GOVERNMENT OF TAMIL NADU

HIGHER SECONDARY FIRST YEAR

VOCATIONAL EDUCATION

Basic Civil Engineering

THEORY & PRACTICAL

A publication under Free Textbook Programme of Government of Tamil Nadu

Department of School Education

Untouchability is Inhuman and a Crime

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Government of Tamil Nadu

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Preface

This book on "Basic Civil Engineering" has been written entirely based on new syllabus framed by TNSCERT. The subject matter is explained in a simple and lucid language, lightened by sufficient colourful diagrams, illustrations with learning objectives.

In each chapter, Quotes, Activities, "Do you Know" and web search links were given which enhance the students knowledge. QR Codes for the tough area of the subject were marked. This will help the students to understand the subject further in detail. A set of Model Questions were also included at the end of each unit.

Case studies which were included at the end of this book would be useful to motivate the students and also give an idea about the diversity of their course.

I extend my sincere thanks to the Director, Joint Director and Staff members whose patronage on this book to come out and the committee of learned Teachers who shouldered the responsibility to bring the book in good shape.

Despite all our efforts, some errors and minor mistakes might have crept in. Your positive suggestion, regarding the improvement of this book will be thankfully acknowledged.

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HOW TO USE THE BOOK

Learning Objectives	Learning objectives are brief statements that describe what students will be expected to learn by the end of school year, course, unit, lesson or class period
Chapter Outline	Illustrate the complete overview of chapter
	Amazing facts, Rhetorical questions to lead students to Engineering inquiry
Activity	Directions are provided to students to conduct activities in order to explore, enrich the concept
Infographics	Visual representation of the lesson to enrich learning
Evaluation	Assess students to pause, think and check their understanding
	To motivate the students to further explore the content digitally and take them in to virtual world
Career corner	List of professions related to the subject
References	List of related books for further details of the topic
Web links	List of digital resources
Glossary	Explanation of Engineering terms
Competitive Exam questions	Model questions to face various competitive exams

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Career Guidance

Vertical Mobility - Higher Education

After completion of Basic Civil Engineering Vocational Group students are eligible

* To join Bachelor degree in Engineering in any discipline in Engineering Colleges.
* To join Bachelor degree in Architecture.
* To join directly in second year Diploma Engineering in polytechnic colleges in any discipline.
* To join AMIE through Distance education which is equal to Bachelor in Engineering.
* To join Diploma in Teacher Education.
* To join B.Sc Mathematics.
* To join B. Com., B.A., B.B.A., B.C.S., B.C.A., etc.
* To join B.L, L.L.B., (Law Courses).
* To join Diploma and B.Sc. in Catering Technology.

Horizontal Mobility (Employment/Self Employment)

Employment

Join as Apprentice Trainee/Site Supervisors in reputed companies like

* L & T Construction pvt ltd.
* Various private construction companies.
* As CAD Draughtsman in Architectural offices.
* As field surveyor.
* As quantity surveyor.

Self-Employment

* After getting sufficient knowledge in this field, can do Building Construction Works individually.

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Competitive Exam

* TNPSC – www.tnpsc.gov.in
* Railway Recruitment Board (RRB) www.Indainrailways.gov.in
* Indian Navy – www.indiannavy.nic.in
* Indian Army – www.indiannavy.nic
* Indian Air Force – www.indianairforce.nic.in
* Indian Coast Guard – www.joinindiancoastguard.gov.in
* Tamilnadu Uniform Service Recruitment Board – www.tnsrb.gov.in
* Central Reserve Police Force (CRPF) www. http://crpf.nic.in
* Indian Postal Department – www.indianpost.gov.in
* LIC of India www.lic.in

