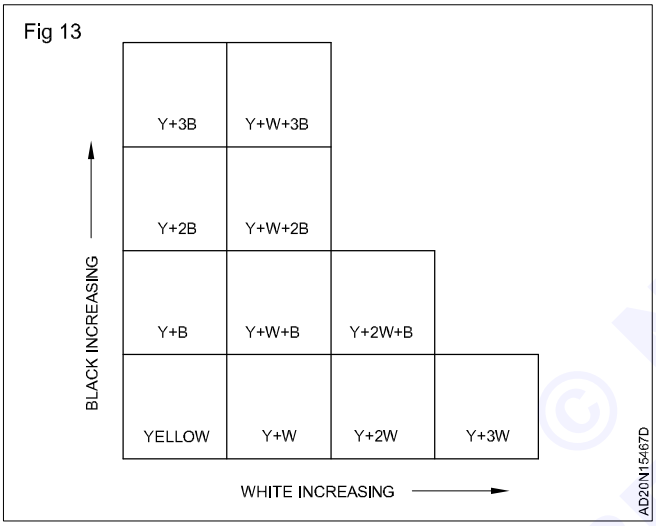


Fig 14

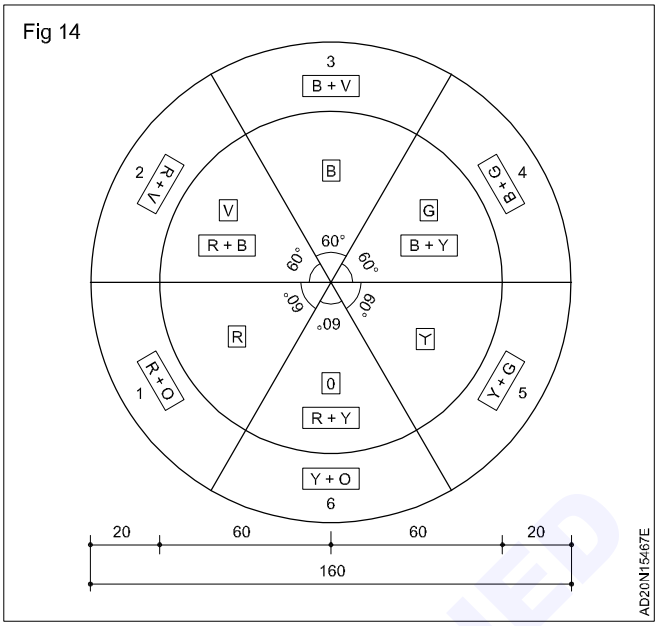


Fig 15

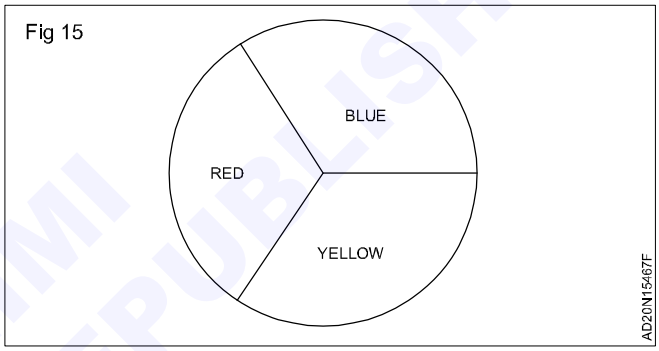


Fig 16

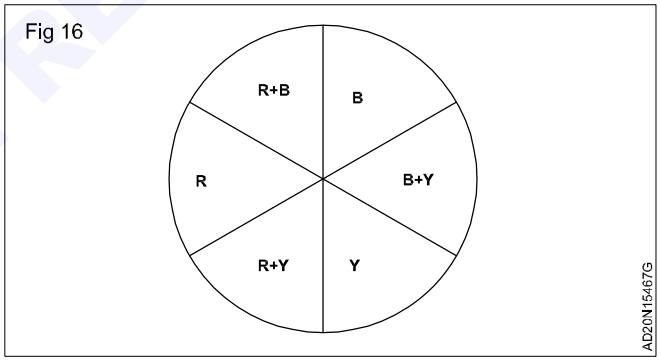
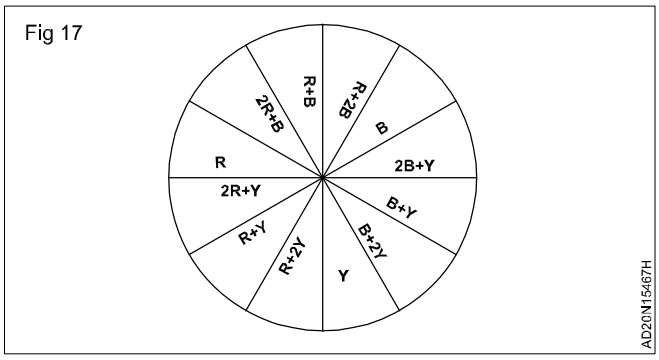


Fig 17



Colour Wheel

It gives good understanding of colours. It consists of the colours of the rainbow arranged in circular fashion. This colour wheel can be used to explain the main relationships of colours. An understanding of these relationship is useful for choosing furnishings, coverings, paints and other colour materials.

The primary, secondary and tertiary colours put in a circle as shown in (Fig 14) forms the colour wheel.

Primary Colours

Yellow, ted and tilve are known as primary colours because they cannot be obtained by mixing other colours (Fig 15)

Secondary Colours

Secondary colours are obtained by mixing two primary colour. They are orange, green and violet. (Fig 16)

Tertiary colours

By mixing two secondary colours, we obtain a tertiary colour, Violet blue, blue green, green yellow, orange yellow, orange red, violet red. (Fig 17)

Psychological impact of colours

Red colour

It is the bright colour in the whole spectrum. It has a dynamic character and denotes courage and aggressiveness. It affects the atmosphere and makes it

hot and non-tolerable. But it is a definite positive colour. It should be used in a room where the sun rays do not reach.

Orange colour

It is gay bright colour. It is a combination of yellow and red. It brings brightness, cheer and happiness in the atmosphere. It gives the feeling of wellbeing. It is suitable for lobby and children room.

Yellow colour

Yellow is the colour of intellectual nature. It is a warm colour and radiates joy and represents beauty and love. Tints of yellow are mostly used in interiors.

Green colour

Green is psychologically the most soothing colour and it is largely found in nature. There is a saying may god keep my memory green'. It is a combination of blue and yellow. It cools the environment and is a natural healing agent. Being soothing and safe colour, even its excess use does not harm.

Blue colour

It is a cool static colour which has the property on increasing the distance from which it is being reflected to the observer. It denotes tranquility. It makes atmosphere calm and soothing. It promotes relaxation after a day of hard work but at the same time too much of blue can be depressing. It is ideal for bed room.

Black colour

If black is properly used, then it can be beautiful and represents earthly qualities.

Gray colour

It is combination of white and black and therefore a mixture of qualities of both. It is a natural colour and balances the polarities between the qualities of black and white.

Beige colour

It is the mixture of light yellow and gray. It can be matched with all colours. It can merge with surroundings. If you are not sure which colour is suitable for a room, try beige.

Brown colour

It is a mixture of red, yellow and black. It represents tradition and conservation taste. It stimulates growth and achievement. It is rich colour as we get qualities of red, yellow ad black. Brown is the best for furniture upholstery and wardrobes.

Classification based on characteristics of colours

Colours can also be classified into various groups based on their characteristics.

Warm colours

Warm colours are those colours which are bright, aggressive, attract attention and excite emotions. It also makes a colour schemes cheerful and rich. The hues from red to yellow colour including orange, pink and brown are on the maximum side warm colours.

Cool colours

Cool colours have opposite effects of warm colours. It cools down the metabolism of the body. Sometimes it

appears gloomy and oppressive but cool shades of blue and green lock clean and inviting for a nice change. The hues from green to violet including blue and all shades of gray are known as cool colours.

Light colours

Light colour is the mixture of basic hues and white colour which reduces the intensity of colour. Light colour is looks soft and sublimed and is preferred in interior decoration. Light colour scheme may look' effective in its quiet way depending on environmental surroundings.

Dark colours

Dark colours are the mixture of basic hues with black or warm colours with their actual hues which may or may not be mixed with black colour. These colours look heavy, dense, strong and solid and generally combined with lighter colours. Dark red, purple, green and blue are associated with royality and dignity.

Dull colours

Dull colours are the mixture of basic colours and gray or in other words we can say diffusion of basic colour in gray. It creates a blurry impression but at the same it helps to reduce tension.

Uses of colour scheme

Colour is responsible for so many factors:

1 It makes the interior pleasing.

2 The dimensions of an interior can be made to look smaller or bigger with the help of colours.

3 It camouflages undersigned elements in an interior

4 It creates a certain mood in an interior - mood of relaxation or mood of activity

Types of colour scheme

1 Monochromatic colour scheme (Fig 18)

A monochromatic colour scheme consists of using one colour in varying intensities. This scheme helps to give a spacious feeling to an interior and provides unity for a composition and a quiet background for objects and people within it.

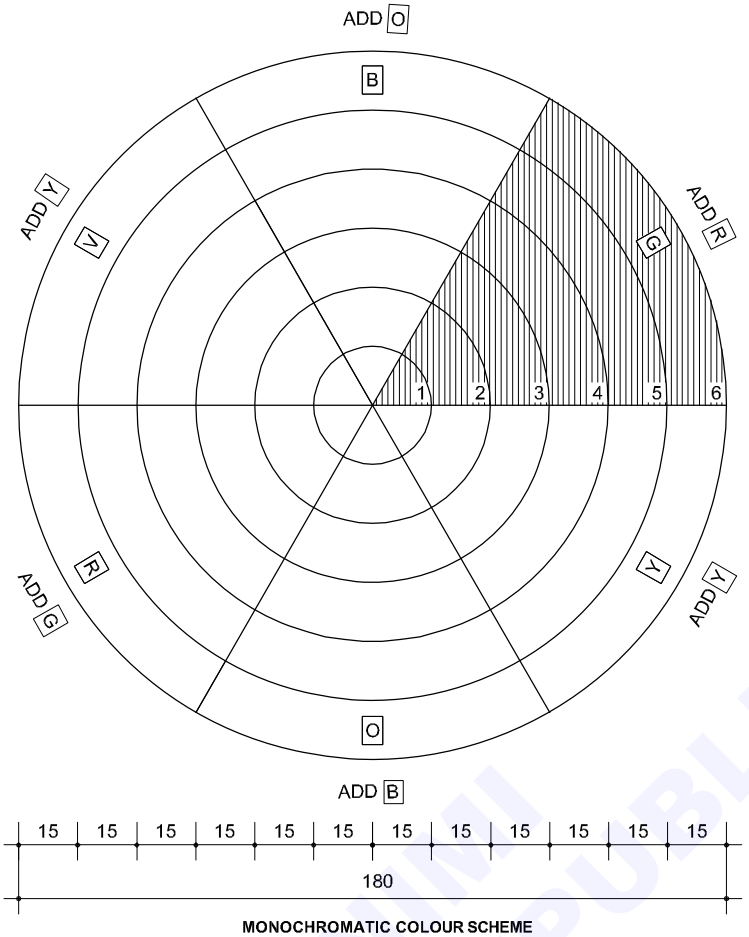
2 Complementary colour schemes (Fig 19)

Complementary colours are directly opposite to each other wheel. These colours need not be used in their pure form. They can be used in many values or intensities.

3 Double complementary colour scheme (Fig 20)

A double complementary colour consists of a pair of complementary colours on the colour wheel. E.g. Yellow and orange and thier respective complementary colours are used in this colour scheme.

Fig 18



MONOCHROMATIC COLOUR SCHEME

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Fig 19

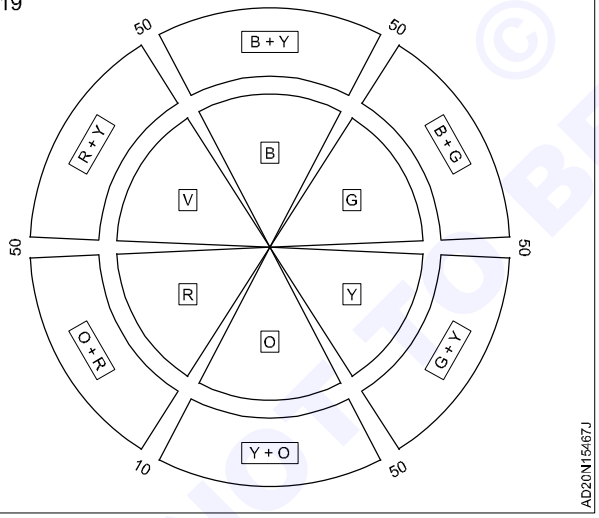

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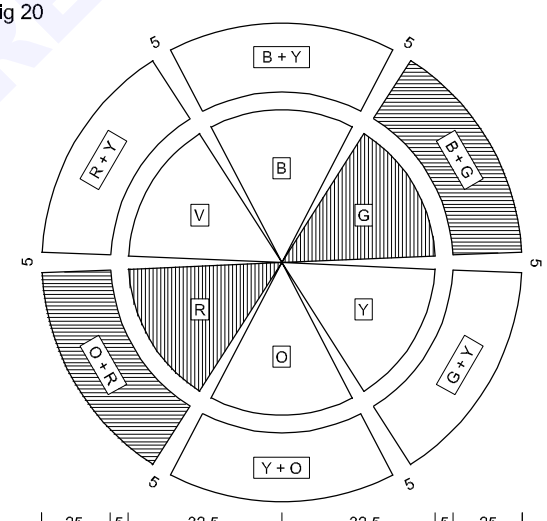
Fig 20



COMPLEMENTARY COLOUR SCHEME

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4 Split complementary colour scheme (Fig 21)

Split complementary colours of two colours that join its complements on the colour wheel. This offers are variety. Eg. Yellow with blue violet and violet.

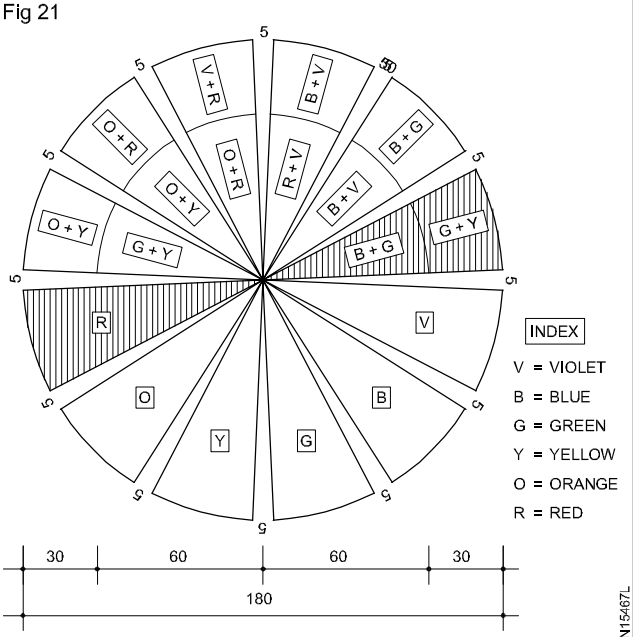
5 Triad colour scheme (Fig 22)

Traid colour scheme combines three colours obtained by placing an equilateral triangle on the colour wheel. By turning the equilateral triangle on the colour wheel different combinations can be obtained.

tetrad colour scheme (Fig 23)

tetrad is formed by any four colours on the wheel, which are adjacent to one another.

Fig 21



SPLIT COMPLEMENTARY COLOUR SCHEME

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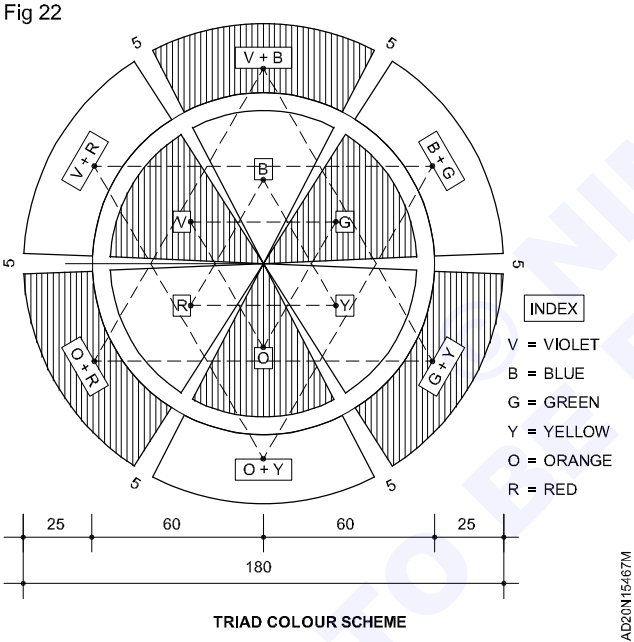
Fig 22



TRIAD COLOUR SCHEME

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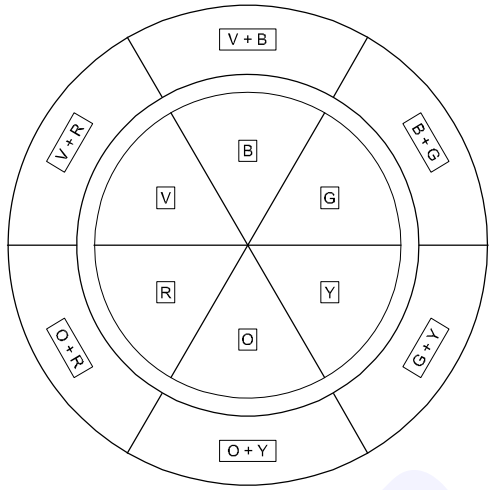
Fig 23



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Guidelines for good colour schemes

a In all colour schemes one colour should dominate. This basic colour occupies 60 to 70.

b Definite colour schemes like harmonious, complementary or traid are recommended.

c A safe colour scheme consists of tints and shades of one colour

d A colour scheme should be definitely dark or light.

e Either warm or cool colours should dominate.

f Every colour scheme must have a dominating colour and secondary colour.

g A neutralized colour (grey) is beast for large areas.

h Rely on colours to brighten dark areas.

Model space view port in AutoCAD

Objectives: At the end of this lesson you shall be able to
- **understand the meaning of model space and view ports**
- **explain the benefits of autocad viewport**
- **explain the types of autocad viewport**
- **create model space view port and layout viewport in Autocad.**

Model space

Model space is an area in which you create two-dimensional and three-dimensional entities based on either the World Coordinate System (WCS) or a user coordinate system (UCS). You view and work in model space while using the Model tab. Your view of this area is a single viewport that fills the screen. In model space, you can split the drawing area into one or more rectangular areas called model space viewports. Viewports are areas that display different views of your model. In large or complex drawings, displaying different views reduces the time needed to zoom or pan in a single view.

an AutoCAD Viewport displays different scaled views or sections of a 2D drawing or 3D model. This feature is specifically designed to help you reduce the time you would ordinarily need to pan or zoom in on a single view, especially when working with complex or large drawings. This is because you can set multiple zoomed-in views of different parts of the drawing or model, which you can then switch between easily and quickly, with the main view remaining unchanged. This way, AutoCAD viewport enables you to easily identify errors you would have otherwise missed if you were looking at the entire drawing.

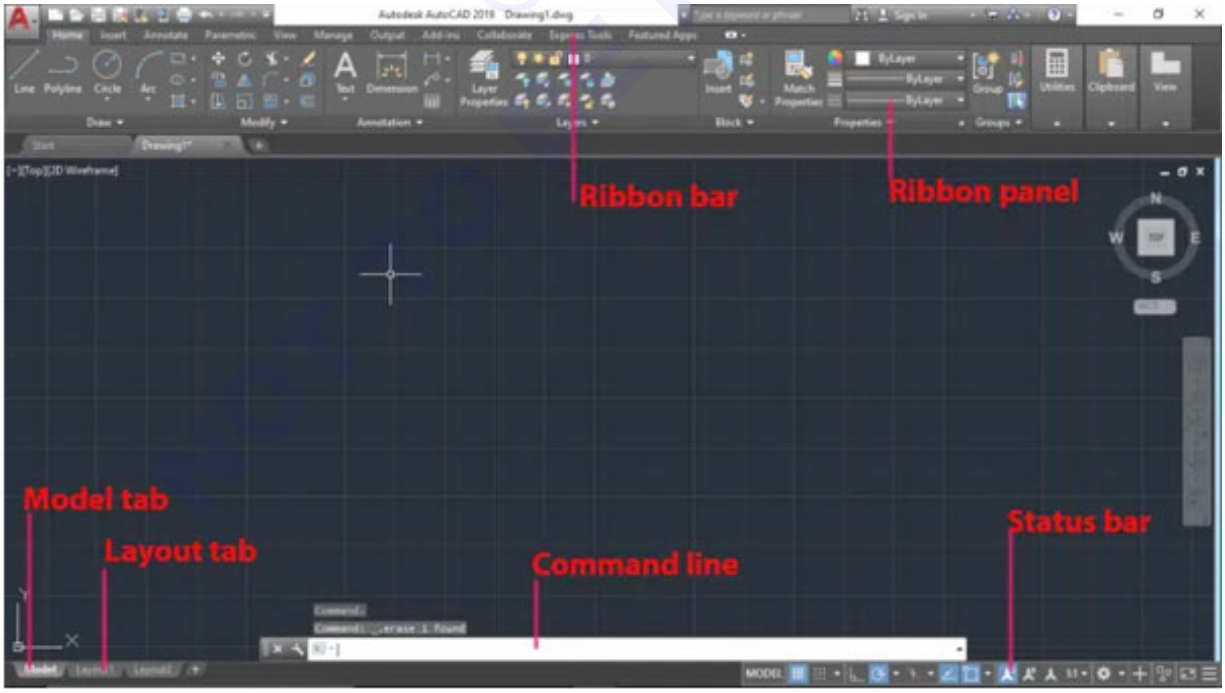
Benefits of AutoCAD Viewport

As you may have already established from the section above, the AutoCAD Viewport feature offers numerous benefits. These include:

- It eliminates the need to pan or zoom into particular sections every time you want to assess the minute details, thereby saving time
- AutoCAD Viewport makes it easy to spot errors you would have otherwise missed
- This feature eliminates the need to draw the various orthogonal projections of a 3D object for each of the six main viewing angles

Types of AutoCAD Viewports (Fig 1)

Fig 1



There are two types of AutoCAD Viewports:

1 Model Space viewport

2 Layout viewport

1 **Model Space Viewports :** When you first launch AutoCAD and subsequently hit 'New Drawing,' the software opens a drawing area containing gridlines, which is located in the Model tab. This drawing area

is limitless in that it covers somewhat of an infinite area and can be zoomed in or out endlessly. It is this drawing area that is known as a model space.

The model space lets you draw any 2D drawing or 3D model you desire. But first, you must define the unit you want to use - whether millimeters, centimeters, inches, or feet. Here, one drawing unit represents one millimeter, one centimeter, one inch, and so on. Simply put, the scale is always 1:1.

By default, the model space usually has a single drawing area known as a model space viewport. This viewport generally enables you to view your drawing. Depending on the complexity of the drawing, however, you can split the drawing area into more than one drawing area using one of the two procedures detailed below.

When dealing with multiple model space viewports, AutoCAD highlights the one on which you are working - the current viewport - using a blue border. Do note that some commands like zooming and panning only apply to the current viewport. However, if you add a geometric object or dimension, this change will apply to all viewports. This means you can begin a command in one viewport and complete it in another.

How to Create a Model Space Viewport in AutoCAD

There are two methods you can deploy to create a model space viewport. These include:

- Using VPORTS command
- Using Viewport Controls button, which is denoted by a minus sign encased in box brackets [-] on the top left section of the model

To create a model space viewport using the VPORTS command, simply follow the procedure below

1 On the command line, type VPORTS and hit enter

2. Select the number and configuration of viewports you want to add on the Viewports pop-up window

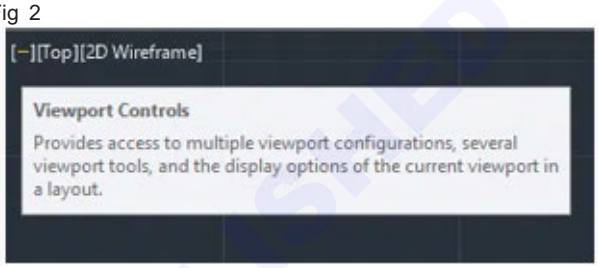
   Here you can add up to four viewports, with the option to decide the location of the viewports relative to each other

3 Click OK

To create a model space viewport using the Viewports Control button, follow these steps:

1 Click the Viewports Control button (Fig 2)

Fig 2

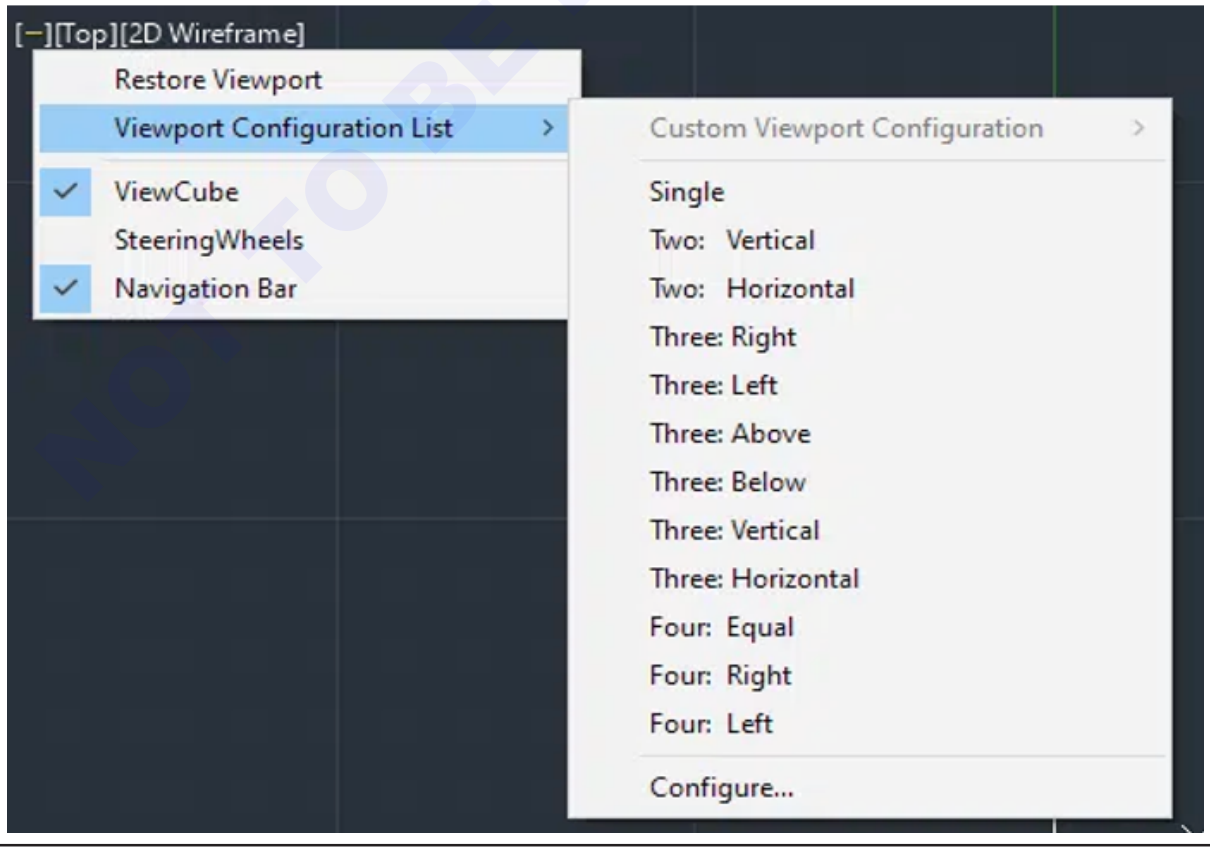


2 Select the Viewport Configuration List option on the resultant dropdown menu (Fig 3)

3 Choose the configuration you want to choose from the list displayed

The model space will automatically refresh to include the new configuration

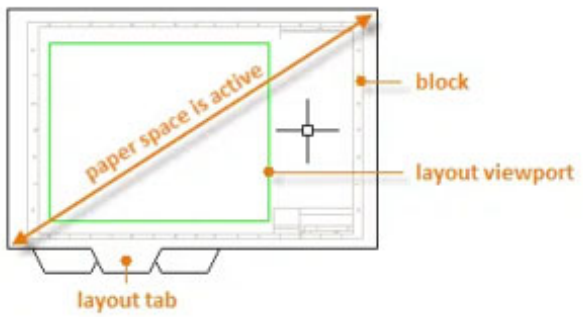
Fig 3



Layout Viewports

The layout viewport is to paper space what model space viewport is to model space. This means a layout viewport can only be accessed when you are on the paper space (in the layout tab). The layout viewport allows you to scale the model space views based on the paper space. (Fig 4)

Fig 4



Unlike the model space, which is limitless and enables you to draw using the 1:1 scale, the paper space is limited based on the paper size you select in the page setup manager. The paper space allows you to include the title block and notes. Additionally, it lets you specify the extent of the layout viewport. And based on the available area, you can include multiple layout viewports within the area shown in green in the image. The viewports can be fashioned from regular shapes such as rectangles or irregular shapes. You can also create a layout viewport from an existing object, as detailed in the procedure below.

By creating multiple layout viewports in the paper space, you can include as many views of the 2D drawing or 3D model as possible. Do note, however, that because the paper space is meant to aid in plotting or printing, you should define the scale of each view. Always keep in mind that the scale in the layout viewports is based on the paper size and level of magnification.

How to Create a Layout Viewport in AutoCAD

There are two approaches you can use to create a layout viewport, namely:

- Using VPORTS command
- Using creation tools on the Layout contextual tab

To create a layout viewport using the VPORTS command, follow the procedure below:

1 Click on the layout tab

2 On the command line, type VPORTS and hit enter

This opens the Viewports pop-up window, which shows that the paper space supports fewer viewports than the model space.

3 Select the number and configuration of viewports you desire and click OK

4 Specify the extent of the paper space

AutoCAD lets you do this by clicking the first corner and drugging the mouse to the opposite corner. Upon specifying the extent, AutoCAD automatically separates the area based on the number of viewports selected.

To create a layout viewport using the tools on the Layout contextual tab, follow this procedure:

1 Click on the layout tabs to move from the model space to the paper space

Alternatively, you can create a new layout by clicking the plus (+) button to the left of the status bar. This second approach enables you to choose the paper size as well as define the plot area, given that you can access the Page Setup Manager.

Toggling the layout tab on creates a new contextual tab atop the software interface.

2 Tap the Layout ribbon tab on the ribbon bar

This tab contains several ribbons, including Layout, Layout Viewports, Create View, Modify View, Update, and Style and Standards. (Fig 5)

3 Select the Rectangular, Polygonal, or Object button on the Layout Viewports ribbon panel (Fig 6)

Fig 5

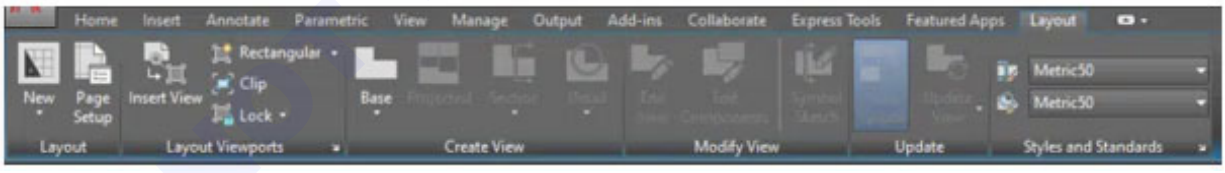
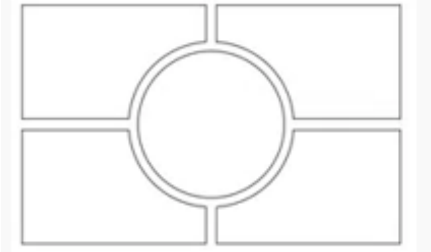


Fig 6



The title of the button will depend on whether you will have selected one of these options before. The Rectangular option allows you to create a rectangular viewport, while the polygonal option lets you create a regularly-shaped or irregularly-shaped viewport. Lastly, the Object option enables you to create a viewport from any objects in your drawing. With this last option, you can create a fancy viewport like the one shown.

4 Define the size of the viewport by clicking the opposite corners of the rectangle, drawing the polygon, or selecting a pre-existing object.

Once you have defined the size, AutoCAD will automatically create the viewport. Do note that you can rotate the rectangular or polygonal viewport as detailed below.