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Assessment

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BASIC ENGINEERING DRAWING

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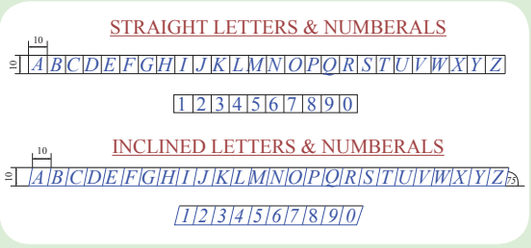
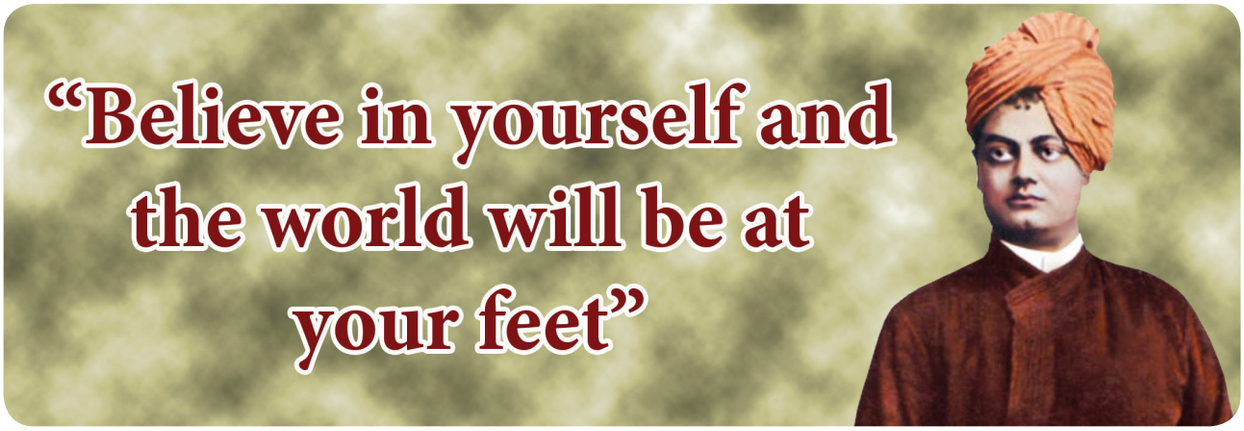
Unit - 1
Basic Civil Engineering

1.1 - DRAWING INSTRUMENTS AND THEIR USES



1.2 - LINES, LETTERING AND DIMENSIONING





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1.1.2. Drawing, Types of Drawing

1.1.3. Drawing Instruments

1.2 Lines, Lettering and Dimensioning

1.2.1. Introduction

1.2.2. Types of Lines

1.2.3. Lettering

1.2.4. Dimensioning

1.2.5. Methods of Dimensioning

1.2.6. Principles of Dimensioning

1.2.7. Exercise on Dimensioning

1.1 DRAWING INSTRUMENTS AND THEIR USES



Learning Objectives

At the end of this lesson you shall be able to

- State the importance of drawing.
- List the drawing instruments.
- Use different drawing instruments.
- Follow precaution in the use of instruments.

1.1.1 Introduction

To produce a best standard product, all the technical personnel (Engineers to Craftsmen) must have a sound knowledge in Engineering drawing. Because Engineering drawing is the language with different types of lines and alphabet. Technical personnel in any industry including craftsman are expected to communicate anything concerning a part or a component by drawings involving lines, symbols, abbreviations, etc.

1.1.2 Drawing - Definition

A drawing is a graphic representation of an object or a part of it and is the

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result of the creative thought by an engineer or technician. Drawing is classified into three types.

Types of Drawing

1. Art Drawing.
2. Geometrical Drawing.
3. Engineering Drawing.

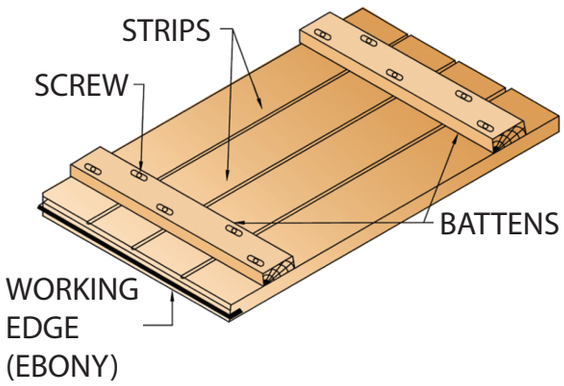
1. **Art Drawing**: Drawing of objects like trees, animals, hills and natural sceneries on the paper is called as "**Art Drawing**".
2. **Geometrical Drawing**: Drawing of geometrical shapes like square, rectangle, triangle, cylinder, sphere, etc., on the paper is called "**Geometrical Drawing**".
3. **Engineering Drawing**: Drawing of Engineering objects like buildings, machines, electricity, etc., on the paper is called "**Engineering Drawing**".

1.1.3 Drawing Instruments

There are so many drawing instruments used to draw a drawing in a simple and accurate way. They are :

1. Drawing Board
2. T-Square
3. Set Squares
4. Protractor
5. Mini Drafter
6. Clinograph
7. French Curves
8. Scale
9. Compass (Bow Compass, Large Compass)
10. Divider
11. Drawing Pencils
12. Pencil Eraser
13. Drawing Sheet

1.1.3.1 Drawing Board





Drawing Board with Stand

Drawing board is one of the main equipment of Draughtsman. It is used for supporting the drawing paper for making drawings. It is rectangular in shape. It is made of well seasoned wooden strips of about 25mm thick, free from knots and



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Standard Size of Drawing Boards as per IS 1444-1989

S.No.	Designation	Drawing-Sheet Size to be used	Size of the Board in mm (Length, Breadth, Thickness)
1	D0	A0	1500 × 1000 × 25
2	D1	A1	1000 × 700 × 25
3	D2	A2	700 × 500 × 15
4	D3	A3	500 × 350 × 15

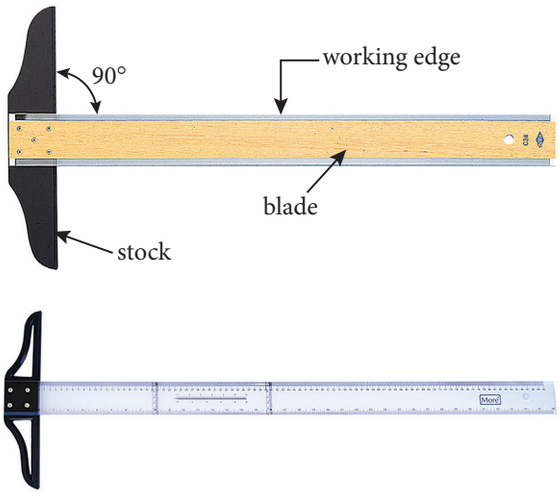
warping. It should be softer enough to allow insertion and removal of drawing pins. Two battens are fastened to the board by screws, in slots. They prevent warping and at the same time permit expansion and contraction of the strips due to the change of moisture in the atmosphere.

One of the shorter edges of the drawing board is provided with an "Ebony edge" (hard wood) fitted perfectly straight, on which the stock of the 'T' square moves. It projects about 4 to 5mm from the board. While working, the ebony edge (working edge) side is to be placed to the left side on a table or castle at a convenient height and slope.

Now-a-days the drawing boards are available with laminated surfaces. The flatness can be checked by placing a straight edge on its surface. If no light passes between them, the surface is perfectly flat.

1.1.3.2 T-Square

It is T - shaped made of well-seasoned wood, or plastic material. It has two parts, namely the head and the blade. One edge of the blade is the working edge. The blade is screwed to this head such that the working edge is at right angle to head.



The standard size of T-Squares as per IS 1360 – 1989.

S.No	Designation	Blade Length in mm
1.	T_0	1500
2.	T_1	1000
3.	T_2	700
4.	T_3	500

The T-Square can move up and down direction only.

The T-Square is used to draw horizontal lines, parallel lines and to guide/hold the setsquares, stencils, etc.

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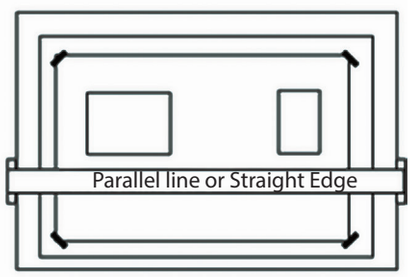
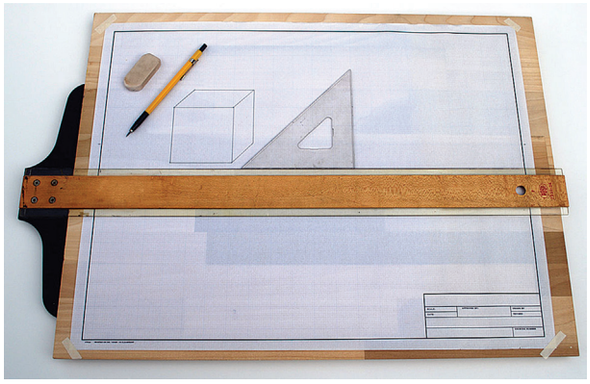
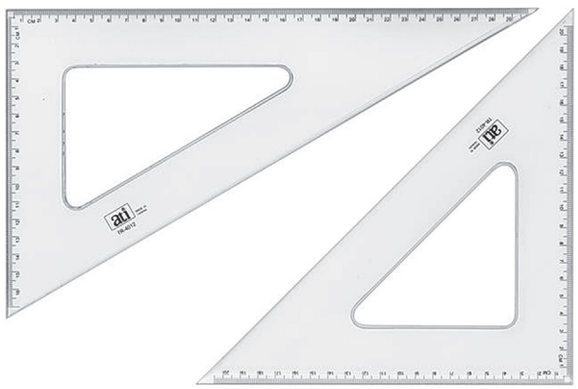