Always ensure that you have a dedicated layer for the viewports. This is because AutoCAD associates the viewport with the current layer of the drawing. And because you do not want the boundary of the viewport to be printed or plotted - as the viewport should essentially be on a transparent layer - it is important to keep a keen eye every time you create a viewport. To change or assign a viewport:

1 Click on the viewport in the paper space to highlight it

2 Head over to the click the Home ribbon

3 Select the viewport layer on the layers dropdown menu in the Layers panel

How to Rotate a Viewport in AutoCAD

AutoCAD allows you to rotate the rectangular or polygonal viewport. Doing so changes not only the orientation of the viewport but also the drawing displayed therein. To rotate the viewport:

1 Click on the rectangular or polygonal viewport to select it

2 Hit the right mouse button

3 Select the Rotate option on the menu that pops up

4 Specify the base point that will act as the center of the rotation

5 Next, you can either specify the rotation angle in the command line or manually rotate the viewport.

6 Hit Enter to end the rotate command

How to Lock a Layout Viewport in AutoCAD

As detailed above, the scale of the layout viewport is based on the paper size and level of magnification. This means that you have to scale the model space views based on the size of the sheet of paper you will have selected in the page setup manager - one unit in the paper space is equal to the actual distance, in millimeters or inches, on the paper. AutoCAD automatically adjusts the scale of the drawing based on the size of the viewport. The software also adjusts the scale if you zoom in or out. This is why it is important to lock the viewport, as detailed below.

However, if you are not careful, it is easy to change the scale you had set earlier, even by accident. For instance, the scale will automatically change if you accidentally click a particular layout viewport and scroll the mouse wheel. This shows the importance of locking the viewport. Locking the layout viewport ensures that you cannot zoom in or out of the model space in the layout tab. Instead, zooming in or out simply changes the level of magnification of the entire paper rather than the drawing.

There are two ways you can lock the viewport, both of which only work when you are in the layout tab:

- The status bar approach
- The Layout-Viewports-ribbon-panel approach

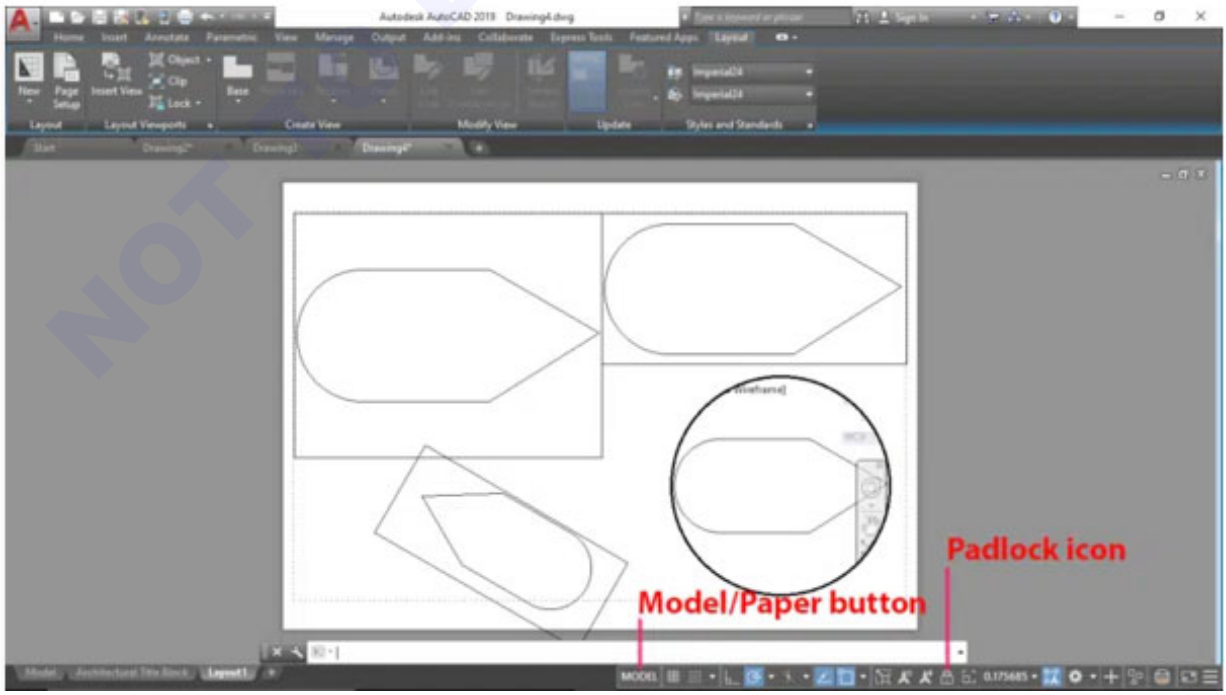
To lock the viewport using the status bar approach, follow the procedure below:

1 Ensure you are on the layout tab

2 On the status bar, click the button labeled PAPER

Hitting this button lets you view the model space via the different viewports on the paper space. To verify that you are in the model space, the PAPER icon will change to MODEL. (Fig 7)

Fig 7



3 Click on the padlock icon on the status bar

If the viewport is locked, the padlock will have a blue background. But if it is unlocked, the padlock will have a transparent background.

To lock the viewport using the Layout Viewports ribbon panel approach, use the following procedure:

1 Ensure you are on the layout tab

2 Click on the Layout ribbon and head over to the Layout Viewports ribbon panel

3 Select the Lock or Unlock button

Like all other AutoCAD operations, the software will either display Lock or Unlock depending on whether you have previously selected one of these options before.

4 To lock the viewport, simply hit Lock

AutoCAD viewports are essential when drawing an object or planning how to print or plot it. In this comprehensive guide to viewports in AutoCAD, we have highlighted what an AutoCAD viewport is, the two main types of them and how to create or modify viewports.

Stairs

Objectives : At the end of this lesson, you shall be able to,

- **define stair, stair case**
- **enlist the technical terms**
- **define the different types of steps.**

Introduction : A stair is a convenient means of access between the floors of a building. It is constructed to provide ready, easy, comfortable and safe ascent/descent with series of steps that are neither laborious nor difficult to climb within an enclosure called stairwell (Staircase).

Definition : A stair is defined as a series of steps suitably arranged for the purpose of connecting different floors of a building. It is provided to afford the means of ascending and descending between floors and landing. The room or enclosure of a building in which the stair is located is known as stair case. The opening or space occupied by the stair is known as stair way. It should be suitably located to provide easy access to all the rooms.

The definitions of technical terms used in connection with the stair are:- (Fig 1&2)

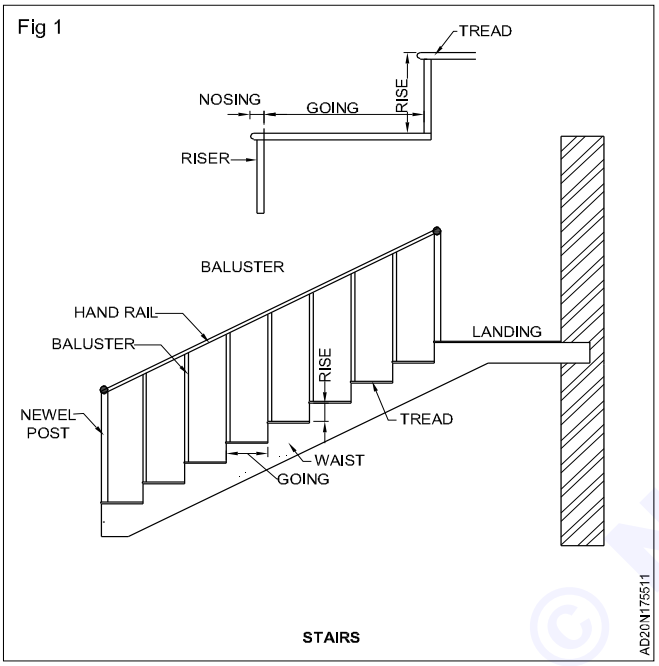
Sl.No	Terms	Definition
1	Tread	The horizontal upper portion of step
2	Going	Horizontal distance between faces of two consecutive risers.
3	Riser	The vertical front member of step
4	Rise	Vertical distance between two successive treads
5	Flight	Series of step between landings
6	Nosing	The projecting part of the tread beyond the face of riser
7	Scotia	Additional moulding provided under the nosing to improve the elevation of step and to provide extra strength to nosing end
8	Walking Line	The approximate line of movement of people on a stair. It may be 45 cm from the centre of handrail.
9	Head room	The vertical distance between the nosing of one flight and the bottom of the flight immediately above.
10	Run	Total length of stair in a horizontal plane. It includes the lengths of landings also. (Fig 2)
11	Soffit	The under surface of stair
12	Waist	The thickness if structural slab in case of RCC stair
13	Stringers	Inclined member in wooden stairs acting as wooden beams to support the steps.
14	String	The inclined member of a stair which supports the ends of step is known as string.
	a Cut or open string.	In the cut or open string, the upper edge is cut away to receives the ends of steps as shown in Fig 3.
	b A closed or housed string.	In the closed or housed string, the ends of steps are housed between straight parallel edges of the string as shown in fig 3.
15	Pitch	The angle of inclination of stair with the floor.
16	Landing	Horizontal platform between two flights to change of direction and to take rest for users.
17	Baluster	The vertical member fixed between string and hand rail to give support to hand rail
18	Handrail	The inclined rail over the string
19	Newel post	Vertical member placed at the end of flights to connect the ends of string and handrail.
20	Balustrade or Barrister	The combined frame work of hand rail and baluster.

STEPS: It is a portion of stairs which permits ascent or decent it comprises of a tread and riser. A stair is composed of a set of steps.

Types of steps (Fig 4)

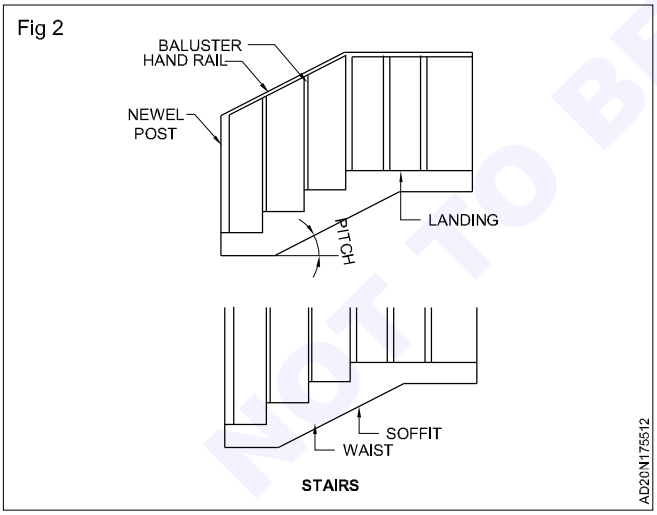
Sl. no	Terms	Definition
1	Flier	Ordinary step of rectangular shape in plan
2	Bull nose step	It forms a circular quadrant in plan and provided at the bottom of flight
3	Commode step	This step has a curved rise and tread
4	Dancing step	Step do not radiate from common center
5	Round ended step	Similar to bull nose step except that its ends are semicircular in plan
6	Splayed step	One end or both ends splayed in plan.
7	Winder	Tapering step and used to change the direction of flight

Fig 1



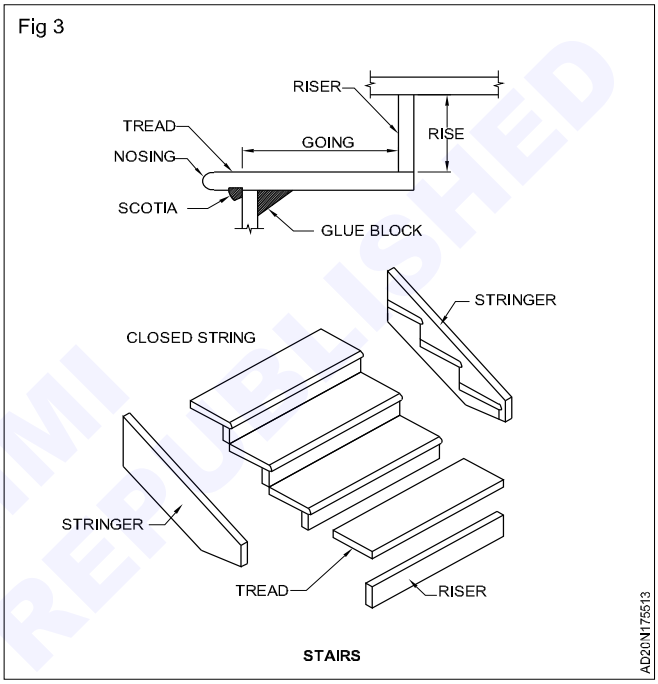
STAIRS

Fig 2



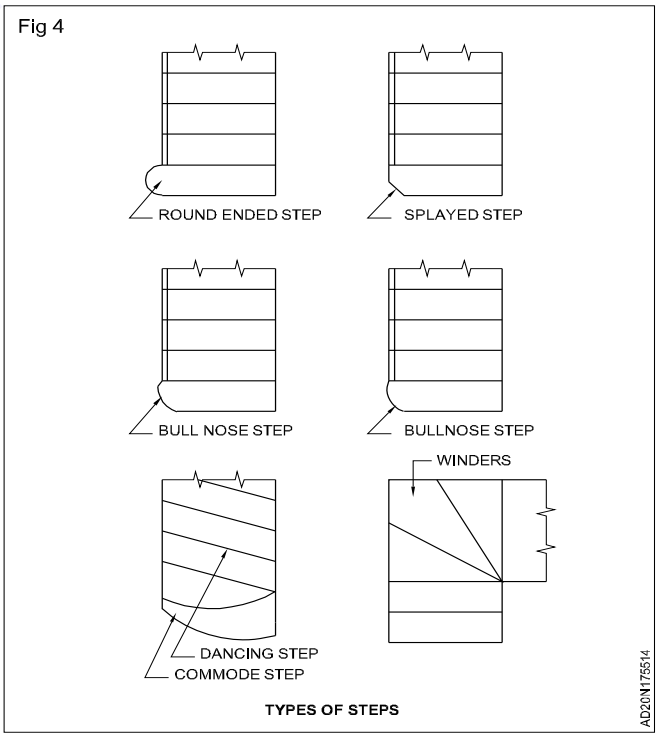
STAIRS

Fig 3



STAIRS

Fig 4



TYPES OF STEPS

Classification of stairs according to shape

Objectives : At the end of this lesson, you shall be able to
- **classify the means of vertical transportation**
- **explain types of stairs according to shape.**

Stair

Types of stairs

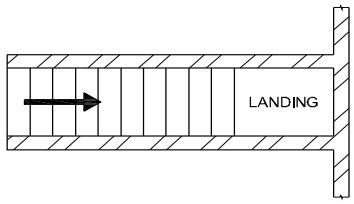
Stairs are classified as follows.

A Straight stair B Turning stair

C Circular or spiral stair D Geometrical stair

A Straight stair : In case of straight stair all steps leads in one direction only. This type of stair may consist of one or more flights and they are used when space available for staircase is long but narrow in shape. (Fig 1)

Fig 1



STRAIGHT STAIR

B Turning stair : In case of turning stair the flights takes turn.

The usual type of turning stair are described below.

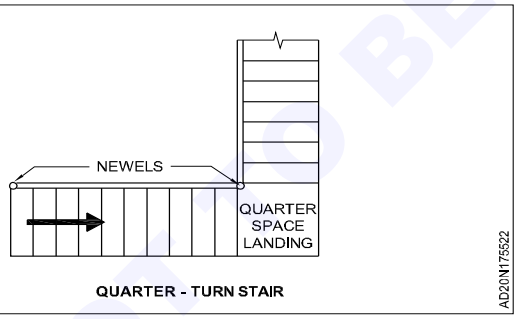
1 Quarter-turn stair

i Biffurcated stair ii Half-turn stair

iii 3-Quarter-turn stair

i Quarter-turn stair (Fig 2) : A stair turning through one right angle is known as a quarter-turn stair.

Fig 2



QUARTER - TURN STAIR

Bifurcated stair (Fig 3) : If a quarter turn stair is branched into two flights. At a landing as shown in figure is known as bifurcated stair.

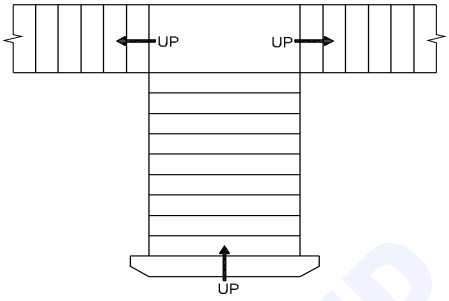
ii Half-turn stair : A stair turning through two right angle is known is a half-turn stair. A half-turn stair may be dog legged stair, and open newel stair.

a Dog-legged stair

b Open-newel stair

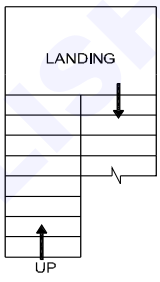
a Dog-legged stair (Fig 4) : The stair its flights run in opposite directions and there is no space between them in space plan. The stair are useful where total width of space available for stair case is equal to twice the width of step.

Fig 3



BIFURCATED STAIR

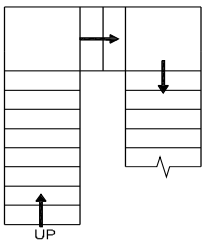
Fig 4



DOG LEGGED STAIR

b Open newel stair (Fig 5) : In case of an open newel stair there is a well or opening between the flights in plan. This well may be rectangular or any geometrical shape and it can be used for fixing lift. These stair are useful where the total width of the space available for staircase has width greater than twice the width of the step.

Fig 5

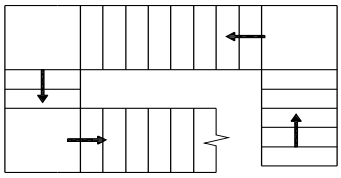


OPEN NEWEL STAIR

iii Three quarter turn stair (Fig 6) : A stair turning through three right angles is known as three quarter-turn stair as shown in figure. In this case an open well is formed.

C Circular helical or spiral stair (Fig 7) : In this type of stair, the steps are radiate from the center. The flights consist of winders only and they may be continued through any desired number of turns. Spiral stair may be constructed of cast-Iron, Mild steel, concrete. Usually the structural design and construction of spiral stair are complicated in nature. For concrete spiral stair, steel reinforcement is heavy and framework is complicated so it is expensive. Spiral stair is useful where space available is limited and where traffic is less.

Fig 6



THREE QUARTER-TURN STAIR

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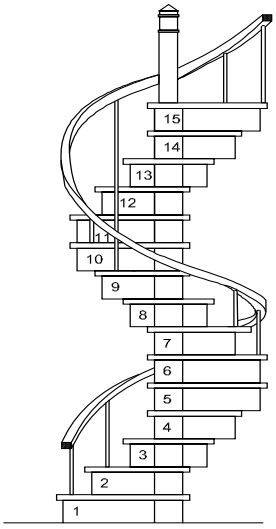
Fig 7



CIRCULAR OR HELICAL OR SPIRAL STAIR

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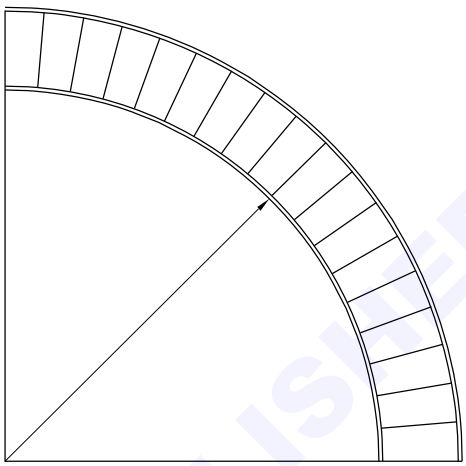
D Geometric Stair (Fig 8)

These stairs have any geometrical shape and they do not require newel post. The handrail of a geometrical stair continuous without interruption and without any angular turns. Considerable skill is required for the construction of a geometrical stair and it is found that a geometrical stair is weaker than corresponding open-newel stair.

Fig 8



GEOMETRICAL STAIR

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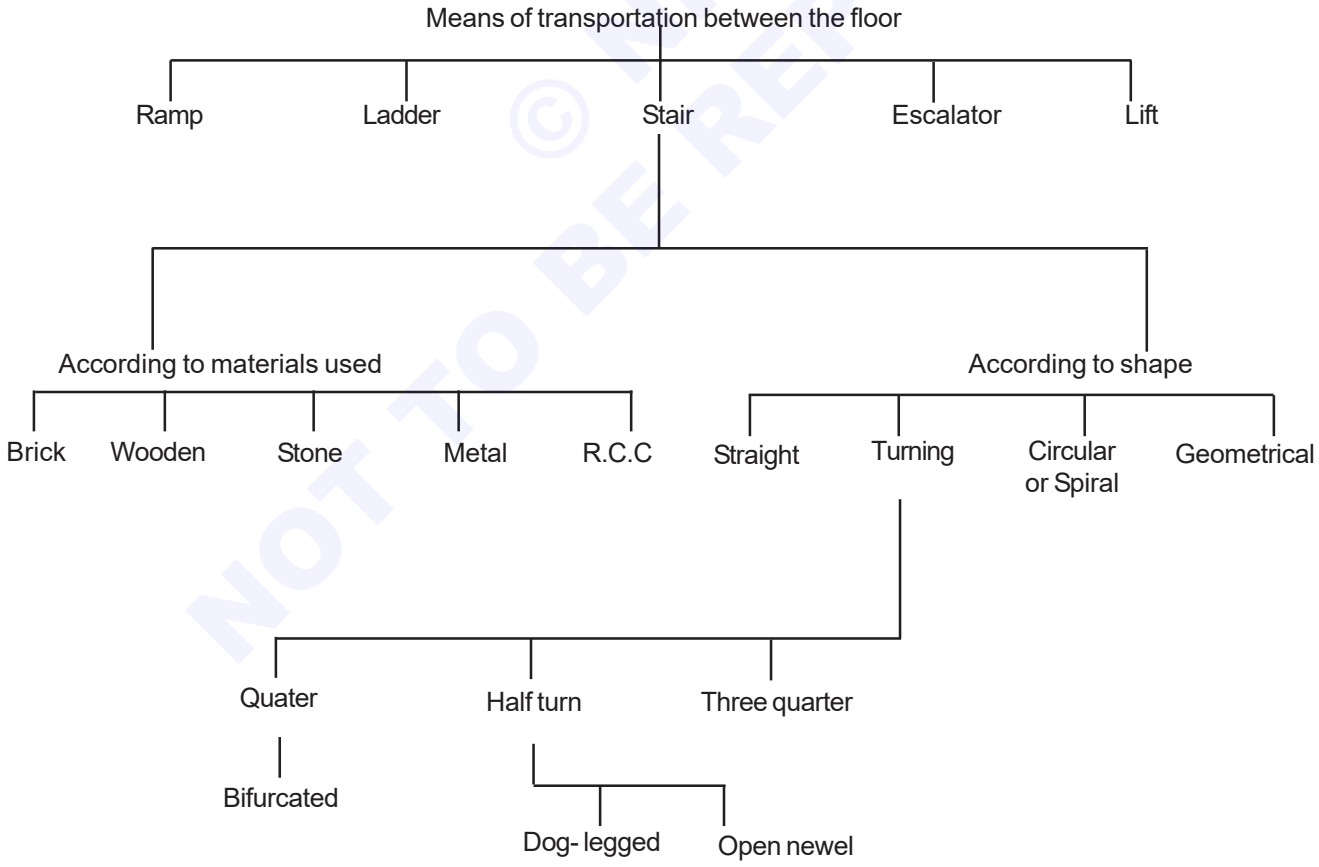


Classifications stair according to material and requirements of good stair

Objectives : At the end of this lesson, you shall be able to,
- **classify the stair according to materials**
- **explain the requirements of a good stairs**
- **design the stair case as per the given data.**

Introduction : Any well planned stair should meet the following criteria for easy, quick and safe ascent/decent.

Classification of stair according to materials used

Following are the materials which are commonly used in the construction of a stair

1 Stone stair

2 Wooden stair

3 Brick stair

4 Metal stair

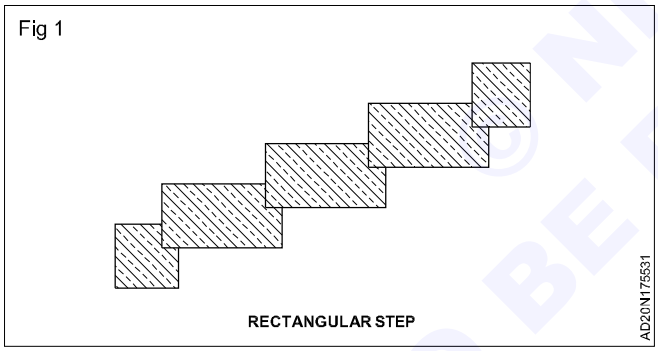
5 R.C.C stair

Stone Stair : The stone to be used for the construction of stair should be hard, non-absorbent and they should possess enough resistance to the action of fire. These stairs are used for ware houses, work shopes etc.

Construction : A stone step may be constructed in any one of the following ways.

a Rectangular step (Fig 1)

Fig 1



In case of a rectangular step the arrangement is made of as shown in figure. The overlap is about 25 mm to 40 mm. This arrangement results in considerable saving in labor of cutting and dressing stone.

b Spandril step (Fig 2) : In this arrangement the steps are cut in such a way so as to obtain a Plane soffit as shown in figure. This arrangement is used where head room is desired. The soffit affords a nice appearance and weight of step is also reduced the ends of spandrel step which are built into the wall should be square so as to provides a horizontal seating or bearing. The soffit can also be made broken or moulded.

c Build up step (Fig 3) : These steps used as treads and risers in the form of thin sawn stone or marble stone, placed over brick or concrete step. The thickness of stone slab may vary from 2-5 cm.

Support and fixing : A stone may be supported and fixed in any one of the following four ways.

Fig 2

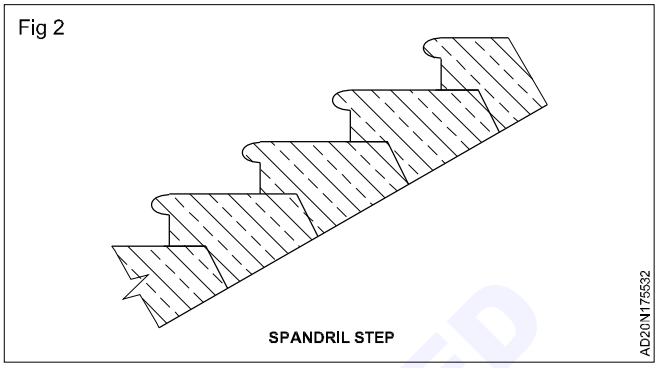
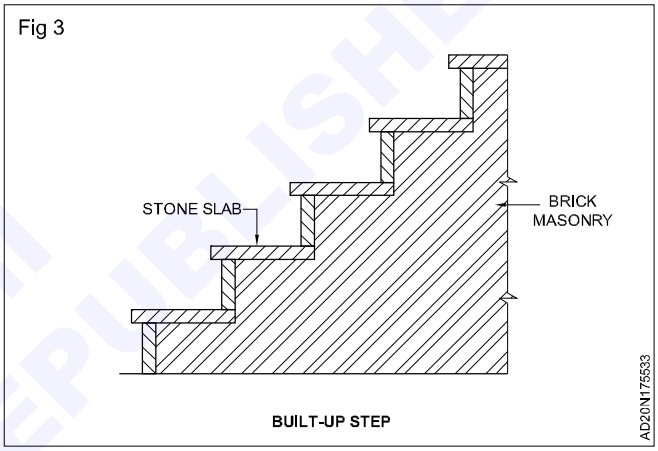


Fig 3



1 The step may be supported and fixed at the both ends in a wall. The bearing in wall should be at least 10cm for stairs up to 1.2m width and 20 cm for stairs having width greater than 1.2m.

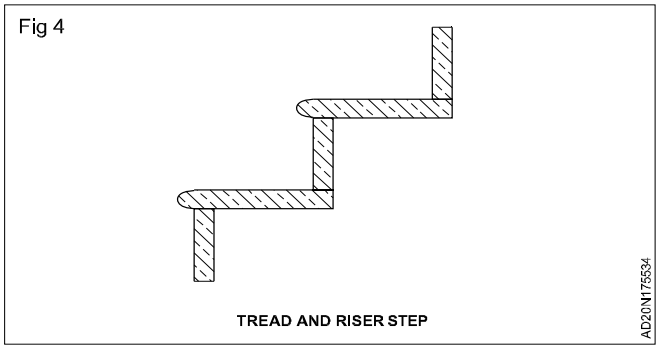
2 The step may be supported at one end in a wall and the other end may be left unsupported, such a cantilever step should not have length more than 1.2m.

3 The step may be supported at one end in a wall and other end, it may be supported by a steel work.

4 The step may be supported both end on a steel work.

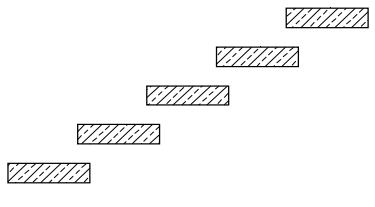
d Tread and Riser step (Fig 4) : In this arrangement the treads and risers of stones are provided as in case of timber steps. The stone slab treads and risers are connected by dowels as shown in figure.

Fig 4



e Cantilever tread-slab step (Fig 5) : In this arrangement the steps are formed of treads only. For this purpose only this slab stones are used without any riser. The steps may either be rectangular or triangular.

Fig 5



CANTILEVER TREAD-SLAB STEP

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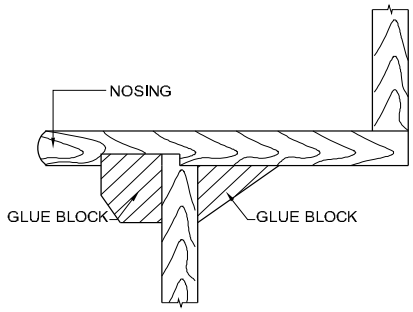
2 Wooden Stair (Timber stair) (Fig 6)

Fig 6



WOODEN STAIR

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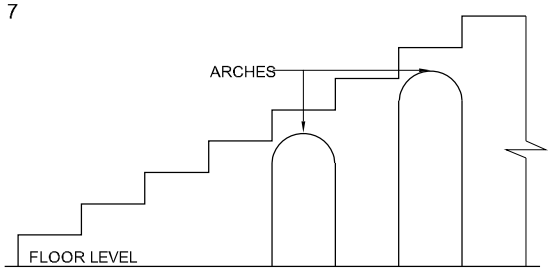
As wooden stairs are light in weight they are mostly used for residential building. But they have very poor fire resistance. They are un suitable for high raise residential building and for public building. Sometimes hard building wood such as (Mahogany, out etc) of paper thickness may be used. The timber used for the construction should be free from fungal decay and insect attack, and should be usual traded before use. In timber stair the strings are the support for the stair and act as inclined beam spanning between the floor and the landing. For additional support, a bearer or a carriage may be place under the treads.

The thickness of tread of a timber stair should not be less than 32mm (1/1/2 inch) and that of riser 25 mm. The nosing of the step should not project beyond the face of the riser for not more than the thickness of the treads. The thickness of the stinger should be 30-50 mm and 25-40 cm deep. Landing is constructed of tongued and grooved boarding on timber joist which are supported on walls.

3 Brick Stair (Fig 7)

These stair are now not frequently used. A brick stair may be made of solid construction or arches may be provided as shown in figure. This arch reduces the quantity of brickwork and gives additional space which can be used for making cupboards. In case of brick stair the treads and risers are generally made equal to the length of 1 ½ bricks and height of two layer of brick respectively. The treads and risers of brick stair are finished with suitable flooring materials.