T-Square with Set Squares and Drawing Board

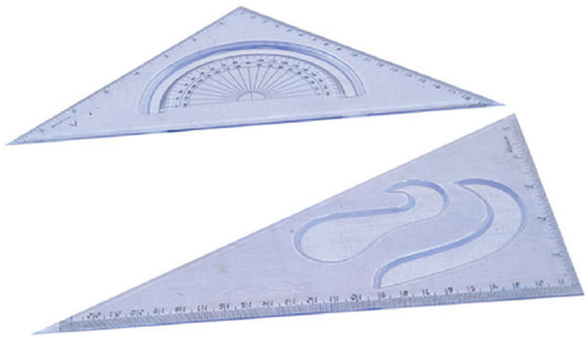
1.1.3.3 Set Squares

Set squares are madeup of transparent celluloid (or) plastic. They are two in number, each having one corner with 90°. The set square with 30°–60° of 25cm long and 45° of 20cm long is convenient for use. Set squares sometimes lose their accuracy due to internal strains. So they should be tested periodically.



30°–60° Set Square **45° Set Square**

Sometimes set squares are built in with french curves or protractor. Set squares are used to draw straight lines except horizontal lines.

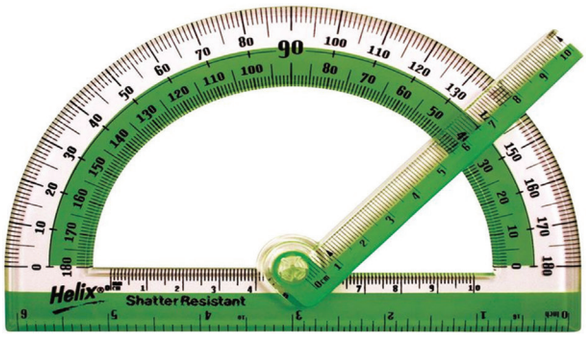


Set Squares with French Curve and Protractor

1.1.3.4 Protractor

Protractor is an instrument used for measuring angles. It is semi-circular in shape and is made of celluloid (or) plastic.

The angles are marked in the circumferential edge at 10° interval both clockwise and anti-clockwise direction. The line joining 0° and 180° is called base of the Protractor.



Protractor With Scale

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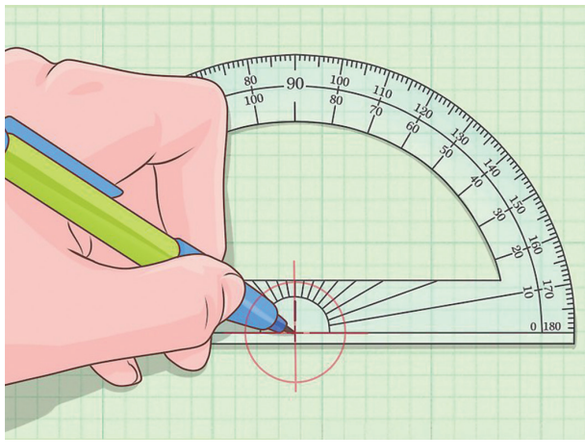
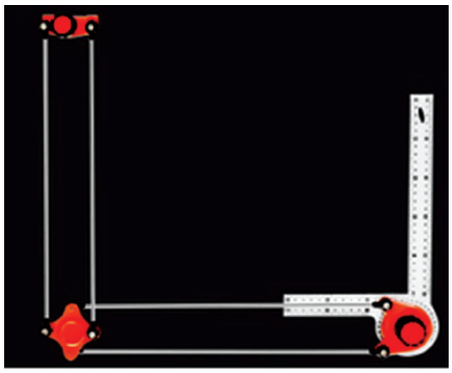
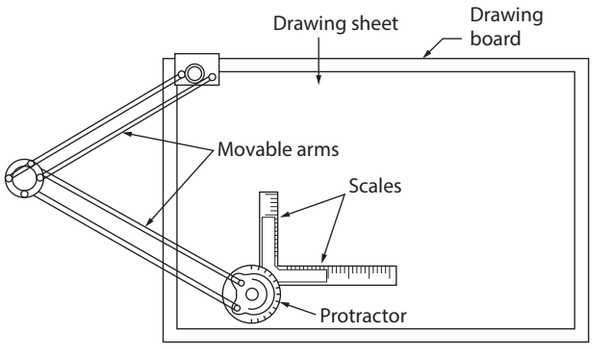