Fig 7



BRICK STAIR

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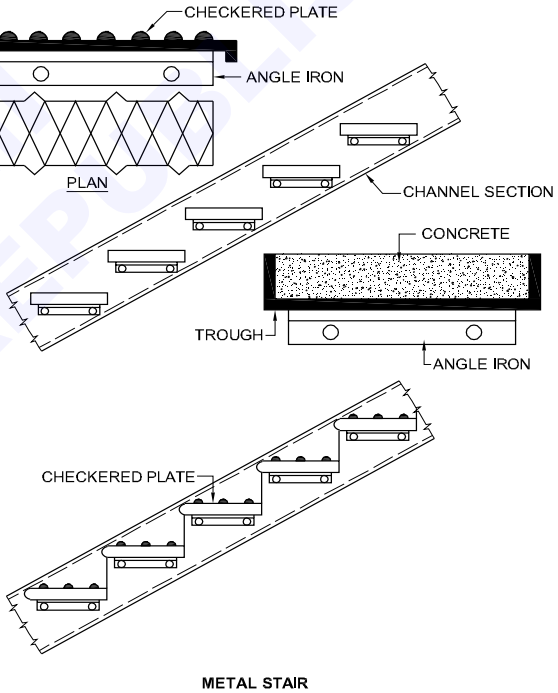
4 Metal Stair (Fig 8)

The External fire - escape stairs are generally made of metal. The common metal used for the construction of stairs is cast-Iron, bronze, mild steel. Metal stairs are generally is used in factories, workshop, godowns etc. In metal stairs the stringers are usually of channel sections and treads and risers are supported on angles, which are connected to the stringers. Tread and riser of a step may be of one unit or separate unit. For metal stair metal baluster with handrail of pipe are used.

Fig 8



METAL STAIR

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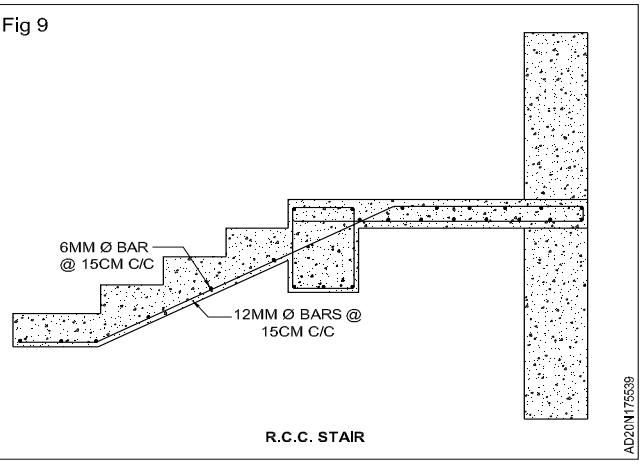
R.C.C Stair (Fig 9)

These stairs are new commonly used in all types of construction. They are found to resist wear and fire better than any other material and can be moulded to the desired shape. The step can be provided with suitable finishing material such as marbles, tiles etc. These stairs can be easily maintained clean and they are strong, durable and pleasing in appearance. A typical R.C.C stair is shown in figure 9. The details and placing of reinforcement will naturally depend on design of R.C.C stair. The steps may be cast-in-sites or pre - cast.

Requirements of a good stairs

A well designed stair should fullfill the following requirements.

Fig 9



R.C.C. STAIR

i **Design of layout** : The height of floor is generally known procedure for determining the no. of treads and risers is as follows.

a The position of 1st and last risers are determined with regard to the position of doors, windows, verandahs etc.

b A convenient height of riser is assumed.

c No. of risers equal to total height of floor divided by height of risers.

$$\text{i.e. no.of risers} = \frac{\text{Total height of floor}}{\text{Height of riser}}$$

d No. of treads = no. of riser -1

This is due to the fact that the surface of the upper floor forms the tread for the top step.

E.g:- For instance let us assume that height of floor is 3.8 m assume the rise of 14 cm.

$$\text{No. of treads} = \frac{3.50}{0.14} = 25 \text{ nos}$$

No. of treads in single flight = 25-1=24 Nos.

No. of treads in double flight = 25-2=23 Nos

Depending upon the space available for staircase the type of stair is selected.

Tread and Riser

In - order to make the ascend and descend easy the tread and risers of a stair should be proportional following rules of thumb are commonly used for obtaining a satisfactory proportion of the tread and riser of a step.

i Rise in cm X going in cm = 40 to 45

ii Rise in cm X going in cm = 426 (approximately)

iii 2 rise in cm X going in cm = 60 (approximately)

Take rise equal to 14 cm and going would be 30 cm as standard.

Other combination of rise and going would be 15 X 28 cm, 16 X 26 cm, 17 X 24 cm.

Minimum width of tread = 250 mm (Residential)

= 300 mm (Other)

Minimum height of riser = 190 mm (Residential)

= 150 mm (Other)

5 Materials and workman ship

The stair should be constructed of sound material and good workman ship so as to impart durability and strength to the stair.

6 Width

The width of stair should be sufficient for 2 persons to pass on it simultaneously and for furniture. The minimum width of stair is taken as about 80 cm.

7 Pitch

The inclination of a stair to the horizontal should be limited to 30°- 45°.

8 Head room

It should preferable not less than 2m.

9 Flight

It is not desirable to provide a flight with more than 12 or at most 15 steps and not less than 3 steps. Suitable landing should be provided to give comfort and safety to the users of the stair.

10 Winders

These are to be avoided as far as possible. However if winders are un- avoidable they should be place at the bottom rather than at the top of the flight.

11 Hand rail

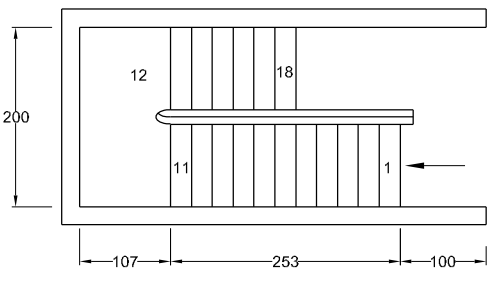
When a flight consists of more than 3 steps a hand rail at least on one side is considered to be necessity.

12 Location

The stair should be suitably located centrally in the building and they are well lighted, well ventilated and have convenient approches.

Problem (Fig 10 & 11)

Fig 10



PROBLEM

1 The inside dimension of a stair case in a residential building are 2m X 4.6m. The height of floor is 3.3 m and the roof consist of R.C.C slab of 12 cm thickness. Design a proper layout of R.C.C slab stair for this building.

Section

Adopt a dog - legged stair

Assume a convenient height of riser say = 18 cm

$$\text{Then the no of raiser} = \frac{\text{Total hight of floor}}{\text{Height of risen}}$$

Total height = 3.30 + 0.12 = 3.42 m

Height of riser = 18 cm

$$Numberofrisers = \frac{3.42}{0.18}$$

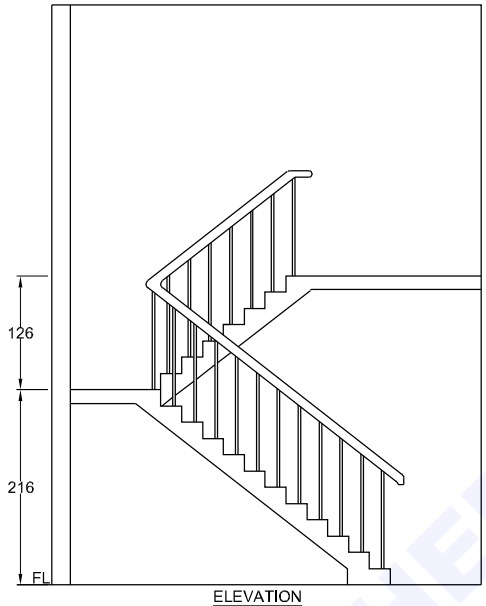
Split the number of risers into two flights conveniently say 12nos in first flight and 7 nos in second flight.

No of steps in 1st flight = 12-1 = 11 nos

No. of steps in 2nd flight = 7-1 = 6 nos

Draw the plan and sectional elevation of the dog legged stair case according the disigned values.

Fig 11



ELEVATION

PROBLEM

AD20N17553B

Floors and floorings

Objectives: At the end of this lesson you shall be able to
- **define the floor and purpose of floors**
- **listout the flooring materials & factors affecting the choice of flooring material**
- **describe the components of a floor**
- **enlist the type of floors.**

Introduction

In order to sub-divide the portion between the plinth level or basement level and roof level, solid constructions are carried out. These constructions are known as floors and exposed top surface of floors are termed as floorings. Ground floors or basement floors are termed as flooring. Ground floor or basement floors, which directly kept on the ground, do not require the provision of a floor. But they are provided with suitable type of flooring. In addition to that measures should be taken to prevent the entry at dampers and for giving thermal insulation.

Definition

It is a horizontal element of a building structure, which divide the building into different levels, for the purpose of creating more accommodation within a restricted space, one above the other and provide support for the occupants, furniture and equipment of a building.

Purpose

The purpose of floor is to creating more accommodation within a restricteed space, one above the other and provide support for the occupants, furniture and equipment of a building.

Flooring Materials

For giving pleasing appearance to the upper surface of the floor, various materials are used. The common materials used as flooring are:

1 Mud
2 Muram
3 Bricks
4 Flag Stones
5 Concrete
6 Terrazzo
7 Mosaic
8 Tiles
9 Marble
10 Granolithic Finish
11 Wood or timber
12 Asphalt
13 Rubber
14 Linoleum
15 Cork

Factors affecting the selection of flooring materials

1 **Appearance:** The material should give pleasing appearance and if should produce the colour effect with the use of building.
2 **Cleanliness:** It should be such that it can be cleaned easily and effectively and has resistance against oil, grease etc.
3 **Comfort:** It should possess good thermal insulation to give comfort for the residents.
4 **Cost:** Cost should be reasonable.
5 **Damp resistance:** The material should offer sufficient resistance against dampness.
6 **Durability:** Resistance to wear, tear and chemical action.
7 Fire resistant
8 Easy to give maintenance
9 Noiseless while Len which using the floor.
10 Non stippery surface but smooth enough to clean easily.

Components of Floor

Floor is composed of two essential components.

1 Sub floor – base course or floor base.
2 Floor covering, or simply flooring.

Sub Floor: It provides proper support to floor covering and the super imposed load are carried by it.

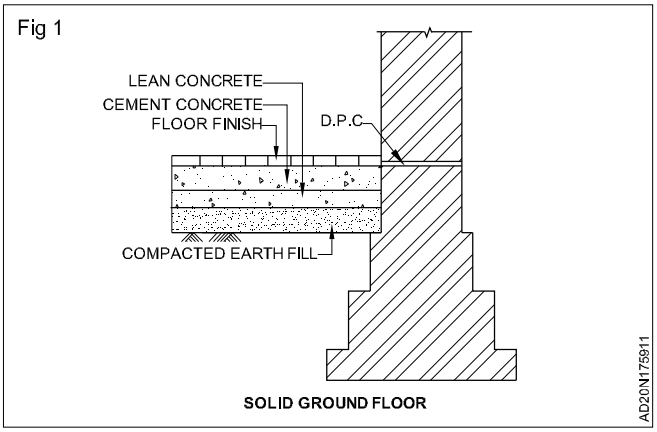
Floor covering: It provides a smooth, clean, impervious and durable surface.

Types of floor

The floor is mainly divided in to two:

1 Ground Floor
2 Upper floor

Ground floor (basement floor) (Fig 1)



The floors resting directly on the ground surface are known as ground floors. They do not require provision of a floor. The major problems of a ground floor are damp exclusion and thermal insulation. For this purpose it is usually provided a bedding concrete of 1:4:8.

Material used for ground floor

Mud floors

1 Such flooring is cheap, hard and fairly impervious.

2 Easy to construct and easy to maintain.

3 It has good thermal insulation property.

4 Over a well-prepared ground, a 25 cm thick selected moist earth (mostly impervious) is spread and is then rammed well to get a compacted thickness of 15 cm.

5 In order to prevent cracks due to drying, small quantity of chopped straw is mixed in the moist earth, before ramming.

6 Sometimes, cow-dung is mixed with earth and a thin layer of this mix is spread over the compacted layer.

7 Sometimes, a thin paint of cement – cow – dung (1:2 to 1:3) is applied.

Muram floors

1 Muram is a form of disintegrated rock with binding material.

2 To construct such a floor, a 15 cm thick layer of muram is laid over prepared sub grade.

3 Over it, a 2.5 cm thick layer of powdered muram (Fine muram) is spread and water is sprinkled over it.

4 The surface is then rammed well.

5 After ramming, the surface is saturated with a 6 mm thin film of water

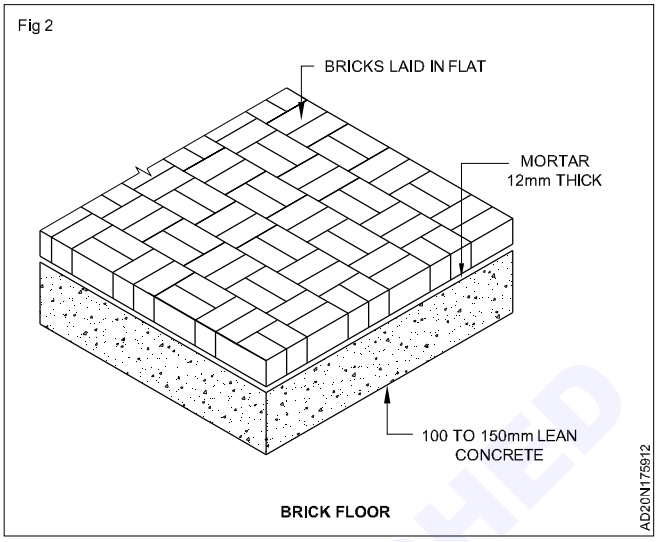
6 The surface well - trampled under the feet of workmen till the cream of muram rises to the top.

7 The surface is levelled and then kept in that state for a day, and then rammed again with wooden rammers.

8 The surface is then smeared or rubbed with thin paste of cow dung and rammed again for two days, during morning hours.

9 Finally, a coating of mud - cow dung mix is applied over the surface.

Brick floors (Fig 2)

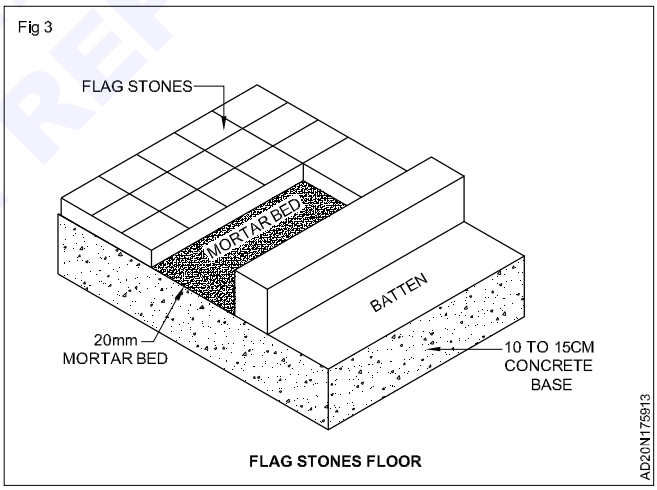


1 These floors are used in cheap type of construction such as stores, godowns, Warehouses etc.

2 The brick to be used should be of uniform shape and colour and good quality.

3 It consists of layer of brick (Flat or on edge) laid over 10 to 15 cm thick P.C.C of 1:8:16

Flag Stone Floor (Fig 3)



1 Flagstone is any laminated sand stone available in 2cm to 4 cm thickness.

2 The stone slabs are laid on concrete base.

3 The sub soil is properly compacted, over which 10 to 15 cm thick lime concrete or lean cement concrete is laid.

4 The Flagstones (Stone slabs) are then laid over 20 to 25 mm thick layer of bed mortar.

5 In laying the slabs, work is started from two diagonally opposite corners and brought up from both sides.

6 A strings is stretched between two corner slabs first to correct level.

i Other slabs are then so laid that their tops touch the string.

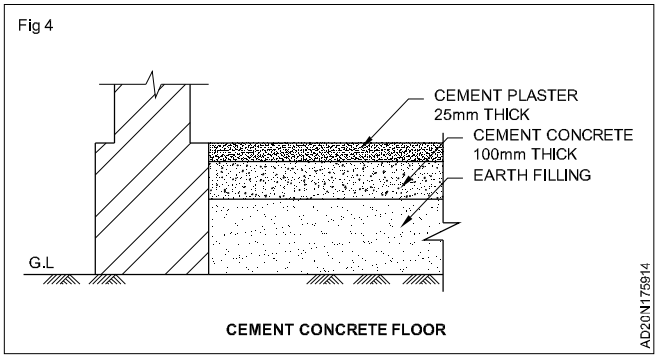
ii If any particular slab falls lower than the string level, it is re-laid by putting fresh layer of stiff mortar.

iii When the stone slabs are properly set, mortar in the joints is raked out to a depth of about 15 to 20 mm and then flush pointed with 1:3 cement mortars.

iv Proper slope is given to the surface for drainage.

v The work is properly cured.

Cement Concrete floor (Fig 4)



1 This is commonly used for residential, commercial and even industrial buildings.

2 It is moderately cheap, quite durable and easy to construct.

3 The floor consists of two components (1) base concrete, and (2) topping or wearing surface.

4 The base course may be 7.5 to 10 cm thick, either in lean cement concrete (1:3:6 to 1:5:10) or line concrete containing 40% mortar of 1:2 line – sand (or 1 lime: 1Surkhi: 1 sand) and 60% coarse aggregate of 40mm nominal size.

5 The base course is laid over well compacted soil, and leveled to rough surface.

6 It is properly cured.

7 When the base concrete has hardened, its surface is brushed with stiff broom and cleaned thoroughly.

8 It is wetted the previous right of laying topping and excess water is drained.

9 The topping is then laid in square or rectangular panels, by use of either glass or plain asbestos strips or by use of wooden battens set on mortar bed.

10 The topping consists of 1:2:4 cement concrete laid to the desired thickness (usually 4 cm) in one single operation. in the panel.

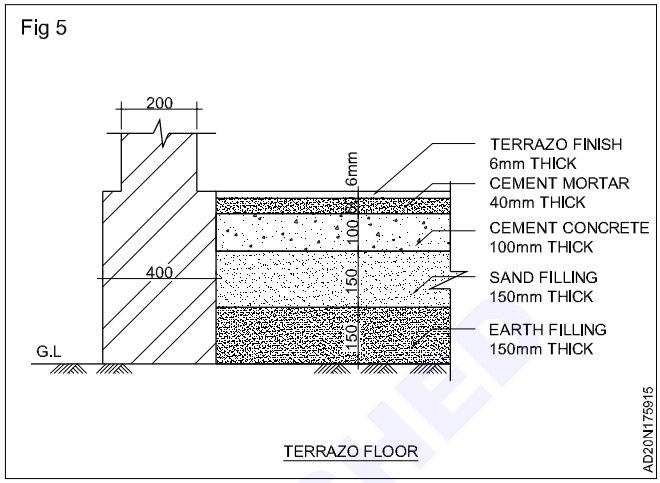
11 Topping concrete is spread evenly with the help of a straight edge, and its surface is thoroughly tamped and floated with wooden floats till the cream of concrete comes at the top.

12 Steel trowel is used for smoothening and finishing the top surface.

13 The prepared surface is protected from sunlight, rain, and other damages for 12 to 20 hours.

14 The surface is then properly cured for a period of 7 to 14 days.

Terazzo floor (Fig 5)



1 In this floor, marble chips of various shades are used as aggregate.

2 The proportion of terrazzo mix is generally 1:2 to 1:3 i.e, one part of cement to two to three parts of marble chips by volume.

3 Prepare base concrete surface of 75cm thick.

4 Over this cement mortar 1:3 of 34 mm thick is laid, and zigzag line are market on it. Surface is cured for effect

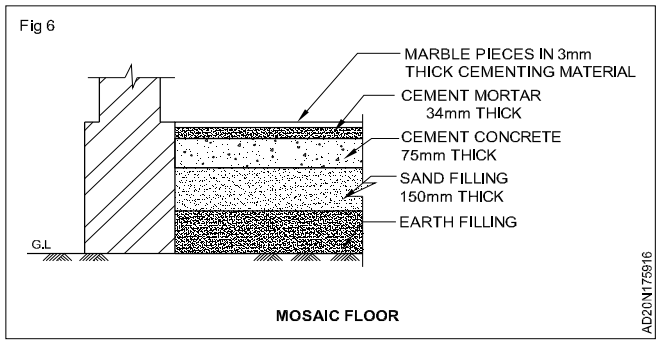
5 The cement and marble chips are thoroughly mixed wet and laid for a thickness 20 mm.

6 The first coat of polishing is done by a coarse carborandom stone, second coat is done by finely grained carborandom stone.

7 Wax is applied as a final coat of polishing to get glossy surface

8 This floor in generally used for residential buildings, bath room, Clock rooms, etc.

Mosaic floor (Fig 6)



1 Mosaic flooring is made of small pieces of broken tiles of china glazed or of cement, or of marble, arranged in different pattern.

2 These pieces are cut to desired shapes and sizes.

3 A concrete base is prepared as in the case of concrete flooring, and over it 5 to 8 cm lime – surkhi mortar is spread and levelled.

4 On this, a 3 mm thick cementing material, in the form of pate comprising two parts of slaked lime, one part of powered marble and one part of puzzolana material, is spread and is left dry for about 4 hours.

5 Small pieces of broken tiles or marble pieces of different colours are arranged in definite patterns and hammered into the cementing layer.

6 The surface is gently rolled by a stone roller.

7 Sprinkle water over the surface.

8 Surface is allowed to dry for 1 day, and is thereafter, rubbed with a pumice stone.

9 The surface is polished smooth.

10 The floor is allowed to dry for two weeks before use.

Tiled floors

1 Firstly, levelled hard bed or 15 cm thick P.C.C is preparedd.

2 Over this bed, a thin layer of cement mortr 1:1 is laid.

3 Then pre cast tiles of cement concrete or pottery are laid over it carefully, filling the joints with mortar, which are generally paper thick.

4 Extra cement is wiped off and joints cleaned with saw dust. After curing the surface is rubbed and polished.

Marble

1 It is a superior type of flooring, used in residential buildings, hospitals, sanatoriums, temples etc. Where extra cleanliness is an essential requirement.

2 Marble slab may be laid in different sizes, usually in rectangular or square shapes.

3 The base concrete is prepared in the same manner as that for concrete flooring.

4 Over the base concrete, 20 mm thick bedding mortar of either 1:4 cement sand mix or (lime putty): 1 (surkhi):1 (coarse sand) mix is spread under the area of each individual slab.

5 The marble slab is then lifted up, and fresh mortar is added to the hollows of the bedding mortar.

6 The mortar is allowed to harden slightly, cement slurry is spread over it, the edges of already laid slabs are smeared with cement slurry paste, and then the marble slab is placed in position.

7 It is gently pushed with wooden mallet so that cement pastes oozes out. This is cleaned with cloth.

8 The paved area is properly cured for about a week.

Granolithic floors

1 It is a finished coat, which is provided over a concrete surface.

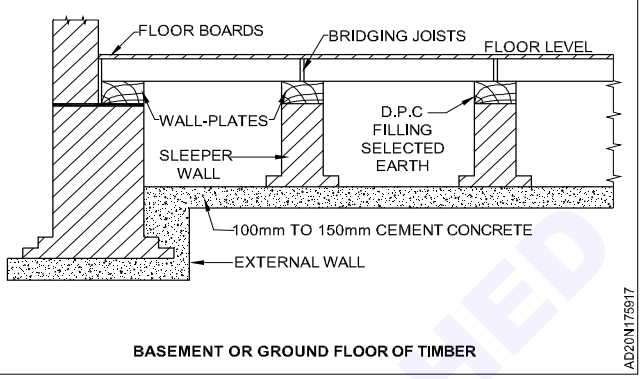
2 The concrete mix used is 1:1:2 or 1:1:3. And aggregate used may be basalt, lime stone or quartz silt.

3 The granolithic layer of concrete is laid before the base concrete is set to get a monolithic construction.

4 The minimum thickness of finishing should be 12 mm.

Wooden floors (Fig 7)

Fig 7



BASEMENT OR GROUND FLOOR OF TIMBER

1 In hilly areas where the wood is available in a large quantity and on the other hand, the climate is damp, wooden floors are used.

2 These are also used in dancing halls, auditoriums, etc.

3 The timber to be used for flooring should be of the best quality, well – seasoned and free from cracks, knots, flaws and other defects.

Asphalt floor

1 The asphalt flooring can be carried out in a variety of colours and in different forms.

2 The asphalt tiles, which are produced from natural asphalt, bitumen, asbestos fiber and mineral pigments are available in different sizes and in a variety of colours.

3 The asphalt terrazzo is formed by the combination of black or coloured asphalt with marble chips.

4 This terrazzo is laid hot and the surface is made smooth by a trowel.

5 The asphalt flooring is water-proof (no space), vermin proof, dustless and joint less.

6 It is used for surface subjected to heavy wear as incase of dairies, breweries, hospitals, shops, restaurants, loading platforms, swimming pools, terrace etc.

Rubber floor

1 It consists of sheets or tiles of rubber, in a variety of patterns and colours.

2 The sheet or tile is manufactured by mixing pure rubber with fillers such as cotton fibre, granulated cork or asbestos fibre.

3 The sheets or tiles are fixed to concrete base or wood by means of appropriate adhesive.

4 Rubber flooring is resilient and noise proof.

5 However, they are costly.

6 They are used only in office or public building.

Linoleum floor

1 It is a covering which is available in rolls, and which is spread directly on concrete or wooden flooring.

2 Linoleum sheet is manufactured by mixing oxidized linseed oil in gum, resins, pigments, wood flour, cork dust and other filler materials.

3 The sheets are either plain or printed, and are available in 2 to 6 mm thickness, and 2 to 4 m width.

4 Linoleum tiles are also available, which can be fixed (or glued) to concrete base or wood floor, in different patterns.

5 Linoleum sheet is either spread as such, or also may be glued to the base by inserting a layer of saturated felt.

6 Linoleum coverings are attractive, resilient, durable and cheap, and can be cleared very easily.

7 However, it is subjected to rotting when kept wet or moist for some time.

8 It cannot, therefore, be used for bath room, kitchens etc.

Cork floor

1 This type of flooring is perfectly noiseless, and is used in libraries, theatres, art galleries, broadcasting station etc.

2 Cork which is the outer bark of cork oak tree, is available in the form of cork carpet and cork tiles.

3 It is fixed to concrete base by inserting a layer of saturated felt.

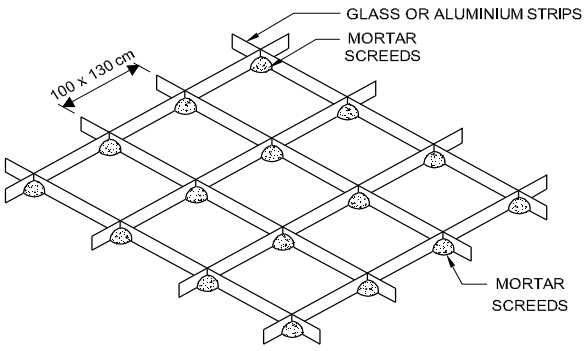
4 Cork Carpet is manufactured by heating granules of cork with linseed oil and compressing it by rolling on canvas.

5 Cork tiles are manufactured from high grade cork or shearing compressed in module to a thickness of 12mm and baked subsequently.

Glass floor (Fig 8)

1 This is special purpose flooring, used in circumstances where it is desired to transmit light from upper floor to lower floor, and specially to admit light at the basement from the upper floor.

Fig 8



METHOD OF FIXING GLASS STRIPS FOR CONCRETE FLOOR

2 Structural glass is available in the form of tiles or slabs, in thickness varying from 12 to 30 mm.

3 These are fixed in closely spaced frames so that glass and the frame can sustain anticipated loads.

4 Glass flooring is very costly, and is not commonly used.

Plastic or PVC floor

1 It is made of plastic material, called Poly Vinyl Chloride (P.V.C), fabricated in the form of tiles of different sizes and different colour shades.

2 These tiles are now widely used in all residential as well as non –residential buildings.

3 The tiles are laid on concrete base.

4 Adhesive of specified make is applied on the base as well as on the back of P.V.C tile with the help of a notched trowel.

5 The tile is laid when the adhesive has set sufficiently (say within 30 minutes of its application); it is gently pressed with the help of a 5 kg weight wooden roller and the oozing out adhesive is wiped off.

6 The floor is washed with warm soap water before use. P.V.C tile flooring is resilient, smooth, good looking and can be easily cleaned.

7 However, it is costly and slippery, and can be damaged very easily when in contract with burning objects.

Upper floors

Objectives: At the end of this lesson you shall be able to
- **define and purpose of the upper floor**
- **listout the type of upper floors**
- **desribe choice of floor.**

Introduction

An upper floor is basically a principal structural element, and the general structural design of a building will greatly influence the choice of the type of floor. Upper floors are supported either on the walls or on columns; they have, therefore, the major problems of strength and stability.

The structural design of upper floors has to be such as to support the loads set up by the use of the building, in

addition to the self weight and the weight of partitions etc. However, the flooring materials are practically the same as used for ground floor.

Definition

The floors constructed above the ground floor are known as upper floors.

Purpose

To create more accommodation with in a restricted space, one above the other and to provide support for the occupants, furniture and equipment of a building.

Types of floor

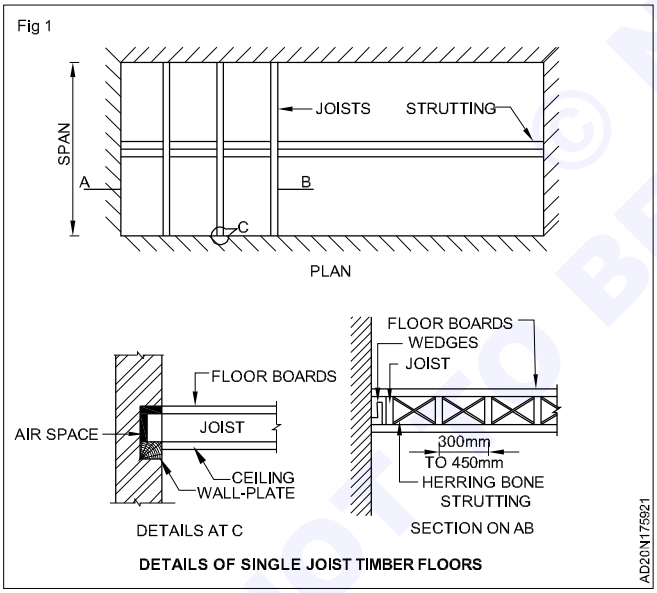
Floors are classified based on types of materials and construction as below.

Floors

- **Timber floors**
  - Single joint floor
  - Double joint timber floor
  - Framed or triple joist floor
- **Composite floors**
  - Double flange stone floor
  - Filler joist floor
  - jack arch floor
  - R.C.C floor
  - Hollow block or rib floor
  - Pre- cast concrete floor

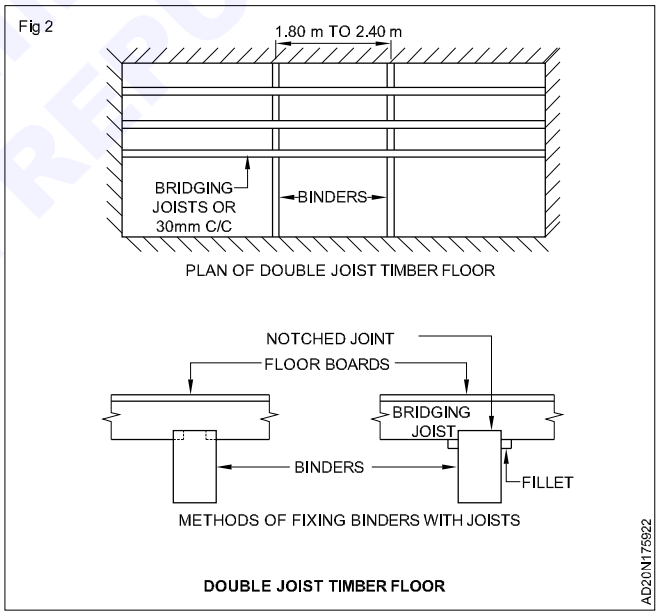
Timber Floor : This type of floor is preferred in hilly areas where timber is easily available, normally it is used in auditoriums where dances or dramas are performed…

A Single joist timber floor (Fig 1)



- It is adopted for maximum span of 3.6 m
- These floors consist of single joists which are place below the floor boards.
- The joists are usually at a center to center distance of 300 mm to 450 mm.
- The joists are supported on wall – plates at their ends.
- When the span of joist exceeds about 2.4m, herring bone strutting are provided.
- Ends of this struts are nailed to the joists.
- At the end, the wedges are provided between the wall and the joist.

B Double joist timber floor (Fig 2)



1 It is stronger than single joist timber floor. Span is up to 7.5m

2 In this type of floor, the intermediate supports, known as the binders, are provided for the bridging joists.

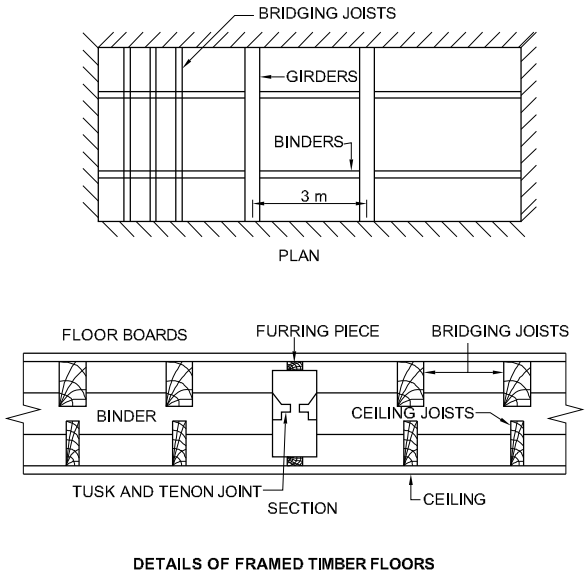
3 The end of binders rest on wooden stone blocks.

C Framed or triple joist timber floor (Fig 3)

1 It is suitable for span greater than 7.5 m

2 In this type of floors, the intermediate support, known as the girders, are provided to support the binders.

Fig 3



DETAILS OF FRAMED TIMBER FLOORS

3 The girders are placed at a center to center distance of 3 m.

4 The ends of binders are supported on iron stirrups which are fixed to the girders.

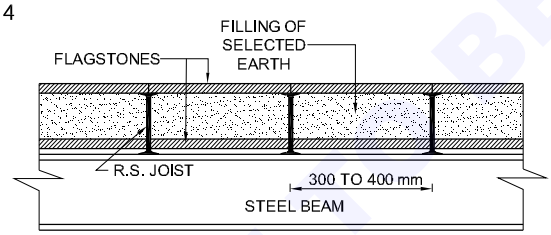
5 The ends of girders rest in walls on stone or concrete templates.

Composite floor

If floors are composed of more than one material, then they are known as composite floors. It is more fire resistant and sound proof than timber floor. It can be easily cleaned and possesses better hygienic property. It can be adopted for long spans.

A – Double flagstone floor (Fig 4)

Fig 4



DOUBLE FLAGSTONE FLOOR

1 Flagstones of two layers are used.

2 If span is about 4 m only steel joists are provided.

3 Top layer of flag stone is finished.

B – Filler joist floor (Fig 5)

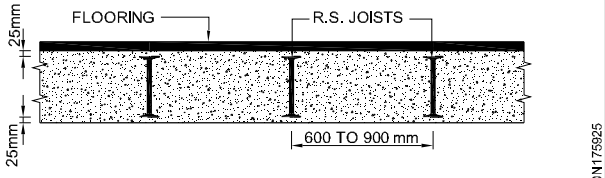
1 Small sections of R S J are placed in concrete.

2 The joists may either rest on wall or on steel beams.

3 The joists act as reinforcement.

4 The concrete should completely surround the joist.

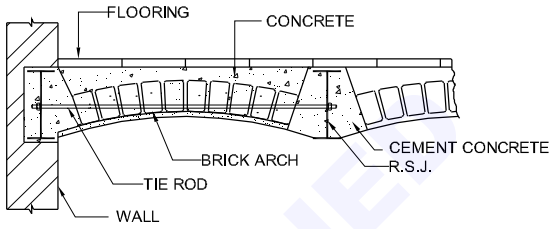
Fig 5



FILLER JOIST FLOOR

C – Jack arch floor (Fig 6)

Fig 6



BRICK JACK ARCH FLOOR

1 Brick or concrete arches are constructed and they rest on the lower flange of mild steel joist.

2 The joists are placed at a distance of about 800 mm to 1200 mm centre to centre.

3 Rise of arch should be 100 mm to 200 mm.

4 The minimum depth of concrete at the crown should be 150mm.

D – R.C.C floor

1 Steel bars and concrete are used to form a floor. Beams and slabs are designed as per load on floor.

2 For R.C.C slab, the thickness varies from 80 mm to 150 mm and the main reinforcement is generally in the form of mild steel bars of diameter varying from 9mm to 12 mm.

3 R.C.C beams are to be provided when the span of slab exceeds 4 m or so.

4 The location, spacing and bending of steel bars are to be decided carefully.

5 RCC work may be cast –in-situ or pre-cast, the former being very common.

6 Suitable flooring can be provided on the surface of an R C.C floor.

7 The R.C.C floors are less costly, durable, and easy to construct and fire proof.

8 However, they are likely to transmit sound.

9 In any case, the R.C.C. floors are fast replacing other types of floors.

10 The reinforcement in the flat slab can be arranged either in two-way system or four-way system.

11 For ordinary loading conditions, the two-way system of reinforcement is generally preferred.

Hallow block or rib floor

1 Hollow blocks of clay or concrete are used to reduce self weight of floor.

2 This type of floor is economical, fire-proof, sound-proof and light in weight.

3 Plumbing and electrical installations can be conveniently carried through the hollow blocks without affecting the appearance.

4 These floors are widely used for building like hospitals, hotels, schools, offices, etc.

E-Pre-cast concrete floor

1 With the development of pre-cast concrete construction technique, it is possible to prepare the pre-cast unit for the floor.

2 These pre-cast units are available in suitable size and can be conveniently handled, transported and fixed.

3 They may be supported either on walls or on rolled steel joists.

4 The sides of each unit contain grooves which are used to connect the adjacent units.

5 The members are light in weight and hence the cost proves to be economical.

6 They are fire-proof and sound-proof.

7 They do not require formwork during construction.

8 They have good thermal insulation.

Choice of floor

Choice of floor depends upon,

1 Span

2 Maximum load on the floor

3 Type of construction

4 Material and labor available

5 Purpose or use of building.

Introduction to design

Objectives: At the end of this lesson you shall be able to
- **describe the design principle**
- **explain the process of design.**

Design principles

Introduction

Design principles are the fundamental ideas and elements that can be applied to achieve successful design. The application of design principles to the elements will generate the design, common design principles are:

Balance

Balance is a psychological sense of equilibrium. As a design principle, balance places the parts of a visual in an aesthetically pleasing arrangement. In visual images, balance is formal when both sides are symmetrical in terms of arrangement. Balance is informal when sides are not exactly symmetrical, but the resulting image is still balanced. Informal balance is more dynamic than formal balance and normally keeps the learner's attention focused on the visual message. There are two main types of balance symmetrical balance, asymmetrical balance. (Fig 1&2)

Fig 1

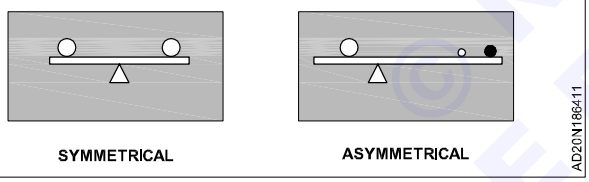


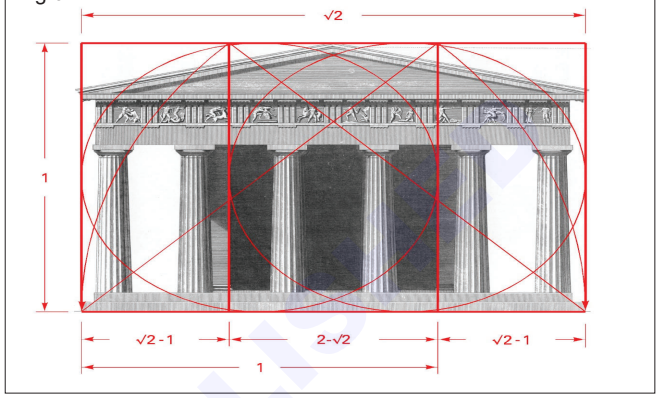
Fig 2

Proportion

Proportion refers to the relative size and scale of the various elements in a design. The issue is the relationship between objects, or parts of a whole. This means that it is necessary discuss proportion in terms of the context or standard used to determine proportions. (Fig 3)

Proportion is fundamental in architectural design, every single element of a building must have a strict proportional relationship to the other, thus creating an overall appearance of harmony, elegance and strength

Fig 3



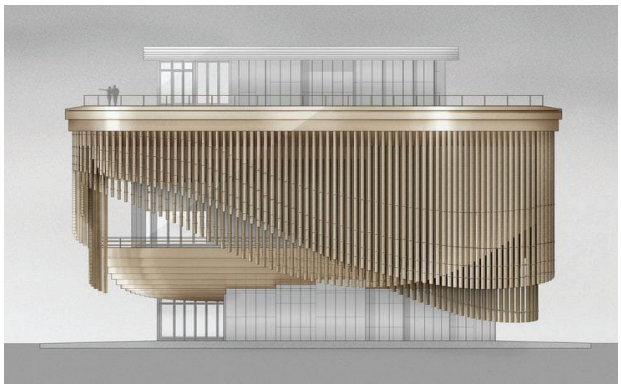
Perspective

Perspective is created through the arrangement of objects in two - dimensional space to look like they appear in real life. Perspective is a learned meaning of the relationship between different objects seen in space. Perspective adds realism to a visual image. Perception can be achieved through the use of relative sizes of objects, overlapping objects and blurring or sharpening objects. (Fig 4)

Movement

Motion or movement in a visual image occurs when objects seems to be moving in a visual image. Movement in a visual image comes from the kinds of shapes, forms, lines and curves that are used. (Fig 5)

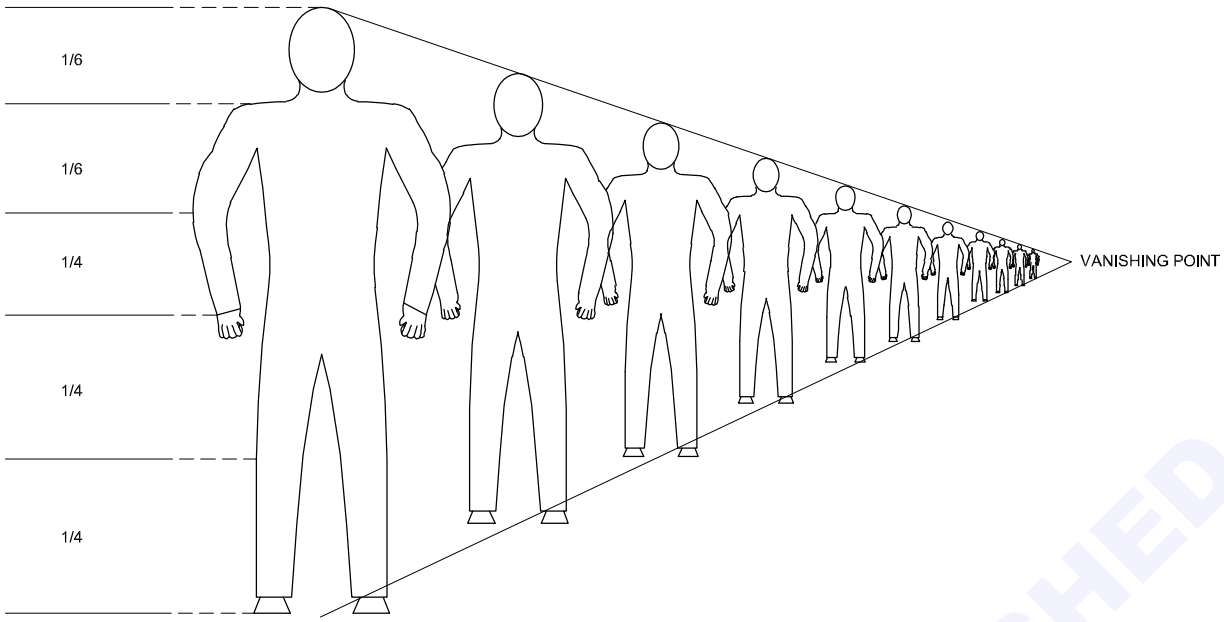
Fig 5



Repetition: Repetition works with pattern to make the artwork seem active. The repetition of elements of design creates unity within the artwork. (Fig 6)

Rhythm: Rhythm is the repetition of visual movement of the elements - colors, shapes, lines, values, forms, spaces and texture. Variety is essential to keep rhythms

Fig 4



exciting and active and to avoid monotony. Movement and rhythm work together to create the visual equivalent of a musical beat. (Fig 7a, 7b, 7c)

Harmony: Harmony in visual design means all parts of the visual image relate to and complement each other. Harmony can be achieved through repetition and rhythm. Rhythm helps direct eye movement. Patterns or shapes can help achieve harmony. By repeating patterns in an interesting arrangement, the overall visual image comes together. (Fig 8)

It can be made where the eye is used to seeing together, so they form a group Ex: Flower pot and plants.

Unity: Unity means the harmony of the whole composition. The parts of a composition made to work together as a total visual theme. Unity is the relationship among the elements of a visual that helps all the elements function together. Unity gives a sense of oneness to a visual image. In other words, the words and the images work together to create meaning. (Fig 9)

Fig 6

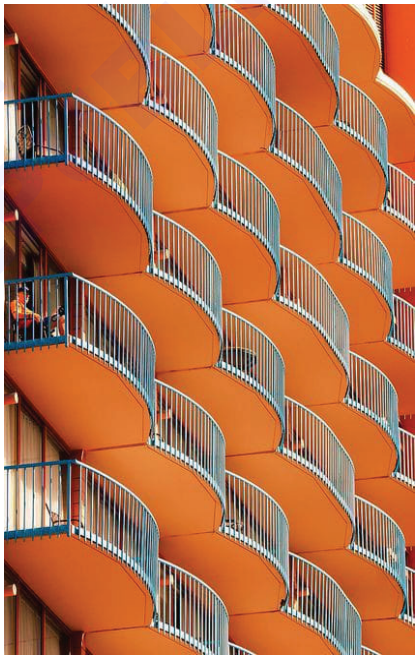
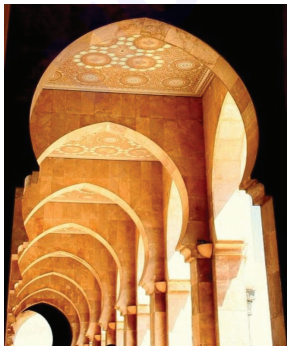


Fig 7



(a)

(b)

(c)

Fig 8

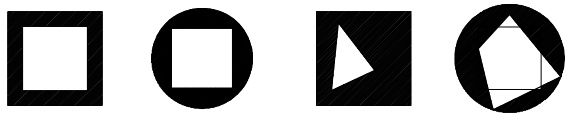
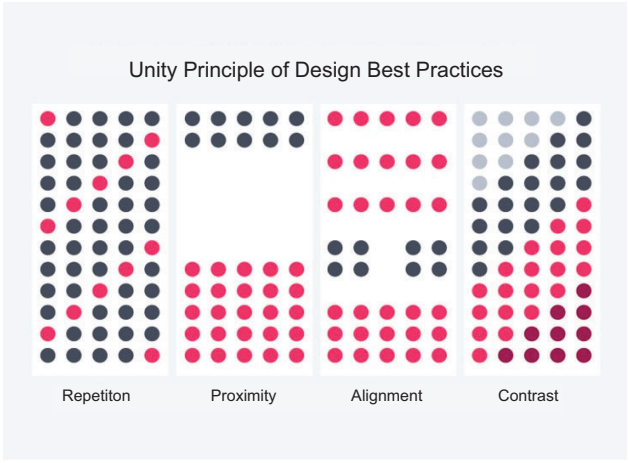
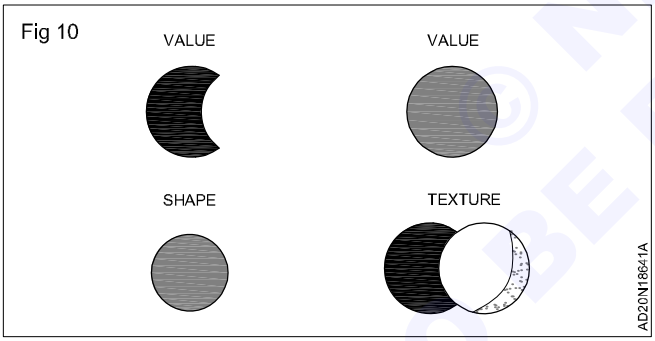


Fig 9



Contrast : Contrast" refers to the deliberate use of differences in design elements, such as color, shape, texture, size, and value, to create visual interest and clarity in a design. By placing against one another contrasting elements, designers can achieve a sense of dynamism and balance in their compositions. (Fig 10)

Fig 10



Here's how contrast can be applied in different design aspects:

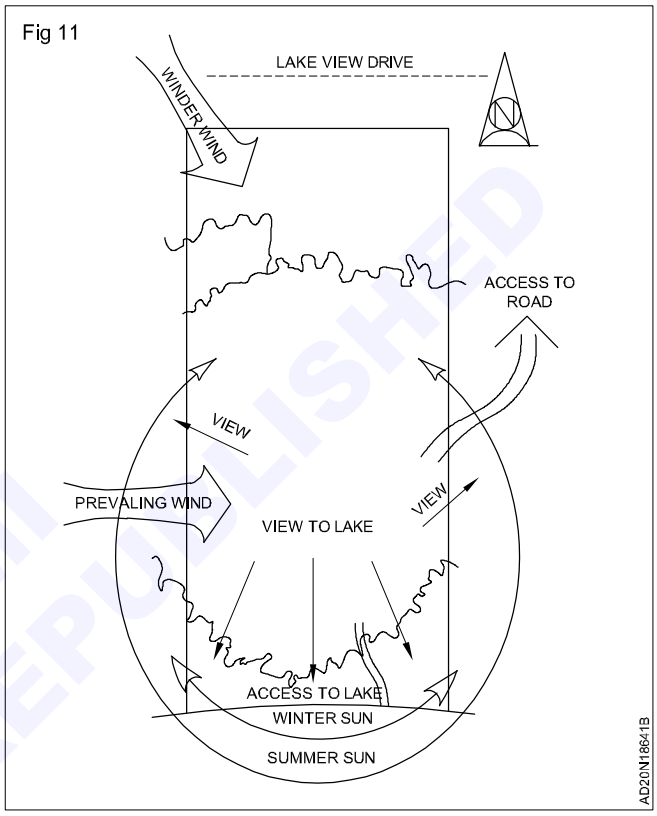
1. **Color Contrast:** The use of different colors in a design to make certain elements stand out or create visual hierarchy.
2. **Shape Contrast:** The use of different shapes and forms to create diversity and evoke specific emotions or meanings.
3. **Texture Contrast:** The juxtaposition of different textures or surface qualities to add depth and tactile interest to a design.
4. **Size Contrast:** Varying the size of elements to create a sense of scale and emphasize specific elements.
5. **Value Contrast:** Playing with lightness and darkness to create contrast and improve readability or visual impact.

By skillfully applying contrast, designers can guide the viewer's attention, communicate ideas more effectively, and elevate the overall visual experience of the design.

Conceptual design ideas

Conceptual design starts with good ideas and thougtful planning. To begin, focus on the proposed building site and note all its characteristics. Intend to take full advantage of anything affecting your lot which may enhance your design. (Fig 11)

Fig 11



Process of design

Step 1 : Site analysis

Step 2 : Site planning

Step 3 : Requirements

Step 4 : Space designation

Step 5 : Proportionately defined rooms

Step 6 : Single line diagram

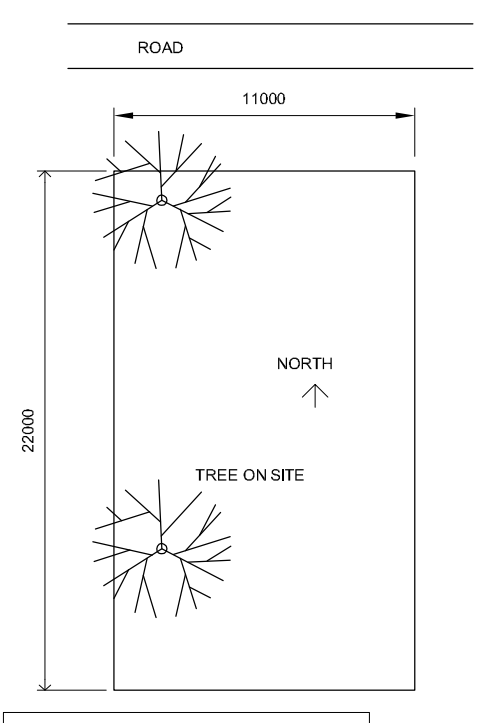
Step 7 : Floor layout analysis

Step 8 : Functional planning

Step 1 : Site analysis

Each site is characterized by various factors that create a unique environment. These influences are called elements. Natural elements include hill and trees, direction of wind, sun and views. Man made elements would include neighbouring buildings, roadways and sources of noises, etc. It may be necessary to visit the site several times to determine the daily effects of the elements. (Fig 12)

Fig 12



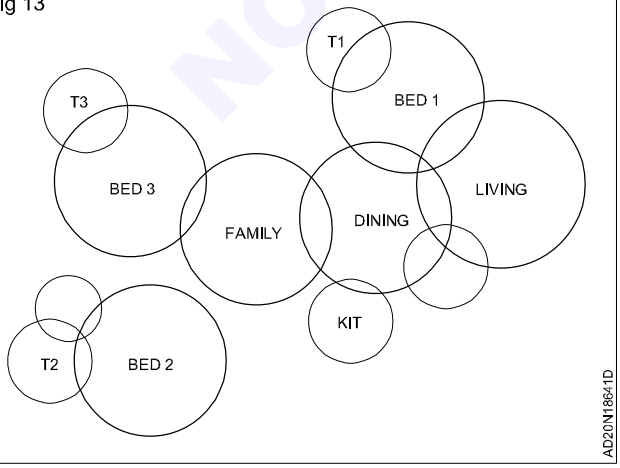
Step 2 : Site planning

Every site has the potential for residential development. Many factors determine the suitability of a site for an individual use. A good site analysis as described in step one should indicate whether the setting is appropriate.

With the approximate location of the natural and manmade elements shown, we can then begin planning the living layout by first establishing the general positioning of the building.

The three basic components of a home are : Living area(L), Working area(W), and Sleeping area (S). Layout these three areas on a plot plan. Be sure to locate them in relation to any features you can take advantage of (ie., solar orientation, view, wind sheltering etc.,) planning a house on a city lot may differ, as compatibility with neighbouring buildings also becomes a factor. (Fig 13)

Fig 13



Step 3 : Requirements

Designing or planning a building in architecture means planning the spaces provided by the building. There kinds of spaces are designed based on the kind of activities to be performed in the building. For example in residence, the set of activities generally performed within a residence must be identified, The Corresponding spaces required to perform These activities are the following.

	Activities	Space required
1	Sitting / Entertaining guest's	Living space
2	Eating	Dining space .
3	Cooking	Kitchen space
4	Sleeping	Bed space
5	Reading / Learning	Study space
6	Family get together / Entertainment	Family space
7	Bathing	Bathroom
8	Sitting outside	Verandah / Sitout

Step 4 : Space designation

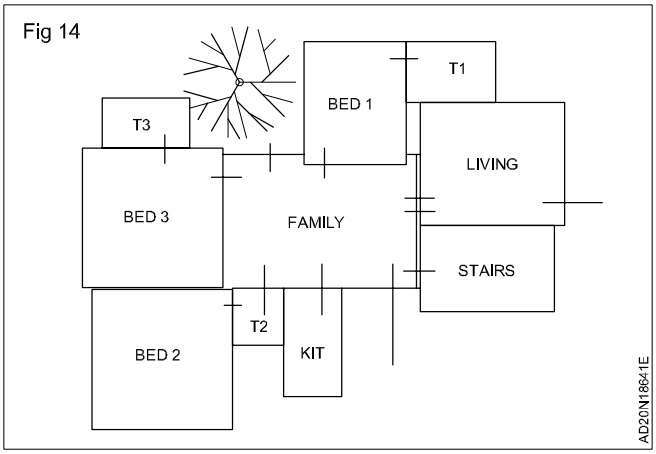
Once you have completed your needs requirement list, assign specific rooms to the working, living and sleeping general areas. Keep the activity of a room consistent with that area - living, working and sleeping. It is important to think about and visualize the relationship of each indoor space and the adjacent external environment. (Fig 13)

Step 5 : Proportionately defined rooms

With specific rooms accounted for a layout of these areas can be formed. Sketch each space in a loose arrangement with regard to the general relationship of rooms established in step four. Illustrate room sizes in proportion to each other, forming a casual floor layout. Outdoor living areas should be included as an integral development of the plan. Utilize exterior spaces adjacent to each indoor area to extend the use of that area.

For example, a living room use for entertaining may be extended to include a sitout for summer enjoyment. Outdoor living areas that are visually accessible to indoor areas can complement each other by adding theme, character and a feeling of spaciousness. (Fig 14)

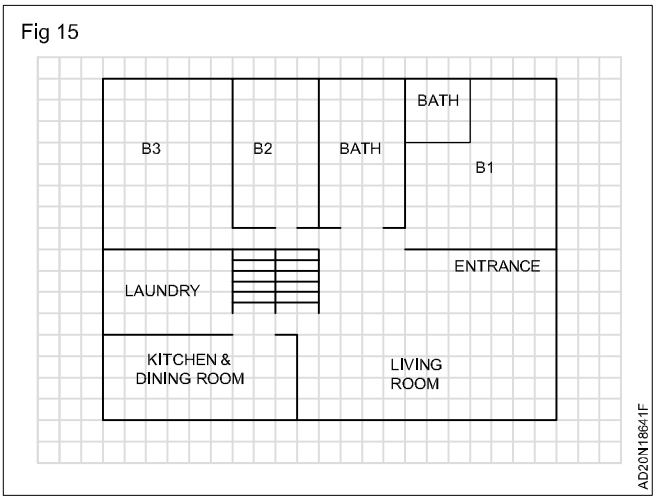
Fig 14



Step 6 : Single line diagram

To realie the usefulness of a plan, the preliminary layout must be converted to a 'single line sketch', with rooms drawn to accurate proportions. A workable sized sketch can be achieved at a scale of one quarter inch equals one foot. (Fig 15)

Fig 15



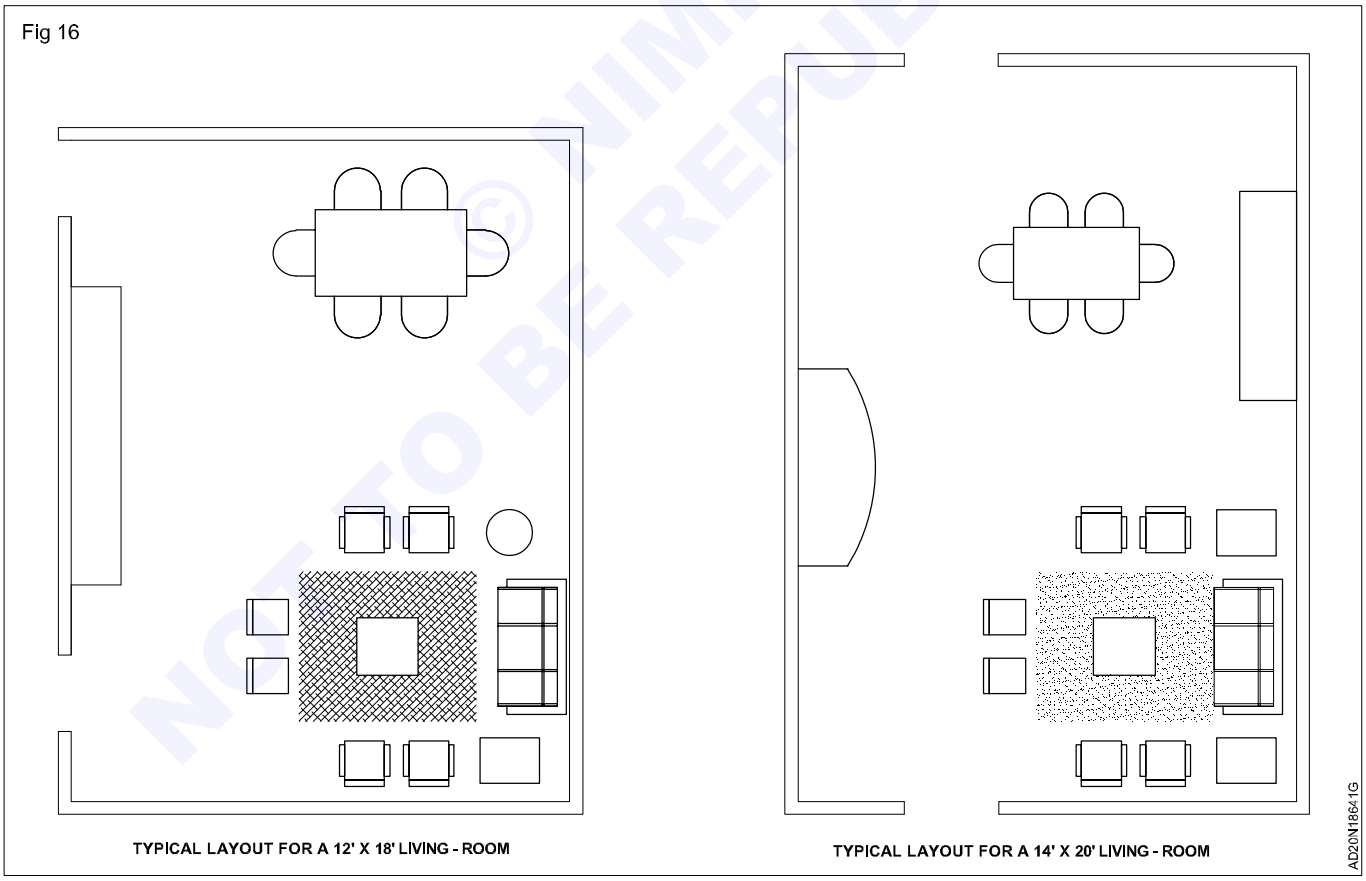
Step 7 : Floor layout analysis

A successful floor plan has no wastage space. The three major components (living, working and sleeping areas) create divisions for each activity. These areas are connected by communicating elements such as halls, stairs, and doorways. These communicating elements are areas where wasted space is often overlooked. A centrally located main entrance should lead to each area without going through another.

Preplan the placement of furnishings to ensure that each room arrangement is suitable. Precise sketches or cutouts of furniture sizes are necessary to layout an accurate living plan of your home. House designs at this stage should remain flexible, allowing for alternations to improve and assist the function of each room. Work areas and bathrooms require permanent furniture which make preplanning essential. Of any area, the kitchen is probably the most used. If not the most useful room in a house.

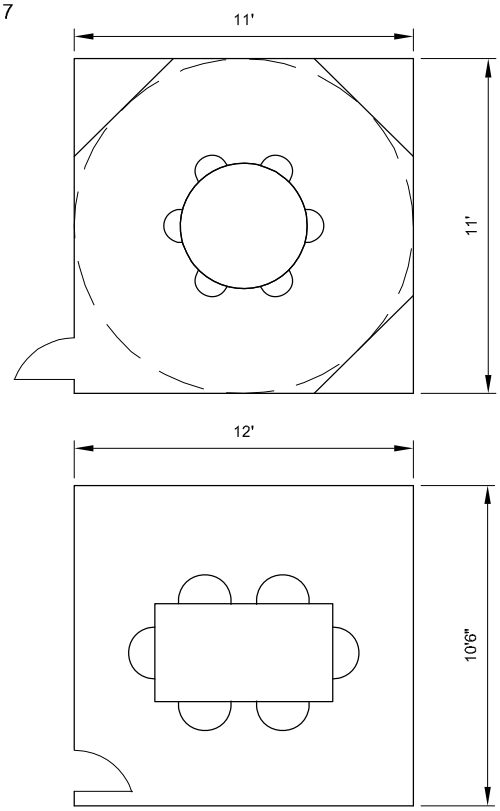
Living room - In a house of 800 square feet built up, the living room must be at least of 12'x18' or 14'x20'. In this you will need these basics - a seating area along with a table or two to place things on, a dining space with chairs and some extra storage. You could also choose to have a separate drawing and dining room. The living room should be in front portion of the house directly accessible from the entrance lobby or the outside. Too many doors should not open into the living room since it decreases the functionality and increases the risk to security. (Fig 16)

Fig 16



Dining room - The most important furniture of the dining room is the dining table and chairs. Depending upon the size of your family, the frequency of entertaining and space available, you can decide on the size of your dining table. In the dining area, there should be atleast two feet between the backs of chairs and nearby walls for passage. The table could be circular or rectangular. Round tables are more suitable if the space is less as it takes up less space than a squarish table. However if the dining table has to accomodate more than eight people, circular tables are not recommended as they take up too much space. (Fig 17)

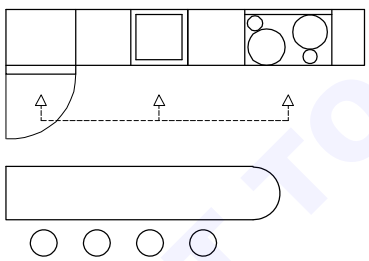
Fig 17



SMALLEST POSSIBLE DINING SIZE REQUIRED FOR SIX PERSONS.

Kitchen: They should be logically arranged according to their use. The work triangle is the area enclosed by an imaginary line connecting the refrigerator, the cooking area and the sink. Ideally the minimum distance between the various activities should not be less than three feet. The perimeter of the triangle should not exceed 25 feet to prevent wasted motion. There are different types of kitchen layout as shown below. (Figs 18 & 19)

Fig 18



THE ONE WALL KITCHEN

Bed rooms: The bedroom should be planned according to the age, marital status of the occupants. The number of bedroom depends on the size of the house. Since bedrooms are private spaces, you should place them at the rear of the house.

If the bedroom is in the front part of the house, it should have only one entrance from the inside portion. You should not access one bedroom through another bedroom. You can put guest bedroom in the front portion of the house.

The minimum size of a functional bedroom is 100 square feet with a minimum dimension of 9 feet. However, in such a room only the bare essentials like a bed and a small cupboard can fit. For fitting a study table, two chairs and a dressing table a bedroom must be atleast 150 square feet. How big your bedroom is should depend on the furniture you are planning to fit in here.

The window should be parallel to the bed position. The window should not be over the bed. When two people sleep in the same room, then the relative position of the two beds in the room depends upon the relationship of the people occupying them. (Fig 20)

Fig 19

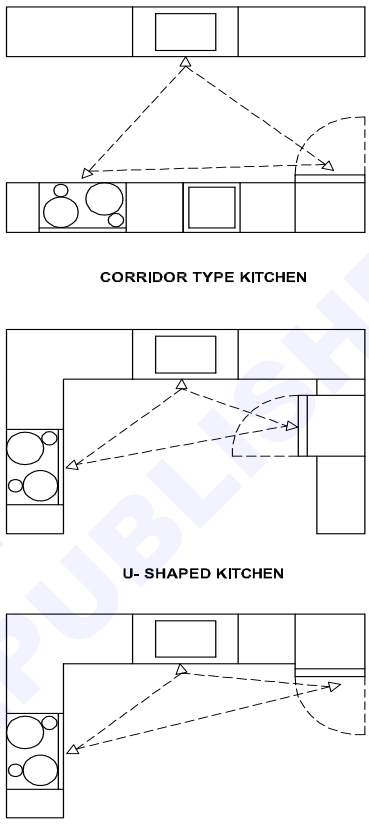
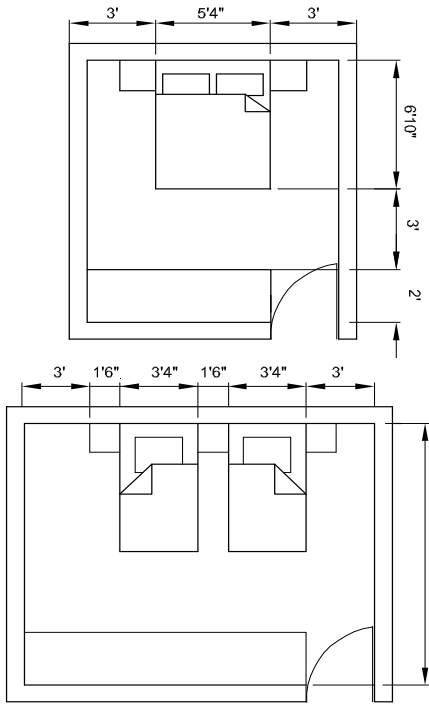


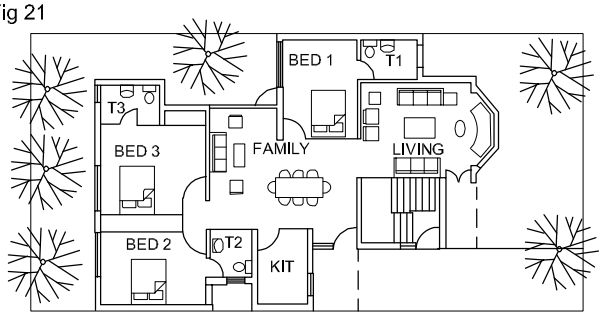
Fig 20



BED ROOMS

Step 8 : Functional planning : The final plan will emerge from this process. You can then start thinking in the third dimension in terms of height, number of floors and volume. The subsequent sketches illustrate how a final plan is derived. (Fig 21 & 22)

Fig 21



GROUND FLOOR PLAN

Living Room = 16'9" x 12'4"

Family/Dining RM = 15'8" x 19'6"

Bed room 1 = 13' x10'

Bed room 2 = 11'6" x14'

Bed room 3 = 11'6" x14'

Kitchen = 6'8" x 9'6"

Toilet 1 = 5'6" x 7'6"

Toilet 2 = 6' x 5'6"

Toilet 3 = 5' x 7'6"

Step 9: The final plan

The final floorplan indicating the arrangement of furniture, the placement of doors and windows and so on.

Designing elevation

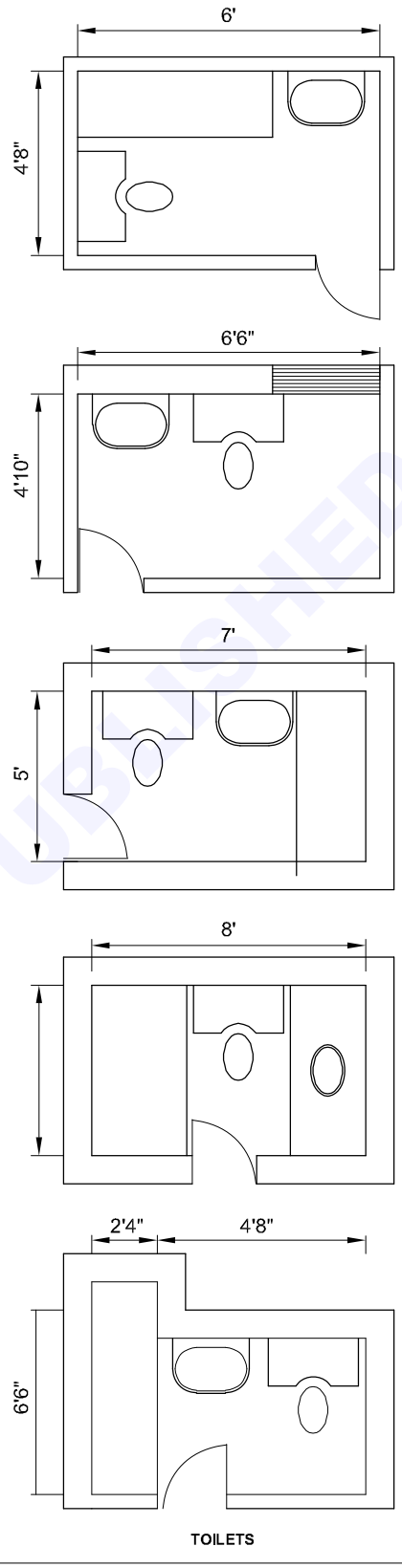
Elevation shows the vertical surfaces of a structure. Designing the elevations of a structure is only one part of the total design process. However, the elevation design reflects the part of the building that people see. The entire structure may be judged by the elevations. (Fig 23)

Design sequence for creating elevations

The first step in elevation design is to choose an architectural style. Then sketch the outline of an exterior wall showning the roof shape and the position of doors, windows and other key features.

Next create a series of progressive sketches to develop an elevation design. Experiment with different roof styles, door and window designs, sliding materials for exterior walls, overhangs, roof materials, etc., Sketches can also show architectural styles derived from the same floor plan. (Fig 24)

Fig 22



TOILETS

Fig 23

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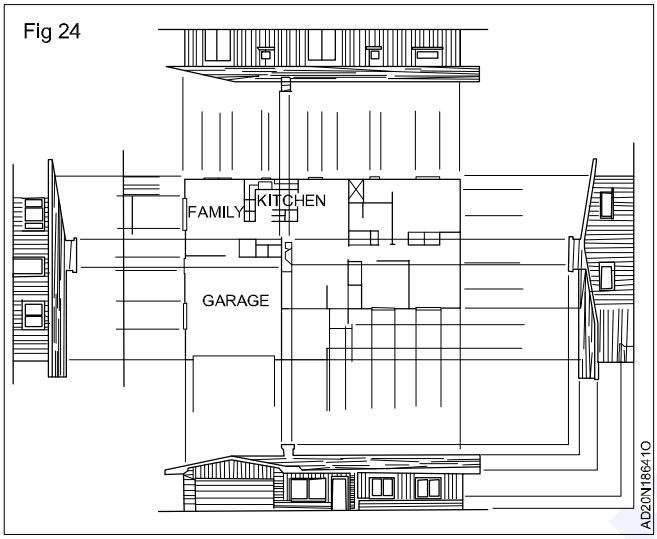
Fig 24



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Roof style and type

To design elevations, a designer needs to know roof styles and which style best matches the buildings overall style. There are many styles of roofs. The gable, hip, flat and shed styles are the most popular. Other features which affect the appearance of the roof must also be considered. In addition to style, the overhang size and the roof pitch must be determined during the design process. (Fig 25)

Roof overhang

The overhang is the portion of the roof that projects past the outside walls. Sufficient roof overhang should be provided to afford protection from the sun, rain and snow. The length and angle of the overhang greatly affects a roof's appearance and ability to provide protection. The amount is also determined by architectural style. (Fig 26 & 27).

Fig 25

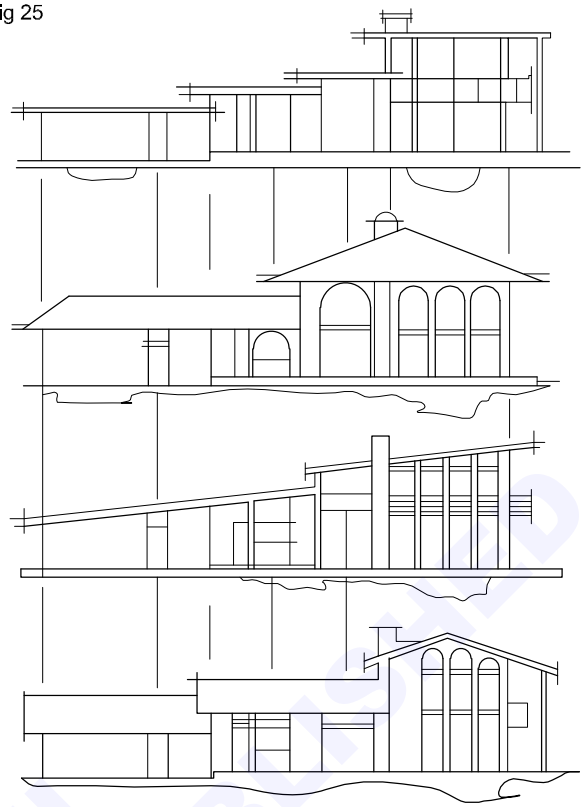

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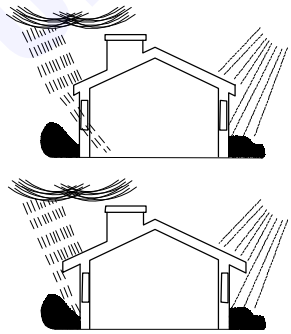
Fig 26



EFFECT OF LONG AND SHORT OVERHANG ON SUN AND RAIN PROTECTION

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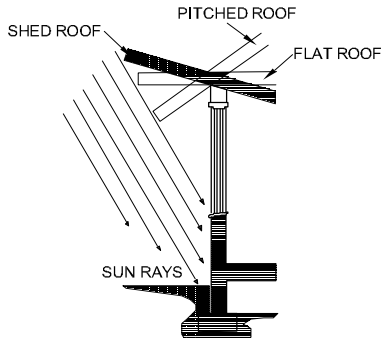
Fig 27



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Damp proof course (DPC)

Objectives : At the end of this lesson you shall be able to
- **define damp proofing**
- **state the causes and effects of dampness**
- **describe the requirements of ideal damp proofing material**
- **state the materials used for damp proofing**
- **explain the methods of damp proofing**
- **explain the water proofing treatments for roofs.**

Introduction

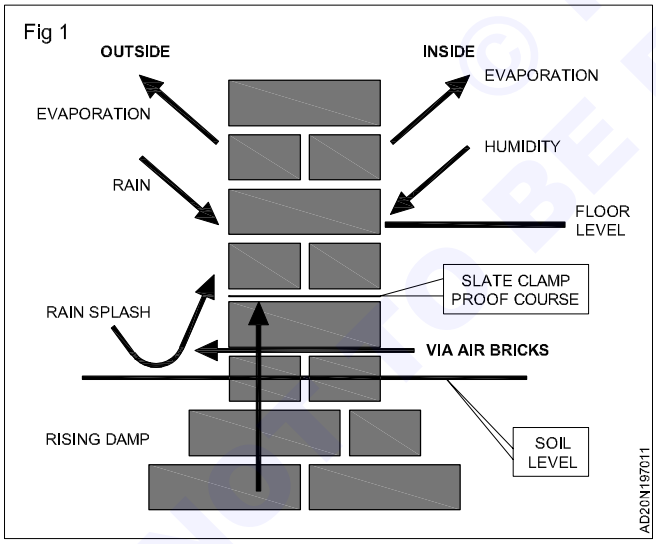
Dampness, is the unwanted and unauthorized accumulation of water in the building components. Continued presence of dampness in the building, deteriorates building components, spoils, the interior decoration and external appearance and affects the health and comfort of the occupants. Hence, in order to prevent the entry of damp into a building, the application of courses known as damp proofing courses, which are provided at various levels, at entry of damp into a building.

Definition

Treatments given to various places of building structure to keep walls, floors and basement dry, is called damp proofing.

Causes of dampness (Fig 1)

Fig 1



1 Rising moisture from ground
2 Condensation
3 Defective junctions between roof slab and parapet wall.
4 Defective roof covering of pitched roof
5 Faulty eaves and valley gutter.
6 Improper rain water pipe connections
7 Inadequate roof slope
8 Splashing of rain water
9 Unprotected tops of wall, parapet walls etc.

Effects of dampness

1 Metals used in the building corroded.
2 Unsighty patches formed
3 Decay of timber
4 Electrical deteriorated leakage of electricity and short circuiting.
5 Floor covering materials get damaged
6 Promotes the growth of termites.
7 Softening and crumbling of plaster
8 Gives rise to breading of mosquitoes, germs of dangerous diseases etc.
9 Wall decoration materials are damaged
10 Floorings get loosened
11 Cause efflorescence.

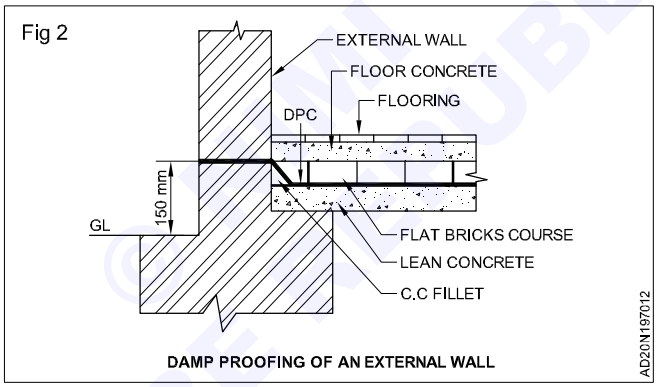
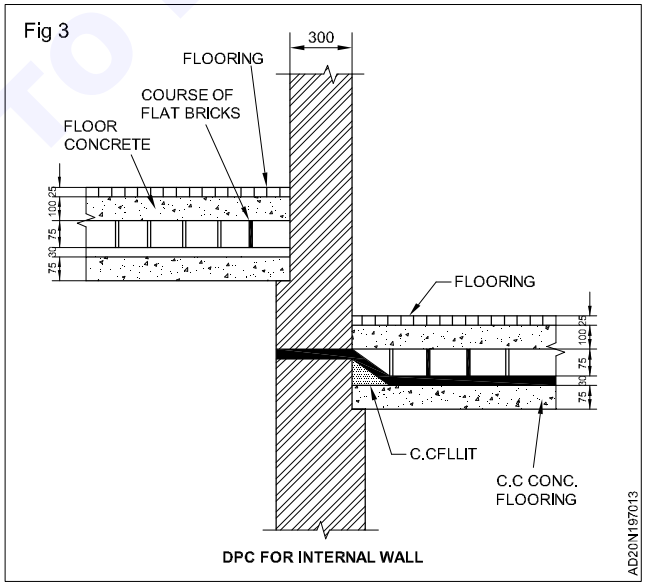
Requirements of an ideal damp proofing material

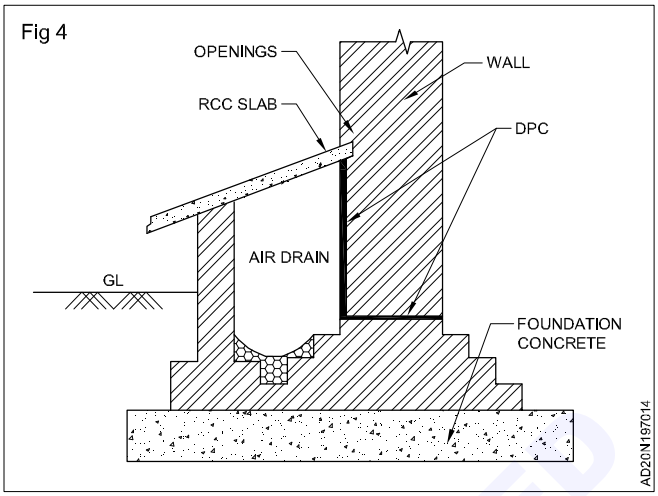
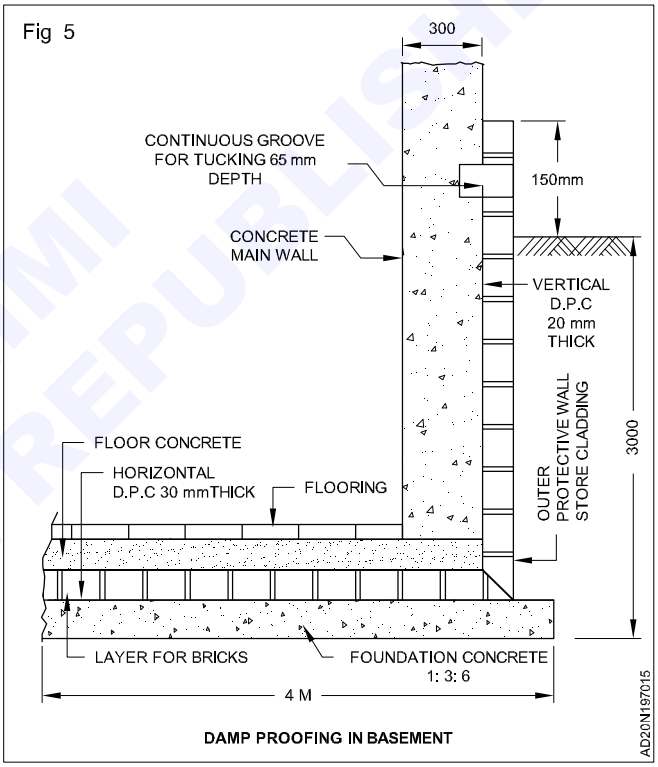
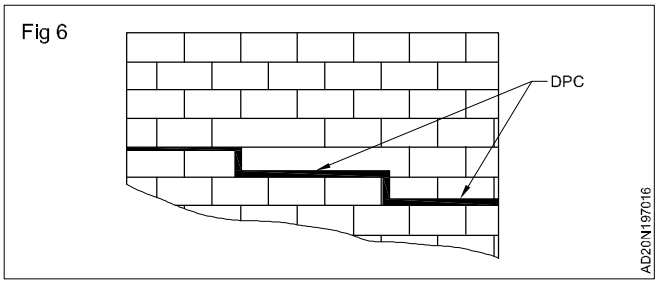
1 Durable
2 Remains steady and do not allow any movement it self.
3 Perfectly impervious
4 Capable of resisting the loads coming over it safely.
5 Flexible
6 Dimensionally stable
7 Reasonably cheap
8 Possible to carryout leak proof jointing work
9 Free from deliquescent salts like sulphate, chlorides and nitrates.

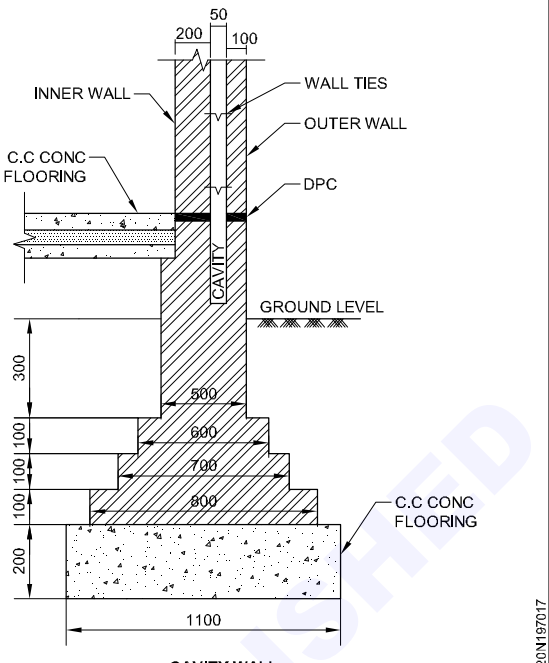
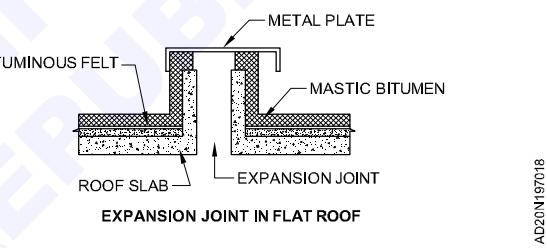
Materials for damp proofing

1 Bitumen
2 Mastic asphalt
3 Bituminous felt
4 Metal sheets (Lead, Copper, Aluminium)
5 Combination of sheets and felts
6 Stones
7 Bricks
8 Mortar
9 Cement concrete
10 Plastic sheet.

Methods of damp proofing

S.No	Method	Description / Figure
1	Integral treatment	Water proofing compounds or materials are added during the process of mixing the materials. Chalk, tale or filler's earth is used to fill the pores in concrete or mortar. Water proofing compounds such as Pudlo, Impervo etc. are used after diluting with water. Concrete is made water repellent by the use of soap solution, calcium and petroleum oil etc.
2	Surface treatment	Joints in brickwork or stone work are pointed or the surface is plastered. Paints, oils, waxes and soap solution are used for surface treatment. The cement paints act as vertical DPC.
3	Membrance damp proofing	This is done by providing a layer of water repellent materials between the source of dampness and part of the structure adjacent to it.
a (i)	Treatment to external walls	Fig 2  DAMP PROOFING OF AN EXTERNAL WALL
(ii)	Treatment to internal walls	Fig 3  DPC FOR INTERNAL WALL

S.No	Method	Description Figure
b	Treatment to foundations against gravitational water	Fig 4 
c	Treatment to basements	Fig 5  DAMP PROOFING IN BASEMENT
d	Treatment to sloping ground	Fig 6 
e	Treatment In pitched roof	1 In pitched roofs , the rain water gutters may be constructed in cement concrete and standard rain water fittings may be used. 2 The gutters lined with bituminous materials.

S.No	Method	Description	Figure
4	Cavity wall construction	Cavity in between two walls prevents the moisture from reaching the inner wall Cavity wall prevent the entry of dampness	Fig 7  CAVITY WALL
5	Treatment to expansion and construction joints	The expansion joints and construction joints should be properly sealed by water proofing materials to obstruct the leakage of water.	Fig 8  EXPANSION JOINT IN FLAT ROOF
6	Guniting	Cement mortar consists of 1:3 is shot on the cleaned surface with the help of a cement gun, under a pressure of 2 to 3 kg/m2. Can be used over pipes, cisterns etc. for resisting water pressure	
7	Pressure grouting	Forcing cement grout, under pressure into cracks,voids,fissures etc. present in the structural components of the building or in the ground	

DPC treatment in buildings

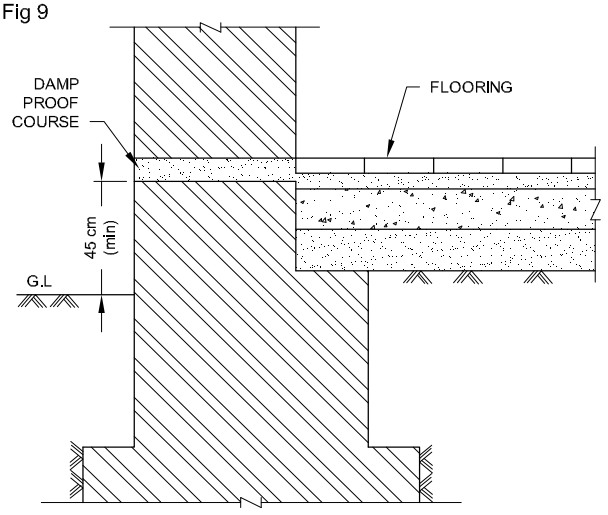
1 Treatment to foundations on ordinary soil

Bricks being porous, brick masonry below ground level can absorb moisture from adjacent ground. This moisture travels up from one course to another by capilary action and can make the wall damp for a considerable height. This can be prevented by providing DPC at appropriate place (as shown in Fig 9).

2 Treatment to foundation on damp soil (Fig 10)

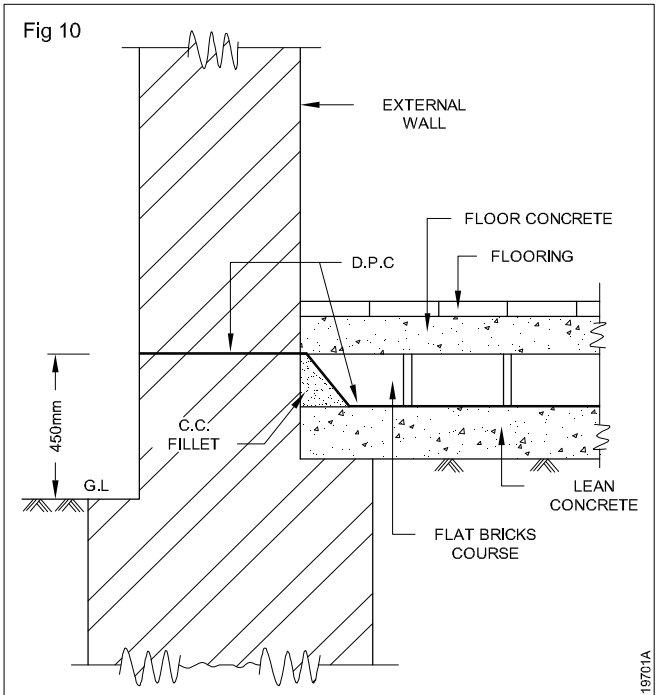
In case of building constructed on damp soil, the DPC is laid over the entire area of ground floor including wall thickness. Bitumen felts can be used for damp proofing treatment.

Fig 9



DAMP PROOFING OF AN EXTERNAL WALL

Fig 10



DAMP PROOFING OF AN EXTERNAL WALL

3 Treatment to basement in ordinary soil (Fig 11)

The treatment consists in providing a horizontal DPC over the entire area of basement floor and then extending it in the form of vertical DPC on the external faces of the basement walls.

4 Treatment to basement in damp soil

In sites where the ground water table is high, the problem of damp proofing of basement can be tackled by one of the following three methods.

a By providing foundation drains and DPC (Fig 12 & 13)

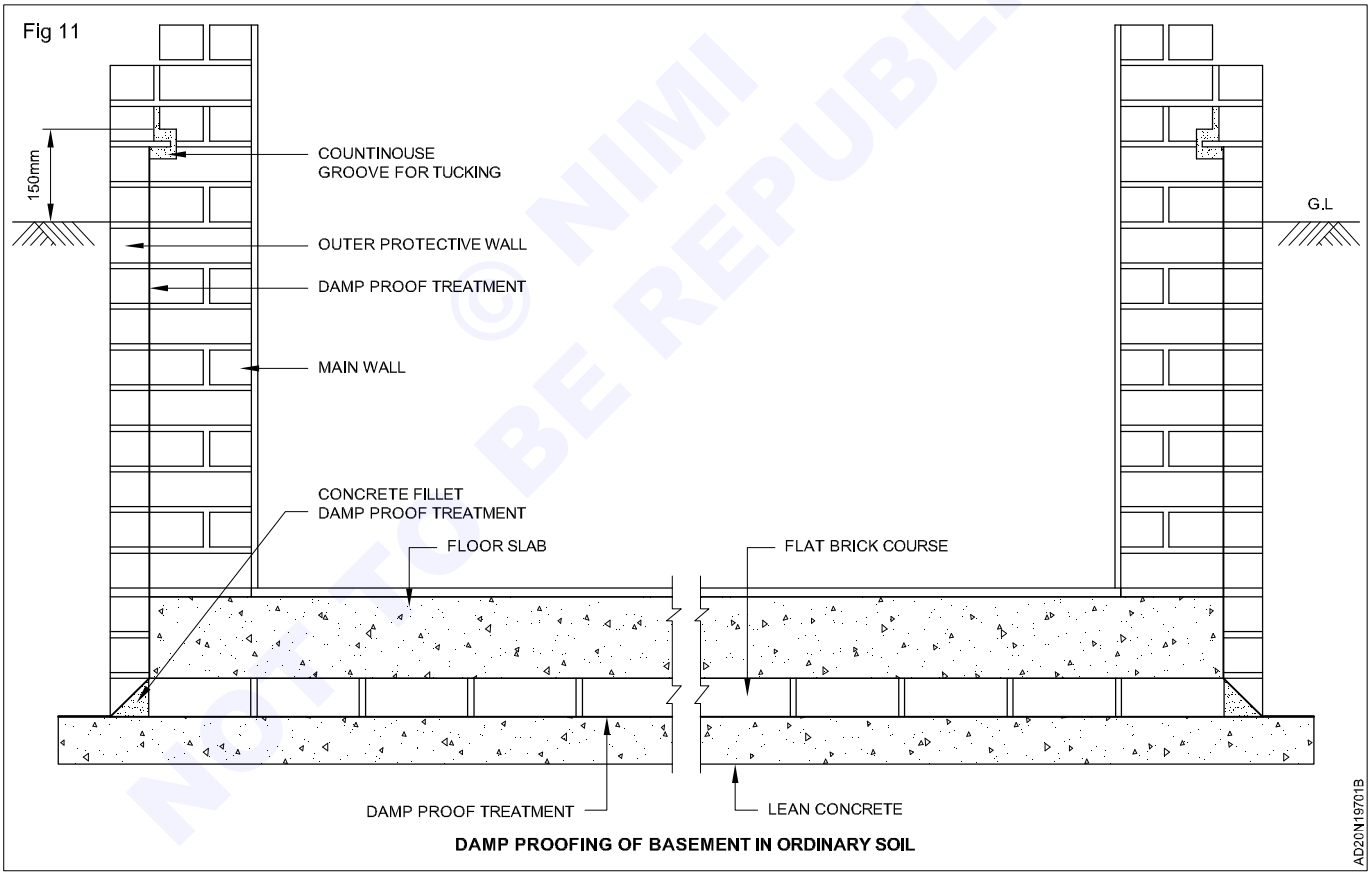
b By providing RCC floor and wall slab and DPC

c Water proofing treatment by using grout consisting of cement mortar admixed with acrylic based chemical along with rough stone slabs (Fig 14)

5 Treatment to flat roofs

Stagnation of water on the roof top is considered to be the root cause of leakage and dampness in flat roofs. This can be avoided by providing adequate roof slope and rain water pipes. A slope of 1:40 or 1:60 is considered desirable.

Fig 11



DAMP PROOFING OF BASEMENT IN ORDINARY SOIL

The other commonly adopted water proofing treatment for flat roofs consist in providing a grading of selected materials over the roof slab.

The following method of grading is adopted to meet the requirement of water proofing:

a) Grading with lime concrete

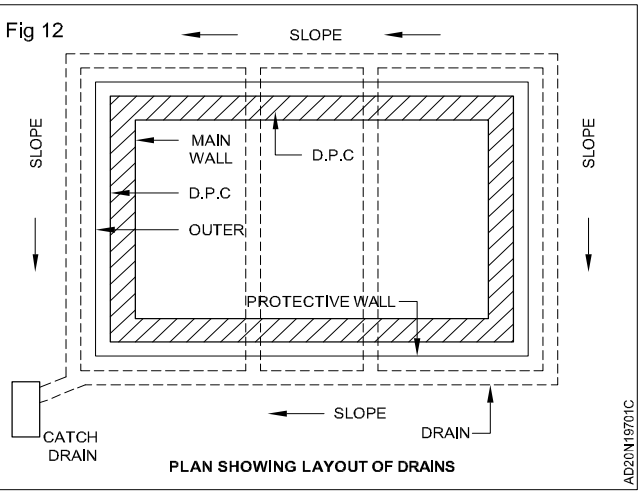
b) Grading with lime concrete with tiles

c) Grading of brick coba laid with grout consisting of cement mortar admixed with acrylic based chemical.

Water proofing treatment to flat roof

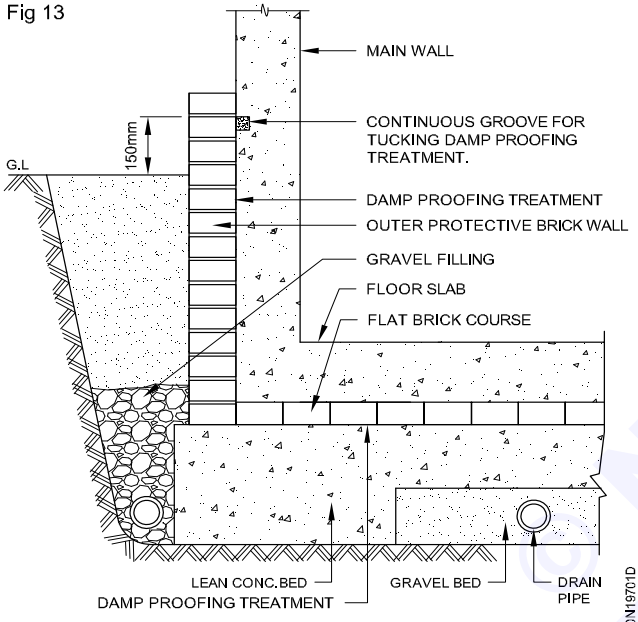
Flat roof must have to be provided with proper water proofing courses. Leakage of water through roof occur mainly due to stagnation of water at low area. To avoid this roof must have proper slope towards the outlets.

Fig 12



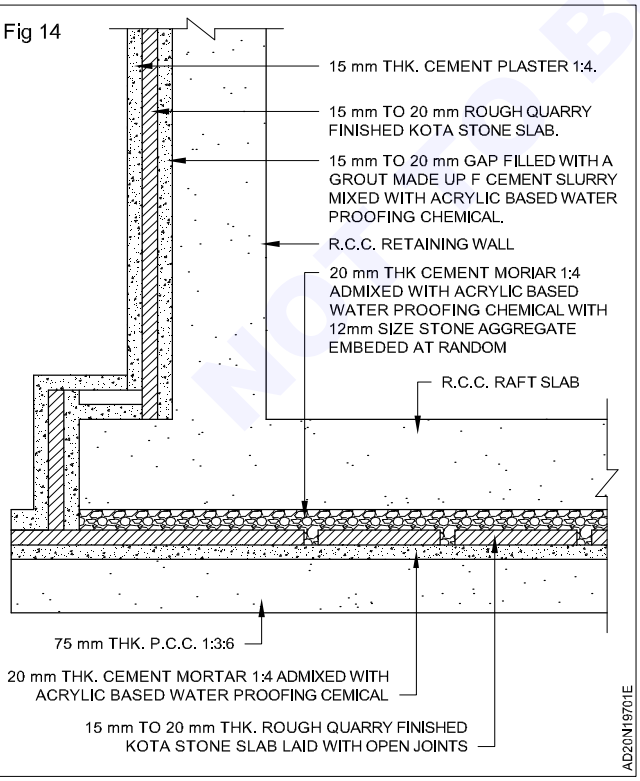
PLAN SHOWING LAYOUT OF DRAINS

Fig 13



D.P.C. IN DAMP SOILS USING FOUNDATION DRAINS.

Fig 14



Following are the commonly adopted methods of water proofing treatments.

A Cement mortar plastering

1 The entire area of roof is cleaned with wire brush and all dirt is removed.

2 A neat cement wash is given to the surface and

3 20mm thick layer of cement mortar mixed with standard water proofing compound is laid and finished smooth.

B Tar felting

1 Hot bitumen is applied over the roof surface and tar felt is laid over it.

C Lime concrete terracing

1 It is most common in southern region of India.

2 They offer good resistance to solar radiation.

3 Lime concrete is made by mixing over burnt brick aggregate of size 25mm with lime mortar of 1:2mix.

4 First 10 cm thick lime concrete is laid, spread and rammed with wooden rammers.

5 Slope if required should be given in this layer.

6 Then entire surface is consolidated by beating.

D Lime concrete terracing with tiles

1 As explained above, proportion, method of laying, consolidation etc. is same.

2 At first a hot bitumen wash is given to the entire roof surface.

3 Then a layer of fine sand is spread immediately, when the bitumen is still hot.

4 Over this 10 cm thick lime concrete is spread and rammed with light rollers to get even thickness or the required slope.

5 Ramming is continued till 10 cm laid thickness will come down to 8 cm.

6 When lime concrete layer is still green, two courses of flat brick tiles are laid in cement mortar 1:3.

E Mud pushka terracing with tile paving

1 At first a layer of hot bitumen is spread over the entire roof surface.

2 The prepared mud pakka earth is spread to a thickness of 10 cm. and compacted to till the thickness reaches to 8cm.

3 Over this 25mm thick layer of mud mortar is laid and allowed to dry.

4 After drying up, a coat of gobi leaping is given.

5 Over this a layer of flat brick tiles is laid in mud mortar, and allowed to dry.

6 Joints are pointed with cement mortar 1:3.

7 Entire roof surface is covered with wet gunny bags.

8 After 12 hours brick terracing is cured by sprinkling of water.

Water proofing treatment for pitched roof

Usually the pitched roof has self draining property. The over laps should be as specified and size of gutters should

be designed taking into consideration the average rainfall. The common methods adopted for water proofing are:

a Covering the entire roof surface with tar felt

b Covering the entire roof surface by lime mortar of proportion 1:1:2 (lime putty: surkhi: coarse sand)

Termite proofing

Objectives: At the end of this lesson you shall be able to
- **define the term termite proofing**
- **state the types of termites**
- **explain the methods of anti termite treatment.**

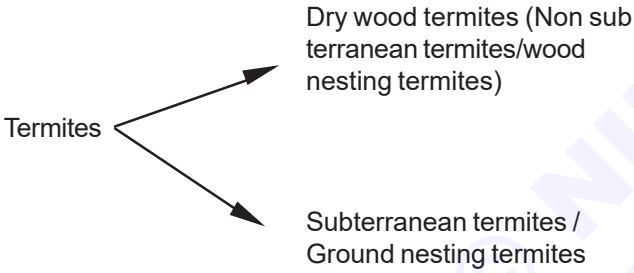
Introduction

The removal of termites from a building is not an easy task. The termites live in a colony and they are very fast in eating wood and other cellulosic materials as food. They damage materials of organic origin with cellulosic base, damage house hold articles like furniture, furnishings, clothing and stationary. Therefore it is necessary to adopt anti termite treatment in building.

Definition

The treatment which is given to a building to prevent or control the growth of termites is called termite proofing.

Types of termites



Methods of Anti-termite treatment

1 Preconstruction treatment

Here three operations involved.

a Site preparation :- Remove stumps, roots, logs, waste wood etc. Detect termite mounds and destruct these by using insecticide solution. Chemicals for preparing solution are DDT, BHC, Aldrin, Heptachlor, Chlordane.

Chemical	Concentration by weight
DDT	5%
BHC	0.5%
Aldrin	0.25%
Heptachlor	0.25%
Chlordane	0.5%

Four litres of the above emulsion in water is required per cubic metre of volume of mound.

b Soil treatment

The best method to protect the building to protect against termites is to apply a chemical treatment to the soil at the time of construction of the building. A complete chemical barrier is created. An insecticide solution consist of any one of the following chemicals in water solution.

Chemical	Concentration by weight
Aldrin	0.5%
Heptachlor	0.5%
Chlordane	1%

The emulsion should be applied evenly at the following stages.

Stage1-In foundation pits, to treat the bottom and sides upto a height of 30 cm.

Stage 2-Refill earth on both sides of the wall, for a width of 30cm and depth of 45cm approximately.

Stage 3-Before laying the floor ,entire levelled surface is to be treated at the rate of 5 litres of emulsion per square metre.

c Structural Barriers:- These are concrete layer of 5cm-7.5cm thick or Metal sheets (Copper or G.I Sheets 0.8mm thick)

Post construction treatment

It is a maintenance treatment. Open earth around building and treat it with chemicals. In wood work or masonry work, bore holes and inject chemicals.

Treratment to basement in damp soil

In basement with damp soil, the moisture levels are significantly higher, making it an ideal environment for termites. The dampness attracts termites and they are more likely to establish colonies in these areas.

Basements with damp soil, the application of termites may require special considerations due to the higher moisture levels. Implementing measures like proper drainage, dehumidifcation and ventilation can significantly reduce termite attraction and activity.

On clay and heavy soils where penetration is likely to be alow and on sloping sites where sum of the treating solution is likely to occur the surface of the soil should be scarified to a depth of atleast 75mm.

Drainge around the building siter shall be ensured so that water does not stagnate in the vicinity of the building. Access of water to the underside of the ground floor shall be prevented through proper constructional measures such as construction of concrete open around the building.

Damp proofing course is laid above the ground level adjoining plinth level of the building in the entire width of the wall. However, it is kept below the floor level. The thickness of the DPC (Dasmp Proof Course) varies between 12mm to 20mm. At certain places it may be 40mm thick also. It is also provided below the sill level of the doors.

Prefabricated panels R.C.C

Objectives: At the end of this lesson you shall be able to
- **state prefabricated R.C.C. panels**
- **introduction, materials used R.C.C. panels.**

Introduction

A prefabricated RCC (Reinforced Cement Concrete) panel refers to a construction component that is manufactured off-site in a controlled environment and then transported to the construction site for installation. These panels are made from a combination of cement, aggregates (such as sand and gravel), water, and reinforcing materials like steel bars or mesh. Prefabricated RCC panels are commonly used in building construction for various purposes due to their numerous advantages, including speed of construction, quality control, reduced labor on-site, and overall cost-effectiveness.

Key characteristics and uses of prefabricated RCC panels include:

Customization: Prefabricated panels can be customized to fit specific project requirements, including size, shape, and design elements.

Fast Construction: Because the panels are manufactured off-site, construction can proceed more rapidly once they are delivered to the site, helping to reduce overall project timelines.

Quality Control: Prefabricated panels are produced under controlled conditions, which can lead to higher quality and consistency in the finished product.

Reduced On-Site Labor: Since much of the manufacturing and assembly takes place off-site, there is less need for extensive on-site labor, which can lead to cost savings.

Structural Stability: RCC panels provide strong structural support, making them suitable for various building applications, including walls, floors, roofs, and facades.

Energy Efficiency: Depending on the design and materials used, prefabricated panels can contribute to better energy efficiency in buildings.

Architectural Flexibility: Prefabricated panels can be designed to accommodate architectural features, openings for windows and doors, and other design considerations.

Environmental Benefits: Prefabrication can lead to reduced construction waste, as well as potential energy savings due to shorter construction durations.

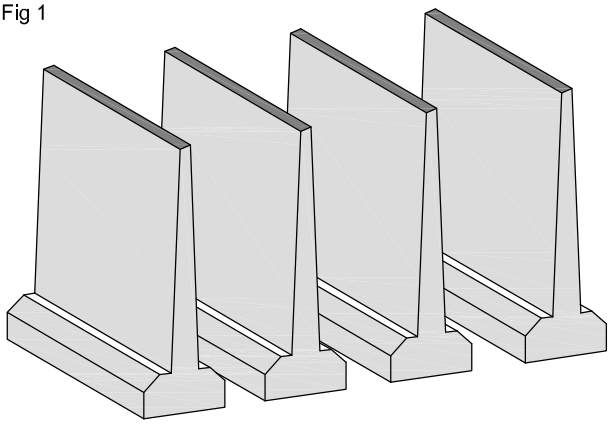
Cost Savings: While the initial costs for manufacturing prefabricated panels may be higher, the overall savings from reduced on-site labor and faster construction timelines can often outweigh the initial investment.

Applications: Prefabricated RCC panels are commonly used for applications such as load-bearing walls, non-load bearing compound walls, exterior cladding, interior partitions, flooring systems, and roofing elements in both residential and commercial construction projects. The size and thickness of panels vary for each application. They can offer a practical solution for speeding up construction and ensuring consistent quality in building projects.

Precast RCC factory wall panel is a ready to use product. The wall panels are designed such that they are economical for construction, easy for transportation and placing. These walls do not require laying of foundation for installation as they are already casted with required base for self-standing. These walls are provided with required base with the respect to the SBC (Safe Bearing Capacity) of the soil. Hence these walls are self- standing. These are completely non-load bearing walls which are designed to take only wind loads. These walls do not require plastering as they are casted with better finish. These walls are joined with a mesh band which is poured with mortar. These walls can be casted for the required number of walls in the given amount of time.

The structural details of wall panel: Length - 2.44m, Thickness – 0.1m, Height – 2.92m, Base width – 0.4m. (Fig 1) Size varies for different manufactures for different applications.

Fig 1



GI powder coated steel pannels

Objectives: At the end of this lesson you shall be able to
- **introduction to modular panels**
- **understand the types of modular panels**
- **identify the key benefits and applications of GI powder coated steel panels.**

Introduction

Modular panels are a very crucial part of the clean room environment as they create a physical barrier between the controlled clean room area and contaminated area majorly, modular panels offer factory prefabrication easy installations and superior performances. Therefore, it requires careful consideration during the design stage and its usage.

Various solutions can be procured from a wide range of panels available.

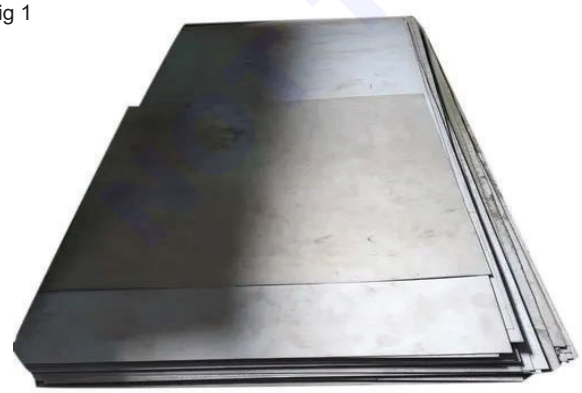
A Based on material of construction

1 MS powder coated
2 ACP (Aluminium composite panels)
3 GI (Galvanized Iron)
4 Pre-painted GI (PPGI)
5 Powder coated GI (PCGI)
6 SS matt finish (Stainless steel)
7 HPL (High Pressure Laminate)
8 GRP (Glass Reinforced Plastic) or FRP (Fibre Reinforced Plastic)

Each panel has different purpose and based on which the selection is made. The material to be used in panel selection is chosen depending on the type of environment, ie., fire resistant, heat resistant, moisture resistant, noise reduction, etc.

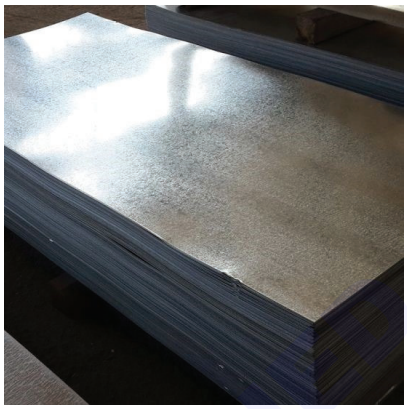
- **MS powder coated panels (Fig 1):** The cheapest option of the available materials, MS powder coated panels are used principally only in the storage or unclassified area of a pharmaceutical facility. Aesthetically, this helps to maintian the uniformity with the classified area.

Fig 1



- **GI (Glavanized Iron) sheets (Fig 2):** GI sheets are used primarily in cleanroom spaces termed as dead areas or unexposed areas, i.e. the face of a panel used for wall cladding or front of the panel towards the ceilinng in non-walkable area.

Fig 2



- **Pre-painted GI (PPGI) and Powder-coated GI (PCGI) (Fig 3):** As opposed to GI, PCGI or PPGI differs in the coating thickness over the GI sheet. In the case of PPGI, there is a thin coating layer that consists of 18-20 micorns and continuous lines are used in the sheet manufacturing facility and (check the meaning). In contrast, PCGI is coated with magnetically charged particles and the thickness is around 0.6 - 0.8 mm. This increase in thicknes ensures durability and longer shelf life (by several years) of PCGI panels.

Fig 3

GI powder coated steel panels

GI (Galvanized Iron) powder-coated steel panels are a type of construction material that consists of steel panels coated with a layer of powder paint. This combination of galvanized steel and powder coating provides enhanced protection against corrosion and environmental elements, while also offering aesthetic options.

1 **Galvanized Iron (GI):** Galvanized iron is steel that has been coated with a layer of zinc through a process called galvanization. This zinc coating acts as a sacrificial barrier, protecting the underlying steel from rust and corrosion. GI panels are known for their durability and resistance to atmospheric conditions.

2 **Powder Coating:** Powder coating is a finishing process where a dry powder is applied to a surface, typically metal, and then heated to fuse the powder into a smooth, protective layer. The result is a hard and durable finish that provides additional protection against corrosion, UV rays, chemicals, and abrasion. Powder coating is available in a wide range of colors and finishes, allowing for customization and aesthetic considerations.

Benefits of GI powder-coated steel panels

Corrosion Resistance: The combination of galvanization and powder coating provides excellent corrosion resistance, making these panels suitable for outdoor and exposed applications.

Durability: The powder coating layer adds durability and extends the lifespan of the panels by protecting them from physical damage and environmental factors.

Aesthetics: Powder coating allows for a wide range of colors and finishes, enhancing the visual appeal of the panels and allowing them to be integrated into various architectural designs.

Low Maintenance: The protective nature of the coating reduces the need for frequent maintenance and repainting.

Environmentally Friendly: Powder coating is known for its environmentally friendly characteristics, as it produces minimal waste and does not contain solvents or volatile organic compounds (VOCs).

Easy Installation: GI powder-coated steel panels are relatively lightweight and can be easily installed in various construction applications.

These panels are commonly used in building exteriors, interior spaces, industrial settings, and other environments where a combination of strength, durability, and aesthetic appeal is desired. Examples of applications include wall panels, roofing sheets (Fig 3), partitions, fencing, gates, and decorative elements.

Indian Architecture

Objectives: At the end of this lesson you shall be able to
- **state buddhist architecture**
- **state stupas (or topes).**

Buddhist architecture (300B.C. - 820A.D.)

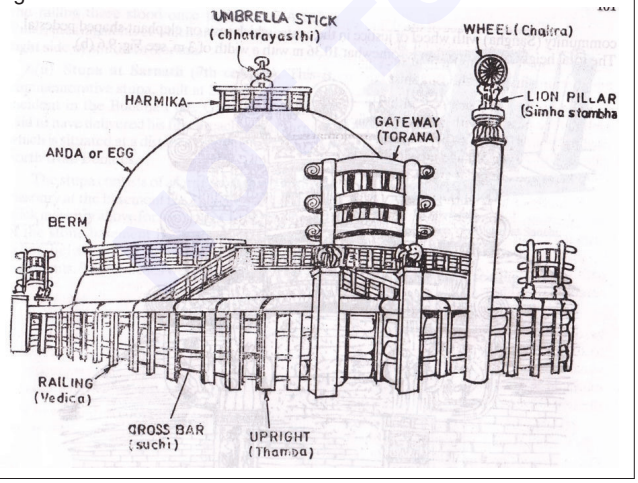
Characteristic features

The major features of this style are stupas. Though primitive buddhism rejected any form of image worship, they represented buddha by means of symbols like stupa, bodhi tree indicating enlightenment, wheel of Law, and his footprints.

Stupas(or Topes)

- These stupas are the circular tumuli built of earth, covered with stone or brick the plan, elevation, section and the total form of which were all derived from circle- the embryo of the most powerful architectural form of Buddhism. They have been called in Prakrit word 'STUPA', and were erected over the scared relics of the monks and worshipped with great reverence. They are therefore also known as 'Relic-shrines'.
- Domes is also called 'Anda' or 'Egg' or Womb (Grabha) as it contains the seed or 'bija' namely the relic of the monk.
- At the top of the dome, was a small square balcony in decorative form, called 'Harmika' (Heaven of 33 gods) enclosing a pedestal.
- The stupa was enclosed within a wooden or stone railing called 'Vedica' with a gate-ways called 'toranas'. (Fig 1)

Fig 1



The Great Stupa, Sanchi (250 B.C.)

- This is the world famous stupa at Sanchi. It is about 40Km from Bhopal in Madhya Pradesh.
- The dome 'anda' or 'egg' is a solid brick work 32.32 m in diameter and 12.8 m high the size of the present day.
- The dome has a slight 'crushed' profile at top and was surmounted by Harmika with a central triple umbrella.
- The facing of the dome consists of dry masonry composed of hammer dressed stones laid in even courses.
- There are four gateways known as 'toranas'.
- Torana consists of two square upright columns with capitals of lion or elephant heads denoting strength.
- The twenty feet between the stone vertical pillars of the Torana are spanned by carved stone beams resting firmly and sailing over on either side of the uprights.
- The top panel is crowned with Tri-Ratna (the three jewels) symbol of the Buddhist trinity.
- Ashoka pillar, the fragments of which are noticed now to the right side of southern torana. (Figs 2 - 5)

Fig 2

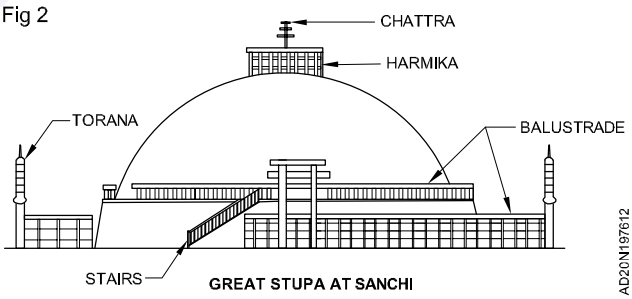


Fig 3

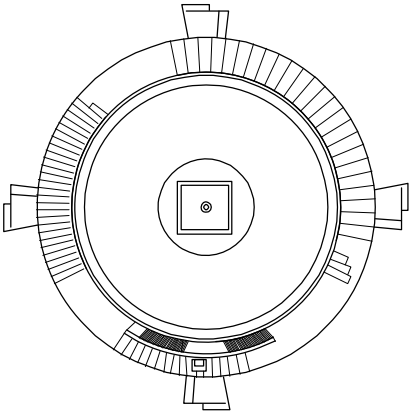
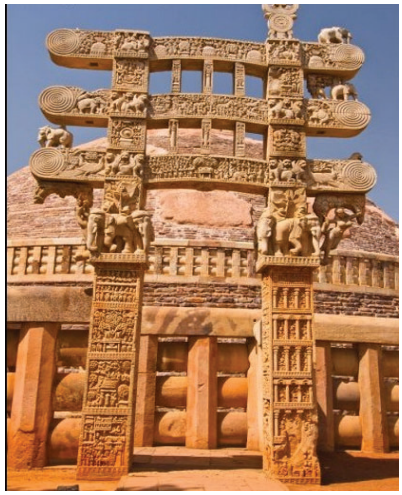


Fig 4

ASHOKEA PILLER

Fig 5



Northern Hindu Style or Indo Aryan Style

Objectives: At the end of this lesson you shall be able to

- **explain the characteristic features of northern hindu architecture**
- **explain the characteristic features of sun temple at konark**
- **explain the characteristic features of lingraja temple at bhuvaneshwar.**

Hindu Architecture

This is subdivided into the following three styles:

1 Northern Hindu style (A.D. 600 to the present day)

2 Central Hindu Style (A.D. 450-750 and 1000-1325 to the present day)

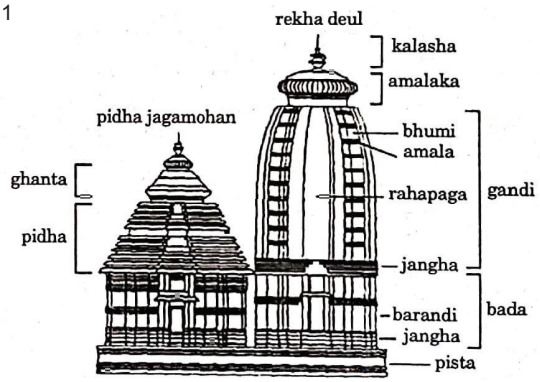
3 South Hindu Style (A.D. 625-1750 to the present day)

Characteristic features of northern Hindu style

- The earliest movement started in the state of Orissa. The beginning of this Orissa group is seen at Bhubaneswar at Puri where there are about thirty temples.
- Most important are the temple of Jagannath at Puri (1000 A.D.) and Sun Temple at Konark (1250 A.D.)
- The typical plan of the temple is square. They adopted mainly trabeated style of construction.
- The main temple rests on high platform called 'pista'.
- The temple is approached by an assembly hall, known as 'Jaga-mohan'-one which pleases the world.
- The main temple is called as Rekha Deul because of its emphasis on vertical lines.
- The Jaga-mohan is also called the Pida Deul since, it is composed of Pidas.
- The deity is placed in the garbha-griha of Rekha Deul over which rises the spire or 'Sikhara' (Urusringa).
- Here the entire tower which is curvilinear in the shape is called the Sikhara.
- The Hindus regarded the temple as the body of Cosmic Man (Purusha).
- So the lower upright part of the main Deul is known as 'bada' (feet) and the upper tapering part is known as 'chhapra (trunk).
- Over the chhapra, is a large melon shaped feature called 'amalaka' (cap stone) crowned with kalasa (head)-called 'Amrit-kalasa', symboling the Jar of Nectar.
- Similarly the 'Jaga-mohan' has the lower upright part-the 'bada' and upper tapering part 'pida' in the form of a terraced pyramid which is crowned with 'Ghanta-kalasa'.
- Due to the religious ritual developments other buildings were added in front, in one axial line, such as 'Bhog-Mandir' i.e. offering hall in the front , and followed by 'nat-mandir' or Dancing Hall' e.g. The sun temple at Konark, Jagannath Temple at Puri, temple of Vaital, Bharateswar temple, Lingraja temple, Mukteswar Temple at Bhuvaneswar.

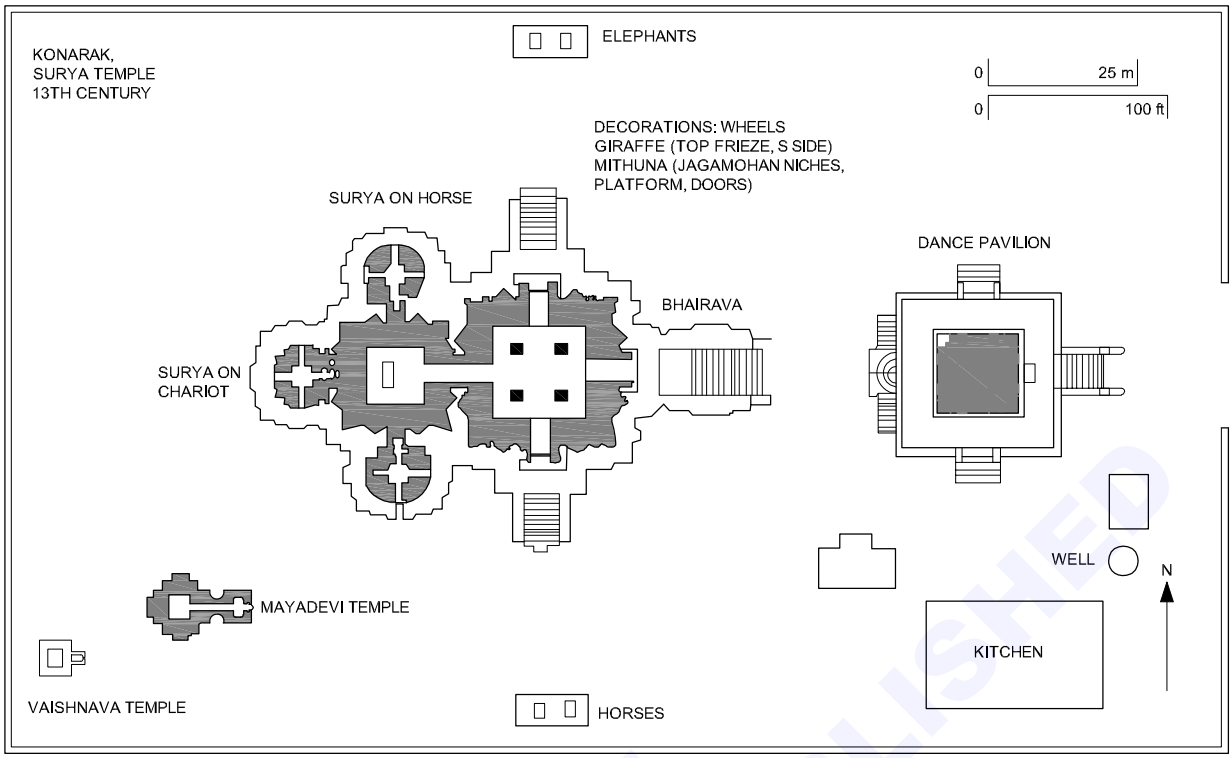
Characteristic features of the sun temple at konark (1250 A.D.) (Figs 1 & 2)

Fig 1



PARTS OF ORISSAN TEMPLE THE LINGARAJA TEMPLE

Fig 2



THE SURIYA TEMPLE

- There are just handfuls of temples devoted to surya, and these are mainly located in the north, west and east of india.
- In 'Sthala Purana' it is mentioned that surya the Sun God rising from the ocean in his chariot of gold cast his shadow on this very spot.
- The magnificient temple was therefore built to glorify , Surya, the Sun God at Konark (Sanskrit meaning Sun's comer).
- The plan of this temple was that of genius and its scale was too great for its execution, hence it was beyond the capacity of the builders to complete it. Even in its magnificent failure, one can see that it was one of the finest artistic creations.
- The temple is formed like a 'ratha' or wheeled chariot being carried by seven horses symbolising the seven rays of the sun that blazes his way through the heaven and preceded by the charioteer Arun.
- The temple resting on a large platform with twelve giant wheels exquisitely carved with erotic sculptures and decorated with medallions on the spokes and hub each nearly 3 m high fixed on either side, was built into two parts consisting of large hall or 'Jaga-mohan' 30.5 m Side and 39 m High and a still larger Deul with its tower rising to a height of 69 m.
- The top 'pida' the pyramidal tower consist of three tiers with series of cornices diminishing at top with wide space between them to accommodate a number of sculptures in bold relief all dancing on musical instruments.
- In order to sustain the weight of the huge 'Kalasa' over the 'pida' the entire ceiling is strengthened with iron grid.
- Nearby there are several colossal groups of sculptures such as a mighty elephant crushing malefactor in its trunk and the two huge statues of war-horses whose impetuosity is controlled by the armed attendants.

Plan of sun temple, konark (Fig 3)

Characteristic features of Lingaraja temple at Bhuvaneshwar (Fig 4)

- The temple had originally only two apartments, the deul and Jaga-mohan, and the Nat-Mandir (dancing hall) and Bhog Mandir (offering hall) are added probably a century or more later, all enclosing in a courtyard measuring 142 m X 158 m.
- The entrance is flanked by two large stone status of lions.
- The most attractive feature of this temple is the great tower of the Deul or Sri Mandir richly built entirely of stone.
- Over it is a necking or beki above which rests the melon-shaped fluted disc or 'amal-sila' and crowned with 'Kalasa'.
- The Shiva linga is said to have emerged from the earth (Bhu) here and hence it is called Bhuvaneshwar.
- In the courtyard there are temples of Parvati, Ganesh, Kartikeya, Balraj, Subhadra and Krishna.

Fig 3

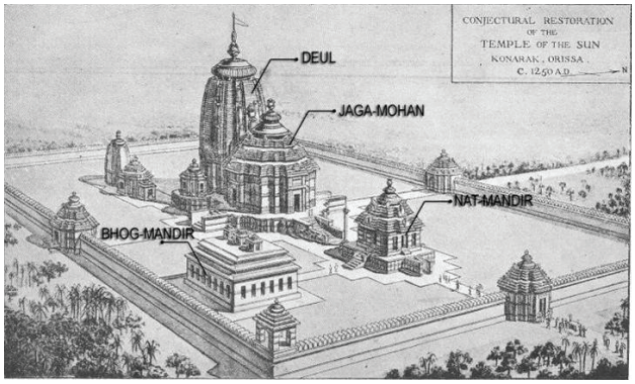


Fig 4

Central Hindu Style

Objectives: At the end of this lesson you shall be able to

- **explain the characteristic features of rock cut cave temples at badami**
- **explain the characteristic features of rock cut cave temples at ellora**
- **explain the characteristic features of ajanta caves**
- **explain the characteristic features of later chalukyan or hoysala architecture.**

Central Hindu style

The architecture falls into the two distinct types

i Rock cut

ii Structural

Characteristic features of rock cut cave temples at badami

- The Chalukyan capital city Badami was protected by the fort wall surrounded by a moat.
- The super superfluous water of 'Agastytirtha' was the sporting place of the royal families.
- Badami was also a religious centre. Goddess 'Banashankari' was the presiding deity.
- But what is most interesting thing from architectural point of view is a series of four cave temples hewn from top to bottom in the scrap of a southern hill called Ranmandal.

i Cave I (Shaiva cave) (Fig 1)

Fig 1

- This cave is hewn on the southern hill and can be reached by climbing about 35 steps.
- This is L shaped cave consists of pillared verandah, a hall and a small square cell hewn deep into the rock.
- The ceiling of the verandah is curved with the huge 'naga' with human form and five hoods.

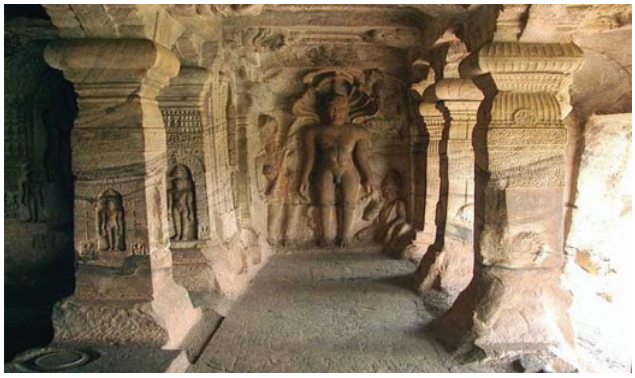
ii Cave II (Vaishnava cave) (Fig 2)

Fig 2

- The cave can be reached by climbing about 65 steps from cave I towards east. Like the first, it all faces towards north.
- The pillars of verandah are carved with bands of ornament and brackets contain animal sculpture 'yalis' supporting the cave of the cave.
- On the eastern wall of the verandah, is a huge image of 'Varaha' - the third incarnation Lord Vishnu holding the 'prithvi' the earth on his snout to save it from legendry oceanic floods. He has kept his left leg on a lotus.
- On the western wall there is a huge sculpture of 'trivikrama' (an incarnation of Vishnu)with eight hands and holds discus, sword, mace and bow.

iii Cave III (Vaishnava cave) (Fig 3)

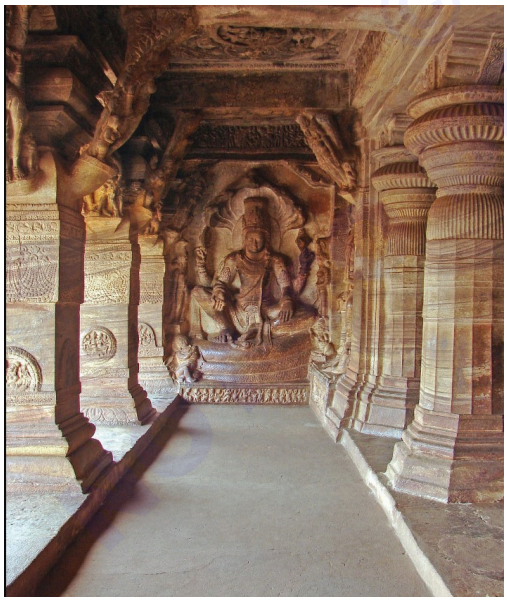
Fig 3



- This cave can be reached by climbing about sixty steps from the cave II toward east, after crossing through the door frame, which contains inscription.
- The inscription states that Mangalesha got excavated this cave. 'Vishnu Griha' and `enshrined the image of lord Vishnu for his elder brother Kirti-Varma in Shaka 500 (AD 578) regarding the first two.
- This cave is about 21m long and 15m deep with high platform, the front face of which is filled with delightful dwarfs playing the musical instruments.
- On the left-wall of the verandah, there is an image of 'Trivikrama' similar to cave II. Just opposite stands a large image of Vishnu with eight hands.

Characteristic features of Caves of Ellora (Fig 4)

Fig 4



- There are seventeen Hindu caves at Ellora with stories from mythology, exquisitively carved into them.
- Cave no. 14 (Ravan ki Khai) depicts the combat between Shiva and the demon Andhakasura; Ravana shaking Kailasha ; cave no. 15 (Dashavatara cave)represents the destruction of Bali the demon king Woman, the dwarf incarnation of Lord Vishnu. But the most famous is the cave no.16, the Kailasa temple.
- The Kailasha temple, Ellora (750-950). The temple stands freely within the excavated basin in the mountain side.
- The island measures about 6-m long 30m wide and rise to about 31m high.
- The main body of the temple measures 46m x 30m long and stands on a lofty plinth 8m high with an entrance from west.
- The cornices, pilasters, niches, and portion of the mandapa are marvellously designed.
- There are five shrines and the stately tower over the main cella rises to a height of 31m in three tiers.
- The cella contains the image of god in the form of lingam . It is said that the course of the river flowing nearby was so ingeniously diverted here that its water fells drop by drop on Shiva lingam for many centuries.
- The cella measures 21m x19m and is supported by sixteen square pillars in a group of four.

Ajanta caves: These caves are about 60km from Jalgaon. The situation of Ajanta is picturesque and romantic. The caves are situated in a horse-shoe-shape valley and spread over a length of more than 500m from east to west wherein flows the small rivulet Waghor. The cave walls are filled with figures of celestial beings, dancers, and deities of the Buddhist pantheon. (Fig 5)

Fig 5

Characteristic features of later chalukyan or hoysala architecture (A.D. 1050-1300) (Fig 6)

Fig 6

- The Hoysala temple consists of plans elaborated into a star-shape stellate plan by means of number of recesses, and offsets.
- This Zig-zag treatment obtained the largest amount of outside surface or facade with comparatively small area.
- The temple stands on jagati or high platforms to serve also as an ambulatory passage.
- The plinth surfaces are exquisitely carved with friezes containing a row of animal sculptures such as horses, elephants, geese etc. tier upon tier.
- The temple consists of three parts, the 'garbha-griha' or womb-house, attached to it is a vestibule or sukhanasi, which connects with a pillared hall called 'Navaranga'.
- In some cases, in front of navaranga an open pillared pavilion or 'nandi-mantapa' or 'mukha mantapa' is provided. The temples have either single or triple cells and are attached to the central mantapa.
- They mainly adopted tabulated style throughout the construction of temples.
- All the Hoysala temples are more refined in treatment of wall surfaces which is specially characteristics of this style.
- The other notable features of this style are the bracket figures called 'madanikas' which depict dainty women dancing, making up, or playing music instruments, surely the acme of romantic aspiration for the female form. The flat ceilings are highly ornate.
- Another outstanding feature is the artistic importance given to the door-ways of main entrance as well as that of inner shrine.
- The moulded lintel and central massive, key-stone of kashivisvesvara Temple at Lakkundi, is carved into a scene of elephants anointing the Goddess laxmi. (Gaja-Laxmi).

South Hindu or Dravidian style architecture

Objectives: At the end of this lesson you shall be able to
- **explain the characteristic features of south hindu architecture**
- **explain the characteristic features of pallava style architecture**
- **explain the characteristic features of chola style architecture**
- **explain the characteristic features of pandya style architecture.**

Dravidian architecture developed its own form and tradition.

Characteristic features of south Hindu or Dravidian architecture (600 A.D)

- Dravidian architecture developed its own form and tradition.
- The early Dravidian temple consists of 'garbha-griha' (womb-house) with a mandapa or the open porch.
- The shrine containing the 'garbha-griha' is crowned with steeply tapering 'sikhara' formed by a horizontal system of storeyed towers, each storey ornamented with cells.
- The mandapa is provided with flatter pyramidal covering.
- The temples were expanded with courtyards called 'prakaras' enclosing tall gate-ways or 'Gopurams' which in due course increased in number.
- Beside these temples, tanks, wells or 'pushkarinis' were constructes.

Dravidian architecture is sub-divided into five styles.

i Pallava style
ii Chola Style
iii Pandya style
iv Vijayanagar style and
v Late pandya style or Madura Style

Characteristic features of Pallava style (600-900 A.D.)

- Rathas are small shrines carved out of a monolithic rock.
- There are series of seven monolithic temples or Rathas chiselled out of big boulders and are widely known as 'Seven pagodas' at Mamallapuram or Mahabalipuram- a city founded on Coromandel Coast, with a flourishing port.
- Entirely carved out of granite rock, they express a novel form of construction.
- The five Rathas now known as Panch Pandav Rathas after the five sons of Pandu, King of Hastinapur; are the most unique in the whole world.
- The other features of this style is "mantapa". There are about ten Mantapas at Mahabali-puram.
- The most important are Mahishasura, Krishna Varaha andDharmaraja Mantapas.
- The Rathas and Mantapas though small in sizes are known for the exceptional character of their design and execution. (Fig 1)

Characteristic features of Shore Temple:

- Amongst the structural or stone built temples, the 'Shore Temple' at Mahabalipuram.
- Its entrance is from the west side of the courtyard. The garbha-griha is enshrined with a large lingam.
- The lingam is made of black marble with 16 sides and perimeter about 2 m.
- The other well-known temple is Shiva temple- the Kailasnath temple at Kanchipuram meaning 'golden city'.
- The temple consists of a sanctuary with pyramidal roof of shikhara, and a massive pillared hall or mantapa enclosed within a rectangular courtyard by high walls.
- On four sides of the central vimana or shrine there are smaller shrines with small shikharas.

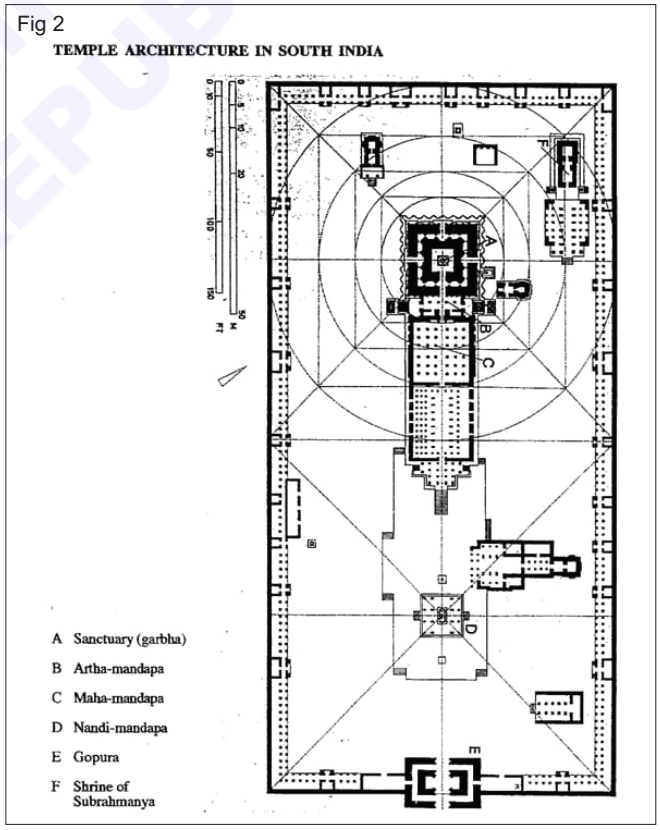
Fig 1

- There is also a large stone 'Nandi'- Shiva's Bull seated on large platform.
- The Nandi measure 1.8 m. high and about 2 m. long.
- The temple of Vaikuntha perumal at Kanchipuram is also noteworthy.
- The third temple of great importance is that of Kamakshi the love-eyed Goddess.
- This one along with temples- Madura, Meenakshi and Kashi Visalakshi- the three well-known goddesses of India are held in high reverence by all Hindus.

Characteristic features of Chola Style (700-1150 A.D.) (Fig 2&3)

- The temple consists of usual compartment such as a pillared hall attached to the vimana or the tower over the sanctum.
- The vimana consisted of series of square receding tiers resembling like a stepped pyramid with a finial or kalasa at top.
- The outer surface is enriched with numerous sculptures mainly high life-size in bold relief in the recesses.
- The dominating elements like the lion, and super-natural beasts were all together avoided.
- The construction developments clearly show that Cholas had begun to form their own architectural style.
- This style achieved maturity which can be easily observed in the Brihadeshwar temple of Tanjavur built in 1000 A.D. by Raja Chola.
- The main features of this temple are sanctuary, the cella, attached to it is 'Nandimantapa', a pillared portico and a large assembly hall.

Fig 2



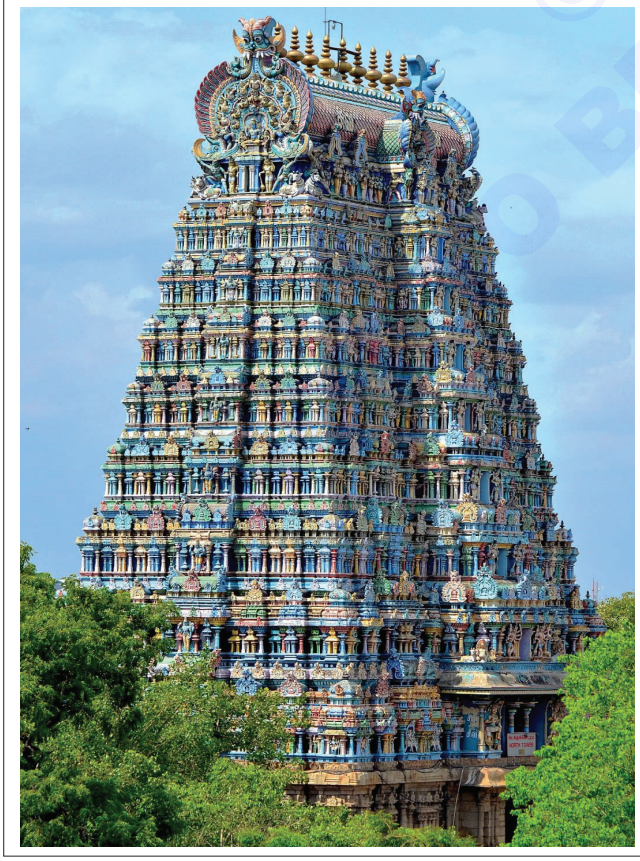
- The giant Nandi measures 4m high and 5m long.
- The most outstanding feature of this temple is the grand tower or the vimana.
- The Tanjavur vimana, though huge in size, is so beautifully proportioned and delicately balanced that it appears hanging in the air like a glittering star.

Fig 3

Characteristic features of Pandya Style (1000-1250 A.D.) (Fig 4)

- The temples were laid on the usual plan but now they were surrounded by high enclosures to emphasize their sanctity, and providing entrances to the enclosures in the form of gate-ways- 'Gopuram' of imposing size and elegant appearance.
- The Gopuram is derived its name from the 'Cow-Gate' of Vedic village, which afterwards became the City-Gate and finally the monumental 'Gopuram' over the main entrance or 'Mahadwar' of the temple.
- This Gopuram is the outstanding feature of this style.
- The Gopuram is a grand piece of artistic workmanship of remarkable details and measures the nearness to God by the visual height of the shikhara.

Fig 4



- The Gopuram with its shikhara soaring high in the sky was the crowning glory of this style.

Characteristic features of The Temple of Madura (1623 A.D) (A sign of surpassing beauty)

- The entrance to the temple is through the Gopuram on the east side which leads to the spacious avenue of Vir Vasantha Raya Mantapam the pillars of which display sublimity and grandeur.
- A small Gopuram leads to the second prakaram which measures 95 m wide and 128 m long.
- The image of Sundareshwar is enshrined in the last enclosure, which consists of three compartments, an assembly hall, a vestibule and the cella over which a small shikhara is provided.
- The temple of Meenakshi measures 46 m x 68 m. Its entrance is by a gateway through a painted corridor about 9 m long known as 'Ashta Shakti Mantapam' so called because after the eight statues of Goddess which support its roof on either side.
- Next comes the 'Meenakshi Nayakar Mantapam' constructed by Meenakshi Nayak, the Diwan of predecessor of Tirumalai Nayak.
- To the south-east of the Meenakshi temple, there is a 'Swarna Pushkarani' or 'Pool of Golden Lilies' an artificial tank for ritual ablution measuring 36 m x 50 m in the second enclosure and surrounded by an elegant pillared colonnade.
- The gopurams are the most outstanding feature of the south Indian temples. The gopurams were covered with multicoloured sculptures.

Temple of Khajuraho

The Khajuraho Group of Monuments are a group of Hindu and Jain temples in Chhatarpur district, Madhya Pradesh, India. Most Khajuraho temples were built between 885 CE and 1000 CE by the Chandela dynasty. Historical records note that the Khajuraho temple site had 85 temples by the 12th century. Of the surviving temples, the Kandariya Mahadeva Temple is decorated with a profusion of sculptures with intricate details, symbolism, and expressiveness of ancient Indian art. All temples, except one (Chaturbhuja) face the sunrise - another symbolic feature that is predominant in Hindu temples. The relative layout of temples integrate masculine and feminine deities and symbols highlight the interdependence. The artworks symbolically highlight the four goals of life considered necessary and proper in Hinduism - dharma, kama, artha and moksha.

Of the surviving temples, six are dedicated to Shiva, eight to Vishnu and his affinities, one to Ganesha, one to Sun god, three to Jain Tirthankars.

An overall examination of site suggests that the Hindu symbolic mandala design principle of square and circles is present each temple plan and design. Further, the territory is laid out in three triangles that converge to form a pentagon. Scholars suggest that this reflects the Hindu

symbolism for three realms or trilokinatha, and five cosmic substances or panchbhuteshvara. (Fig 5a, 5b)

Fig 5a

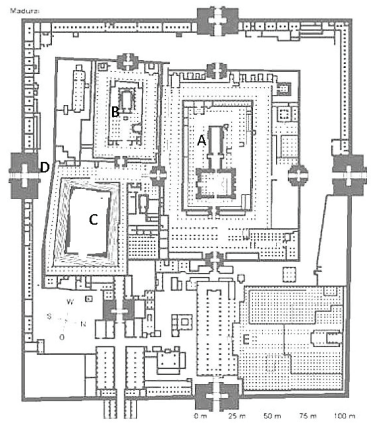
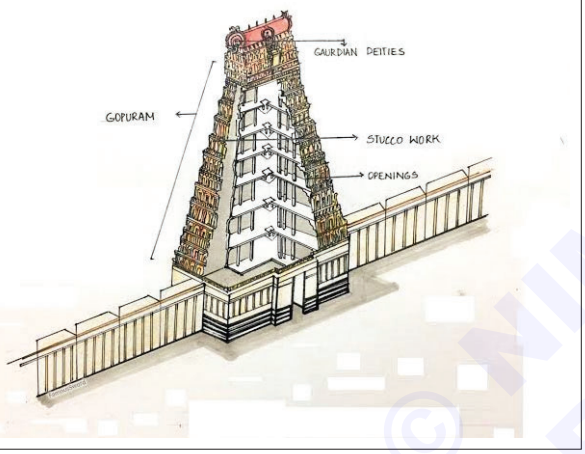


Fig 5b



Plan of Kandariya Mahadeva Temple (Fig 6)

1 Ardha mandapa
2 Mandapa
3 Maha manadapa
4 Antarala
5 Garba griha
6 Pradakshina
7 Transepts
8 Jagati
9 Subsidiary shrines

Khajuraho temples, almost all Hindu temple designs, follow a grid geometrical design called vastu-purusha-mandala. Mandala means circle, Purusha is universal essence at the core of Hindu tradition, while Vastu means the dwelling structure. (Fig 7)

Fig 7

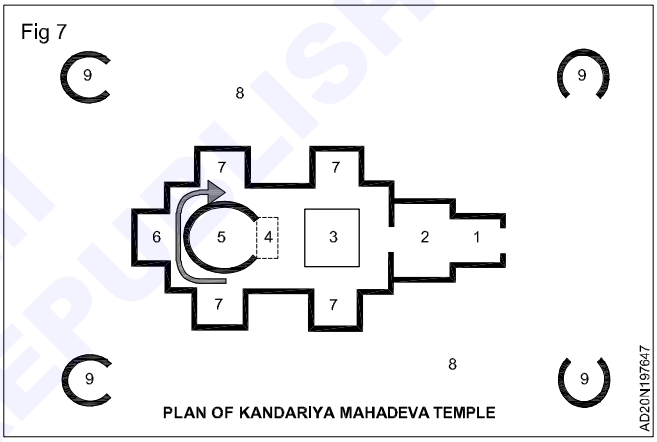
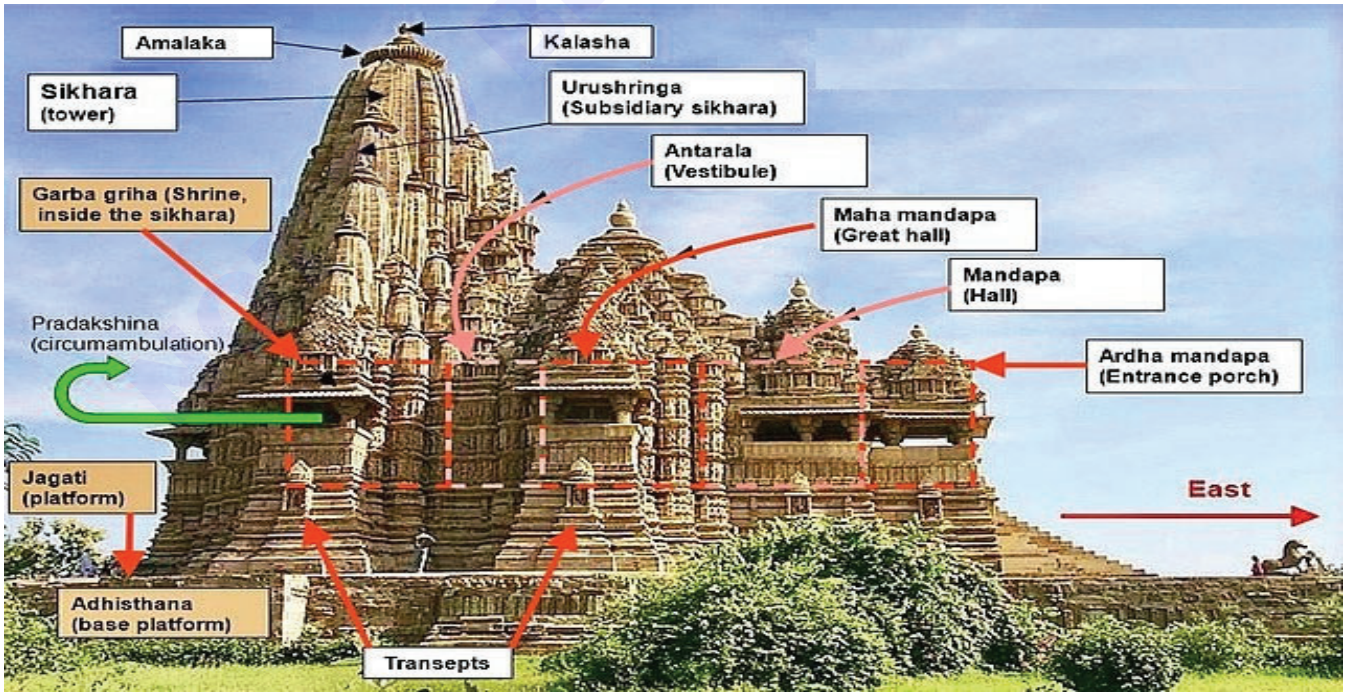


Fig 6



The design lays out a Hindu temple in a symmetrical, concentrically layered, self-repeating structure around the core of the temple called garbhagriya. The shikhara, or spire, of the temple rises above the garbhagriya. The circle of mandala circumscribe the square. The square is considered divine for its perfection and as a symbolic product of knowledge and human thought, while circle is considered earthly, human and observed in everyday life (moon, sun, horizon, water drop, rainbow). Above the vastu-purusha-mandala of each temple is a superstructure with a dome called Shikhara (or Vimana, Spire). In each temple, the central space typically is surrounded by an ambulatory for the pilgrim to walk around and ritually circumambulate the Purusa and the main deity.[30] The pillars, walls, and ceilings around the space, as well as outside have highly ornate carvings or images of the four just and necessary pursuits of life.

Egyptian Architecture

Objectives: At the end of this lesson you shall be able to

- **explain the characteristic features of egyptian architecture**
- **explain the characteristic features of pyramids and the great pyramid of cheops at giza**
- **explain the characteristic features of great sphinx of chepheren.**

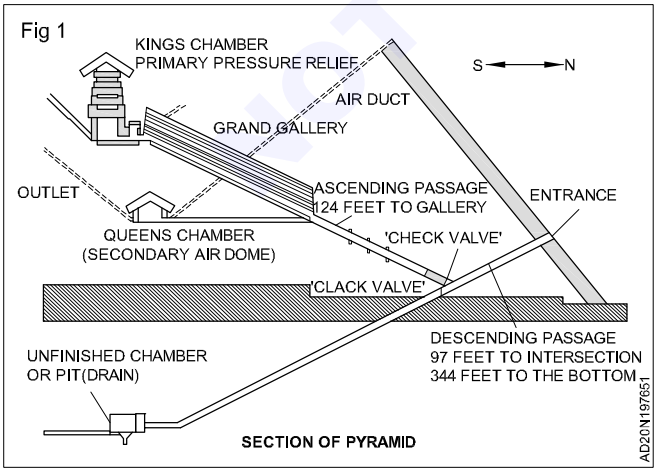
Formation and Development of Egyptian architecture

- The Nile, the longest, mightiest, life giving river is the conduit of ancient culture and essence of Egypt.
- Its green valley is the cradle of civilisation.
- The availability of building materials determines the character and style of architecture.
- It is remarkable to note that only the temples and tombs were built with stones whereas all the houses even the palaces were built with unbacked bricks.
- Egyptian literature has been preserved on papyrus plant and tablets.

Characteristic features of Pyramids

- These are built only for the Pharaohs as massive and impregnable tombs.
- The finest and the most geometrically pure form was attained such at Giza.
- The pyramids were enclosed by high massive walls and within them were a temple for worship, a chapel for offering, a small cause way over the canal to connect the Valley Building with the river 'Nile' by which the royal funeral procession usually arrived.
- The dead body of the kind was preserved in the sarcophagus by mummification. (Fig 1)

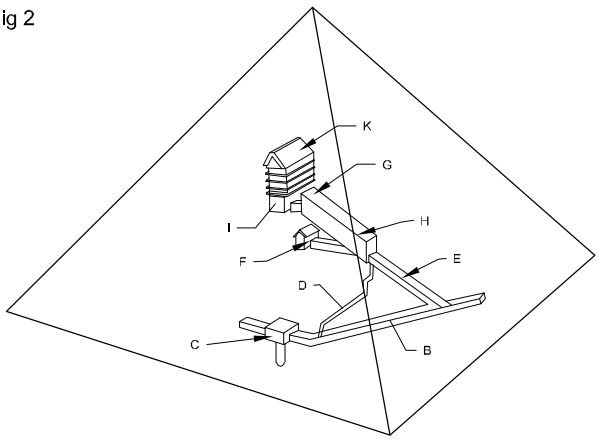
Fig 1



Characteristic features of The Great Pyramid of Cheops at Giza (C.2723-2563 B.C.) (Fig 2)

- This pyramid is built outside the Memphis's city near Cairo for Cheops also known as Khufu, the Second King of Fourth Dynasty.
- The pyramidal base measures 230.5 m X 230.5 m and thrusts 146m into sapphire sky.
- The four faces form roughly equilateral triangles and their sides make an angle of 51o52' with the ground.
- The pyramid is built in solid stones with a casting of finally dressed Tura lime stones and the apex stone was once coated with gold.
- And the most notable thing is that the Egyptians worked with such precision that "neither needle nor hair" could be inserted at the joints of the lime stone casing blocks.
- From north, an entrance is provided nearly at a height of 17 m from the ground through which a small corridor is built.
- The ascending corridor is widened into a large passage which is now well-known as the 'Grand-Gallery'.

Fig 2



- At the end of the Grand Gallery is the King's Chamber where, the granite sarcophagus is placed.
- The King's Chamber 10.36 m long, 5.23 m wide and 5.8 m high is lined with granite and covered with five tiers of stone beams raising to a height to a height of 21 m from the floor.
- Two air-shafts about 20 cm X 15 cm are provided from outer faces of the pyramid to the King's Chamber t server as ventilation as well as a free passage for the 'Ka'-the spirit of the deceased Pharaoh.
- Similar air-shafts are also provided in the Queen's and underground chambers
- This tombs of Pharaoh took nearly one lakh workers two full decades to build. It is the largest stone building in the ancient world with more than two million lime stones and granite blocks each weighting about two to three tonnes.

The Great Sphinx of Chephren (before 2600 B.C.) (Fig 3)

- It is a colossal monster carved out of a single rock lying a little to the northwest of Valley Building of King Chaperon also known as Khafra.
- It has a body of a recumbent lion and head of Chephren, the king in Fourth Dynasty, wearing the royal head-dress a false beard and sacred cobra-brow ornament.
- The Pharaoh himself is represented as a mysterious protector of God gazing as the rising sum.
- The colossal statue is 20 m high 73.17 m long, and the face itself measures 4.12 m.
- The smallest toenail is large enough for a man to sit on.

Fig 3

GREAT SPHINX OF CHEPHREN

AD20N197653

Greek architecture(650 B.C. - 30 B.C.)(Preceded by Aegean Circa 3000 - 1100 B.C.)

Objectives: At the end of this lesson you shall be able to

- **explain the formation and development of greek architecture**
- **explain the proportioning of greek classic orders**
- **explain the characteristic features of the greek doric order**
- **explain the characteristic features of the greek ionic order**
- **explain the characteristic features of the greek corinthian order**
- **explain the characteristic features of the temple of parthenon at athens**
- **explain the characteristic features of the olympia stadium.**

Formation and Development of greek architecture

- The 'Aegean' culture was started on 'Crete' an island in the Mediterranean Sea in about 3000 B.C by the migration of the people from Asia Minor.
- After the fall of 'Aegean' its culture was extended to Greece and its islands centuries later.
- Greece and her islands had plenty of building materials. But amongst them, the building stone of great importance was the unrivalled marble which was plenty near Athens.
- The Greek temples were usually oriented towards east so that the statues of the deities were lit by the glory of the morning sun.
- The Greeks were democratic and women played important role in social life. The idea was based on individual freedom.
- Greeks' national games and festivals encouraged literature, music and drama.

Proportioning of Greek classic orders

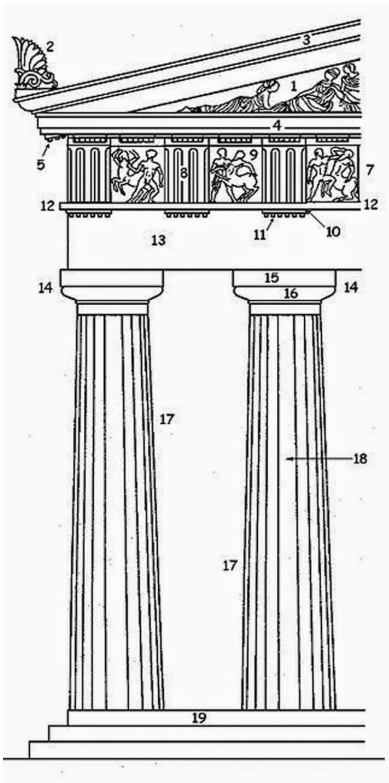
The following table shows the proportioning of the Greek-Orders.

Name of order Greek order	Height of Column in terms of lower diameter	Height of Entablature in terms of ower diameter
Doric	7	2
Ionic	9	2
Corinthian	10	2 ¼

The Greek Doric order (Fig 1)

The word Doric comes from Dorians, the people of ancient Greece. The Order is taken from the famous Temples of Parthenon at Athens.

Fig 1



Parts of an Ancient Greek temple of the Doric Order:

1. Tympanum,
2. Acroterium,
3. Sima
4. Cornice
5. Mutules
7. Frieze
8. Triglyph
9. Metope
10. Regula
11. Gutta
12. Taenia
13. Architrave
14. Capital
15. Abacus
16. Echinus
17. Column
18. Fluting
19. Stylobate

GREEK DORIC ORDER

a Columns

- The column height is six to seven times its lower diameter 'D'.
- The Column has no base but stands directly on a platform of three steps called crepidoma.
- The shaft is circular and gradually tapers to ¾ to 2/3 at top.
- The shaft in its length is divided into 20 flutes i.e. elliptical channels or grooves, separated by sharp projections or Arises.
- The 'Inter columniation 'or centre distance between two adjacent columns measured at the lower diameter of their shafts is 2D.
- The distinctive capital which is semi-diameter high consists of 'Abacus' and 'Enhinus'.

b Entablature

- The entablature which is two diameter high, consists of three parts ,namely 'Architrave', 'Frieze' and 'Cornice'.

Architrave

It is lintel proper which is plain and 3/4 d in height. The architrave projects slightly beyond the face of the columns.

Frieze

- The frieze which is ¾ 'D' high contains 'Triglyph' and 'Metope'.
- The triglyph is formed by two upright v- shaped channels with similar half channels on both ends which are rounded at top. The width of triglyph is usually one module.
- The triglyph are so arranged that the spaces between them are nearly 'squares'.
- These squares are called 'Metopes' which unlike the triglyphs are set back from the face of architrave as they generally contain sculptures of hunting, fighting.

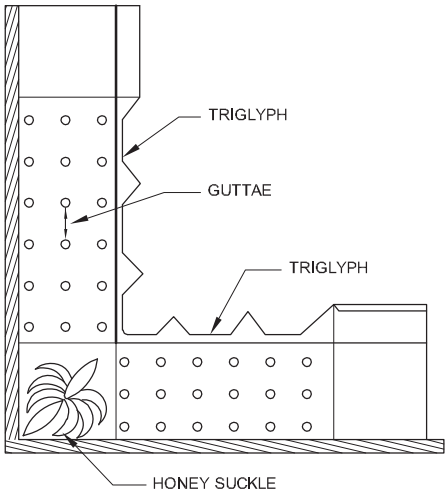
Cornice (Fig 2)

Fig 2

ANTEFIEXA ORNAMENT

- It is the crowning part. It is semi- diameter high.
- It has at top the curved shaped slab called 'Cymatium' or a gutter - moulding resting on a birds beak and below this is corona or vertical face.
- The cornice projects beyond the frieze by one module.
- The Greek Doric is the oldest of the orders and is most sturdy, robust yet it has grace and fine proportion. This was Greek's national order. (Fig 3&4)

Fig 3



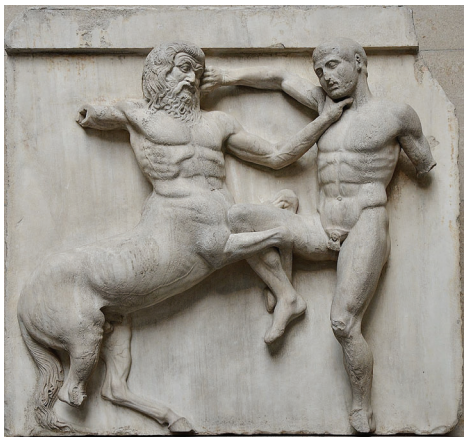
SECTION LOOKING UP THROUGH CORNER TRIGLYPH

The Greek Ionic Order: This order is named after the Ionians of ancient Greece. The order is taken from the temple of "Erechtheion" built in the year 409 B.C. (Fig 5&6)

a Column

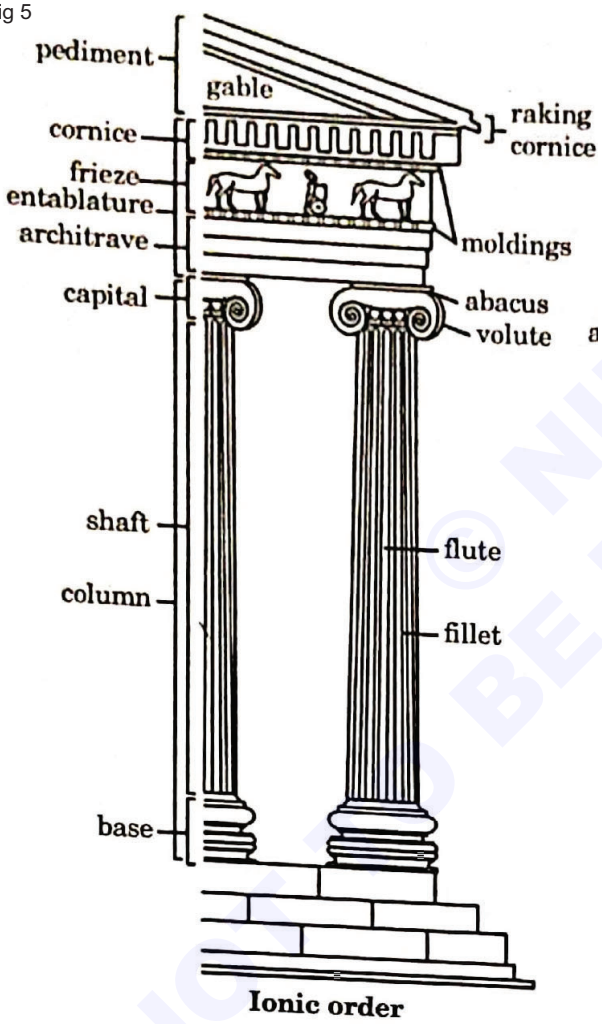
- The column has a base. The column height including base, shaft, and capital is usually nine times the lower diameter.

Fig 4



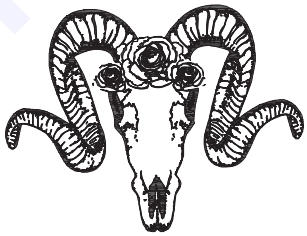
METOPE FROM PARTHENON

Fig 5



Ionic order

Fig 6



HORNS

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- The moulded base which is semi diameter in height consists of upper and lower 'torus' separated by 'Scotia' and fillets.
- The circular shaft has 24 flutes separated by fillets and not by arises as in Doric order.
- The shaft diminishes to $\frac{5}{6}$ the diameter at its top.
- The Inter-columniation is 4D.
- The Capital which is ¾ to $\frac{2}{3}$ diameter high has a pair of volutes both on the front and back of the column and connected at sides by the concave cushion either plain or ornamented, with flutes, fillets and beads.

b Entablature

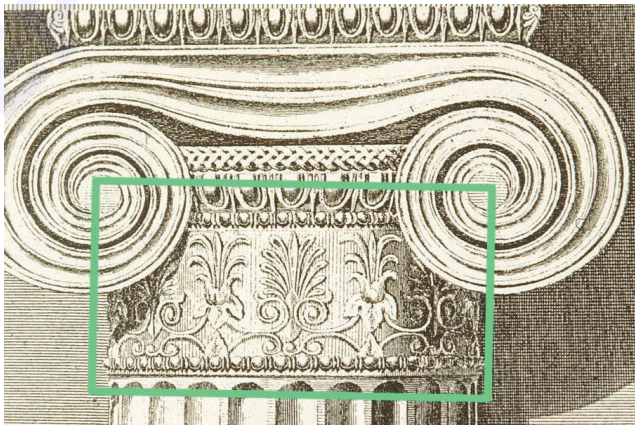
The Ionic entablature varies in height but is usually about two diameter high. It consists of the following:

Architrave: It is ¾ diameter high. It consists of triple fasciae i.e. three beams projecting one above the other. The top cyma reverse contains 'leaf and dart' ornament.

Frieze: It is either plain or ornamented by a continuous band of sculpture. It is ¾ diameters high.

Cornice: It is semi -diameter high. It is also carried along the side cornices and rain water spouts in the shape of lion's heads are provided at regular intervals to drain out the rain water from the roof. The Greek Ionic Order is more ornate than the Doric. It has grace, Elegance and refinement of outlines. (Fig 7&8)

Fig 7



HONEY SUCKLE ORNAMENT AT IONIC ORDER

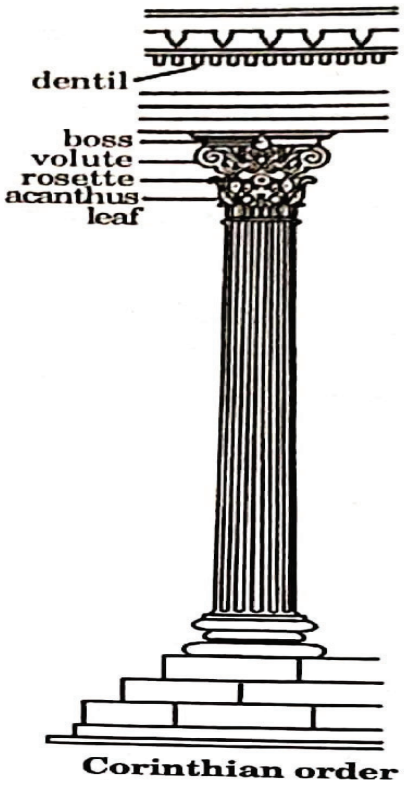
Fig 8

RAINWATER SPOUT

The Greek Corinthian Order

The order is taken from the 'Choragic Monument of Lysicrates.' (Fig 9)

Fig 9



a Column

- The column including base, shaft and capital is about ten times its lower diameter in height.
- The base is semi-diameter high like the Ionian Order with its upper and lower torus separated by Scotia and Fillets.
- The lower torus is 1? times the diameter of the shaft. It has 24 flutes separated by fillets, which are nearly one- fourth of the width of the flutes.
- The intercolumniation is 3D.
- Usual type of capital has a deep inverted bell shape, the lower part of which contains two rows of eight acanthus leaves resting on lotus or water leaves and in the upper part rise eight 'caulicles' (caulis=a stalk) in between the leaves of the upper row.

B Entablature

The Corinthian entablature which is usually 2 ¼ diameter high bears a close resemblance to the Ionic Order. It contains the following:

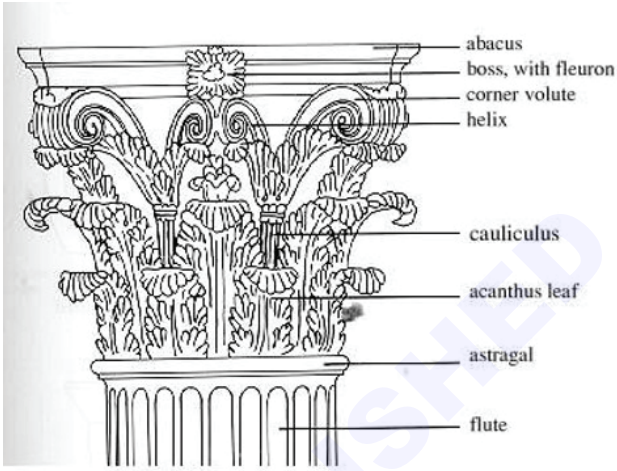
Architrave: It is ¾ diameter high and is divided in three fasciae i.e. three slabs raised one above the other with slight projections.

Frieze: It is also ¾ diameter high and ornamented by a continuous band of sculptures.

Cornice: It is lighter than other types. It is also ¾ diameters high and contains dentils below the corona. At top 'antifixal' ornament is provided.

The Greek Corinthian Order was chiefly used as a decorative feature and was little used by the Greeks. This order is more lighter and delicate than either the Doric and the Ionic. (Fig 10)

Fig 10

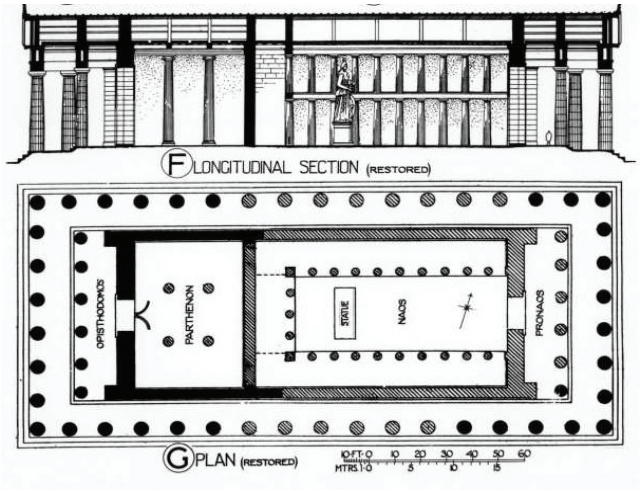


Corinthian Capital

Characteristic features of the temple of Parthenon at athens (447-432 B.C.)

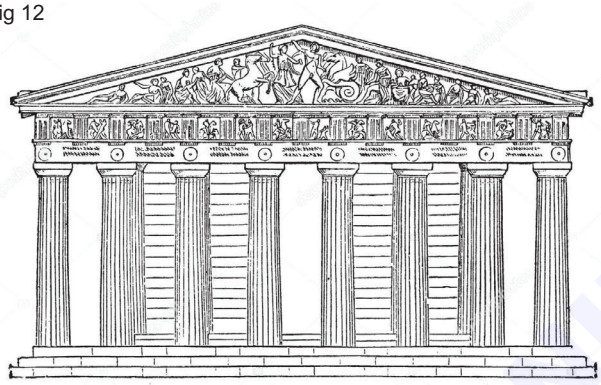
- The temple is built entirely in pentelic marble on the high ground Of Acropolis, south of Temple of Athena (old) and dedicated to Athena Parthenos the virgin Athena.
- It is constructed by the architects Ictinus and Callicrates under the supervision of master sculptor Pheidias.
- The temple is built on rectangular plan 71m (228'2") long and 32m (101-4") wide.
- It stands on crepidoma, a platform of three steps with tread 70 cm and rise 50 cm and curve up in the middle of all the four sides.
- The temple is designed in octa-style i.e. eight columns in front and back, which lean inward.
- There are seventeen columns on either side measuring the corner columns twice.
- The temple is constructed facing east so that the first rays of the rising sun should fall and illuminate the statue of Athena, which is placed in 'naos' measuring 30m long, 19mwidewith three rows of columns, ten on each side and five on western side in two tiers.
- The statue of Athena in gold and ivory with eyes of precious stones was the finest sculptural achievement of master artist Pheidias.
- The statue measured 13 m with its pedestal.
- The temple at its glory stood as a miracle of architecture with its shining marble, sensuous sculpture in glowing colours.

Fig 11



PLAN AND SECTION OF PARTHENON (RESTORED)

Fig 12



ELEVATION OF PARTHENIN (RESTORED)

Characteristic features of Olympia stadium (Fig 13)

- All the Greek's games were celebrated at Stadiums.
- The stadium had a length of 183 m with hemi-spherical ends, and rows of seats were raised on either side for spectators.
- The oldest one is at Olympia.
- The Olympic games were conducted for five days, the first day was devoted to ceremony and taking Olympic oaths etc. on the second day, a flame was lit on a sacrificial altar and various sport events were conducted, such as chariot race, horse race, Pentathlon-a multiple event testing five skills in running, long-jumping, javelin throwing, discus throwing, wrestling; and Pankration (all in wrestling).
- The last and fifth day was reserved for declaration of the winners and distribution of prizes.

Fig 13

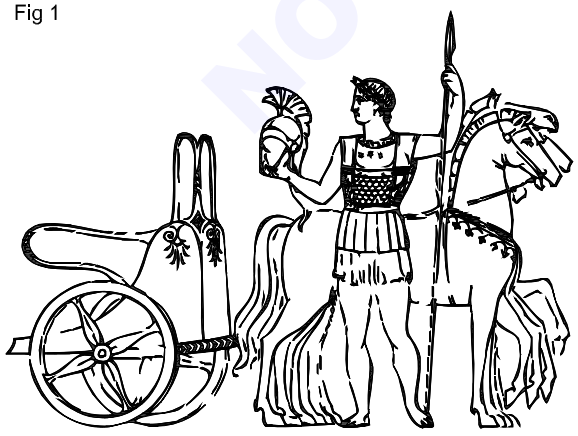
Roman architecture(300 B.C. - AD 365) (Preceded by Etruscan 750 - 100 B.C.)

Objectives: At the end of this lesson you shall be able to
- **explain the formation and development of roman architecture**
- **explain the characteristic features of the temple of saturn at rome(A.D.284)**
- **explain the characteristic features of the pantheon at rome**
- **explain the characteristic features of basilica of trajan at rome**
- **explain the characteristic features of the coliseum at rome.**

Formation and Development of roman architecture

- The ancient capital Rome founded near river Tiber was protected by seven surrounding hills.
- The country is located centrally in Europe and is very mountainous.
- The coast was not indented like the Greece. Under these marked geographical differences, the architecture developed with different characters.
- The Romans art and culture spread over Europe, Western Asia and Northern Africa which later on came under the Roman Empires.
- The most important material that helped to build huge gigantic buildings of Rome was the Lime concrete.
- It was largely used not only for vault and domes but also for walls, roads etc. the "pozzolana", a volcanic earth, was readily available near Pozzuoli.
- The Roman's were empire builders.
- They did not merely depend on colonization but conquered many parts of the world.
- Roman's were pioneers of road construction.
- For them roads were primarily a military importance for the movement of their army and chariots.
- Romans were not only builders, warriors but also skilled sportsmen, as is evident from the construction of stadiums, and circuses. (Fig 1)
- Their love for luxury finally contributed to the fall of rome.

Fig 1



ROMAN CHARIOT AND SOLDIER

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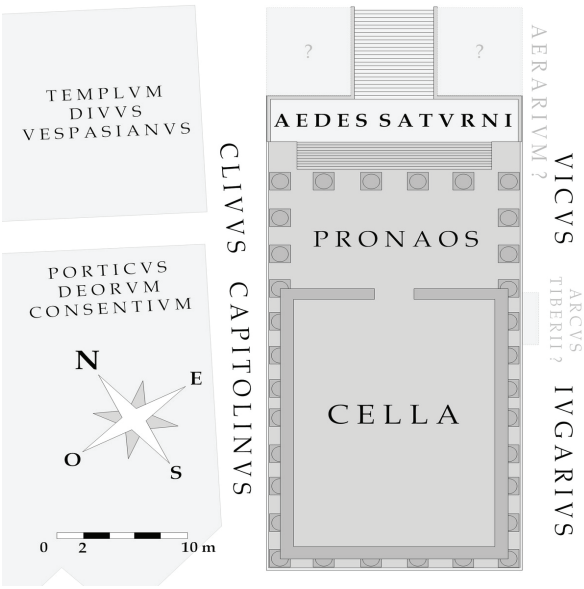
Characteristic features of temple of Saturn at Rome (A.D. 284)

- The temple is rectangular in plan and stands on a podium i.e. a continuous pedestal of 3.7 M high, approached with a colonnaded portico of granite columns 12M high with no. of steps.
- The cella or main chamber of the temple is rectangular in plan measuring 16.7M wide and 24.4M deep.
- The temple is designed in hexastyle i.e. with six columns in front portico, 3 on each side counting the corner column twice and the remaining column over cella is pseudoperipteral or constructed in the walls.
- The columns are of Ionic order and the capital consists of typical spiral volutes scrolls showing on all four sides.
- The entablature is 2.4 M high .the pediment consists of floral design with ornamental status at the top and at ends. The tympanium in the pediment contains sculpture.

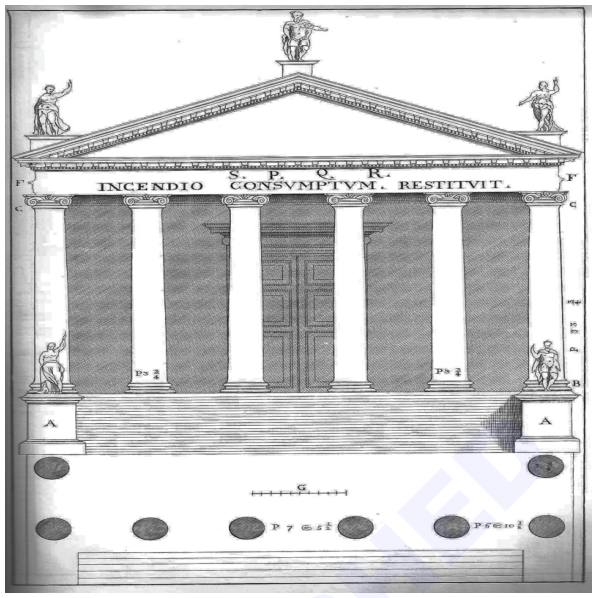
Characteristic features of the pantheon at Rome (Fig 2)

- This is circular in plan 44M in diameter with a colonnaded portico in front.
- The octa-style portico is 33.5M wide and 18M deep in the centre, which forms the entrance to the circular temple.
- The temple bears the inscription as" M.Agrippa made me" though Hadrian had also been the architect for this structure.
- The monolithic granite columns are of corinthian order, unfluted and 1.5 M in diameter and 14M high.
- The column supports the entablature 3.35M high and a pediment containing once the bronze relief representing a 'gigantomachy' or battle of the titans and other deities.
- Behind the portico are the niches where the large status of Augustus and Agrippa where erected.
- There are two monolithic marble columns 10.6M high in the site exedrae except that opposite the entrance.
- The Pantheon is outstanding example of Romans skillful construction and the right use of the materials for the right purposes.

Fig 2



(a)



(b)

- The hemi-spherical dome is provided with coffers in five ranges which not only provide ornamentation but also help in reducing its heavy weight.
- A circular unglazed opening of 8.23 M in diameter is provided at the top of the dome, for lighting of the building, which provides attractive an impressive effect.(Fig 3&4)

Fig 3

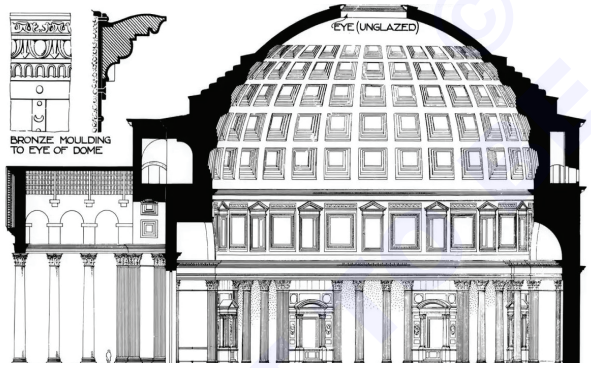
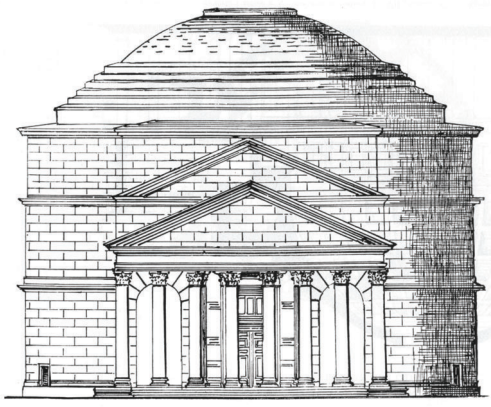


Fig 4

Characteristic features of basilica of Trajan at Rome (A.D.98-112) (Fig 5,6,7)

- The name basilica comes from Greek word meaning royal.
- So it may have come to Rome from Hellenistic regal pomp.
- These basilicas are known as halls of justice. These were also used for commercial services.
- The usual plan is rectangular twice as long as its width with apsidal ends.
- The entrance for the basilica was through a portico from Trajan's forum adjoining it were Greek and Latin libraries with the famous Trajan's column 35M high in an open court between them.
- The peristyled enclosure consisted of a central nave 56.5M wide and 118M long with double aisles each 7.3 M wide.

Fig 5



- The basilica was about 40M high. The columns of red granite with white marble Corinthian capitals supported the galleries over the side aisles.
- At the apsidal ends were tribunals on raised dias around which were seats for Praetor or judges and accessors and in front was Altar where sacrifice was offered before transacting business.

Fig 6

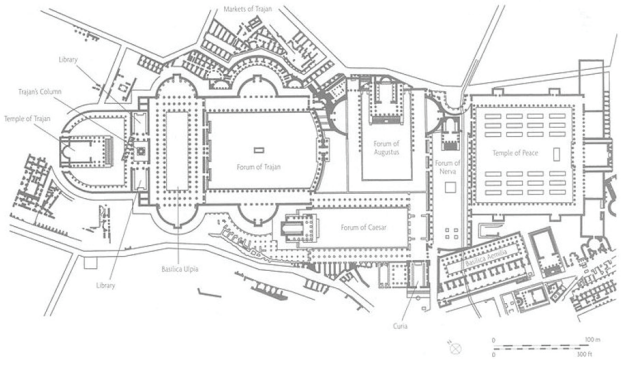
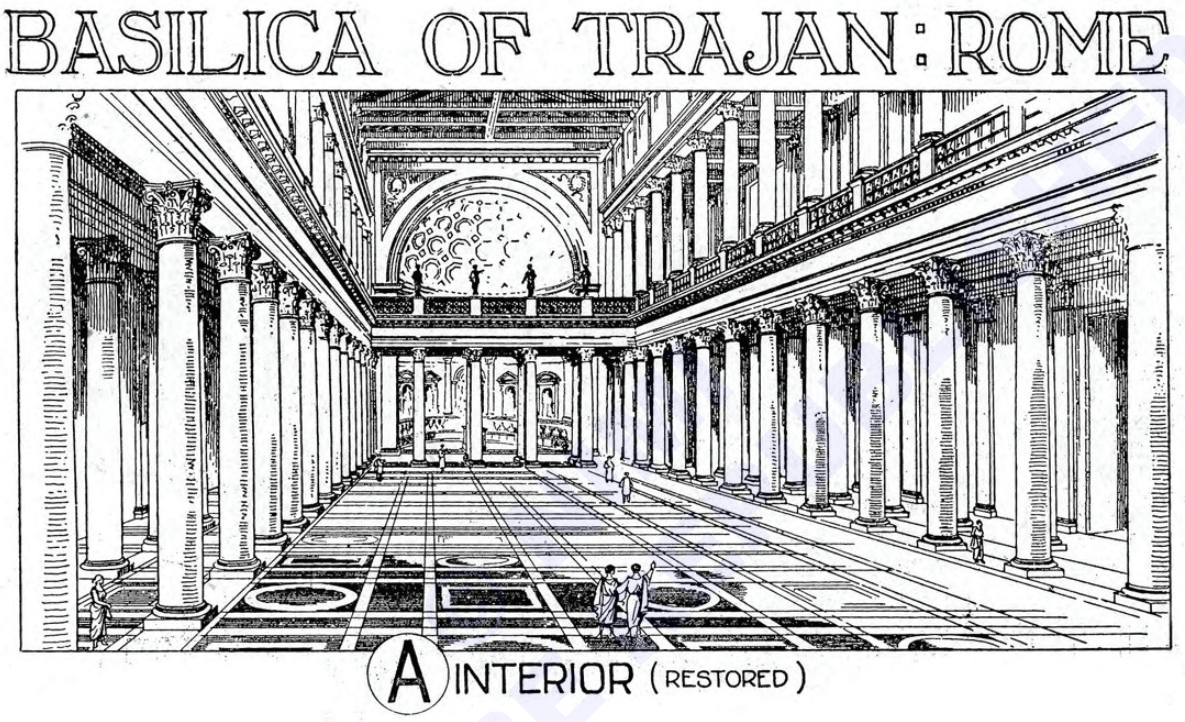
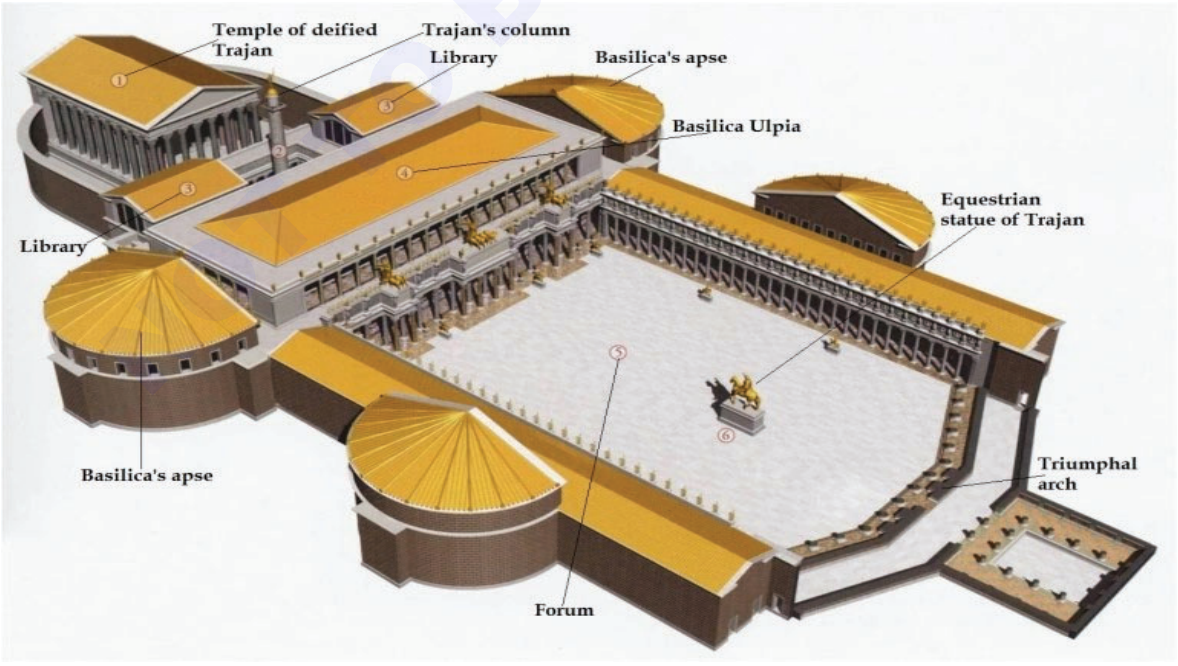


Fig 7



(a)



(b)

Characteristic features of coliseum or colosseum at Rome (A.D.70-A.D.82) (Fig 8,9,10)

- It is so called because of its size and also its close proximity with a colossal statue of Emperor Nero. o It is also known as Flavian Amphitheatre so called because it was built by Flavian Emperors.
- The external facade, about 48 M high was divided in four storeys, each one had 80 external arch opening.
- The entrance was from the ground floor to various tiers of seat.tha main arena was oval shaped measuring 87M x55M enclosed by a wall 4.5M high.
- Behind it was a podium with imperial throne for Emperor and seats for Generals.
- Beyond the podium, an auditorium was constructed on a rising platform with seats in four divisions for about 50000 spectators, all of which were reached by stairs from the surrounding corridors placed at regular intervals between the radiating vaults.
- Dens for wild beasts from one end and for gladiators from opposite end were provided in its lower tier at the level of the arena.
- The structure was enormously thick and weighty. So it was honeycombed at regular interval by empty shafts and to lighten its bulk it was ingeniously sub-divided by a web of infixed brick arches.
- The radiating concrete vaults were hidden support and formed the indestructible foundation of the four storeys.
- Those entire gigantic edifices based on a unique set of highly developed technique of great strength was very difficult to destroy.
- It were therefore rightly said "when the Collosseum, Rome falls shall fall".

Fig 8

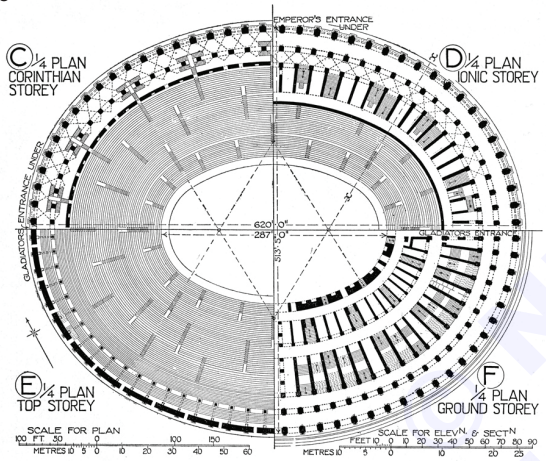


Fig 9

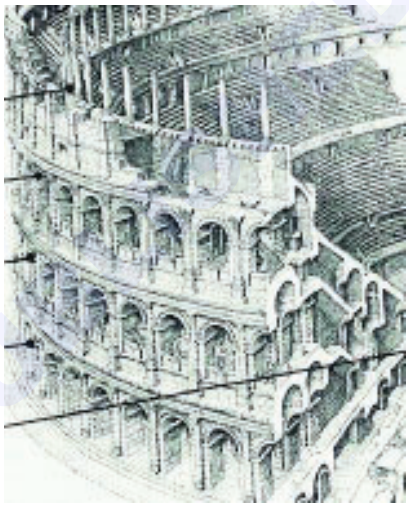


Fig 10