Protractor can also be used to divide a circle into equal parts.

1.1.3.5 Mini Drafter:





Parts of Mini-Drafter

A drafting machine is used by professional draughtsmans to prepare drawings. It combines the functions of T – Square, set square, scales, clinograph and protractor. The miniature version of the drafting machine known as "**Mini-drafter**". It is used for drafting by students.

One end of the mini drafter is clamped by means of a clamping screw (c.s.) to the longer edge of the drawing board. At its other end, an adjustable knob (k) having protractor (P) markings is fitted. Two Scales of transparent celluloid, set at right angles to each other are attached to the knob.

In short, the mini drafter is used for different drafting operations like, to draw horizontal, vertical and inclined lines, parallel and perpendicular lines and also for measuring lines and angles.

1.1.3.6 Clinograph

An adjustable set square which changes angular measurement is known as clinograph. These are made-up of transparent plastic (or) celluloid. Clinograph can be adjusted to any required

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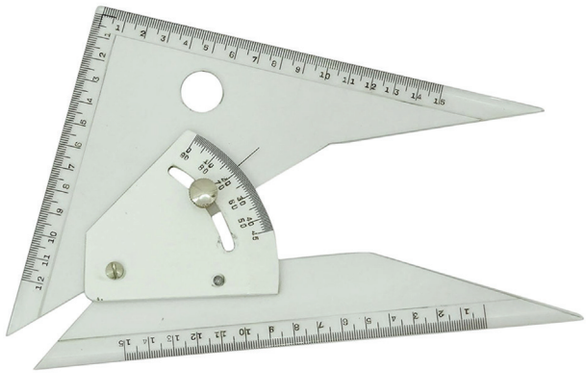
Who invented drafting machine?

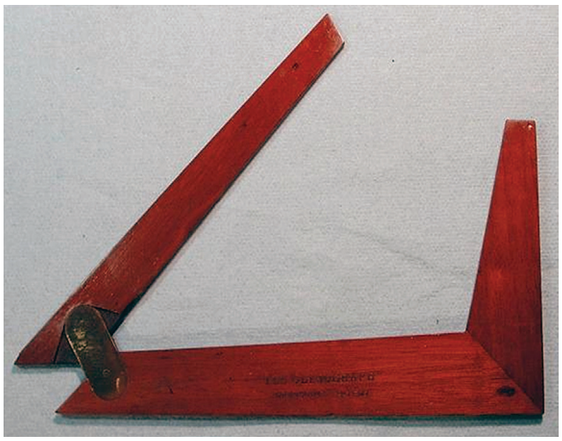
The drafting machine was invented by Charles H. Little in 1901. He founded the universal drafting Machine Company in Cleveland, Ohio to manufacture and sell the instrument.

Search link: Htttp://en.m.wikipedia.org>wiki>drafting machine.



angle by using the degrees given at the centre and fixed firmly after adjustment by using a screw provided. With T square, clinograph is used to draw parallel lines to any inclined line.

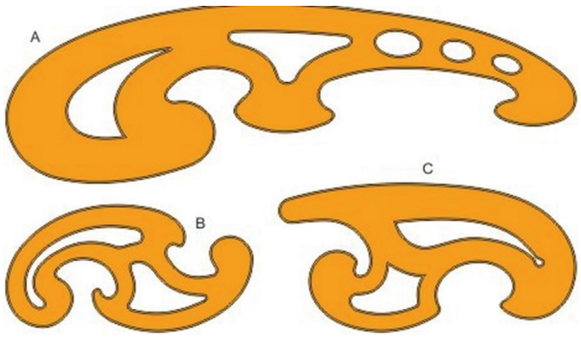




Clinograph

1.1.3.7 French Curves:

French curve is made of transparent celluloid or plastic. It is used to draw irregular curved lines. It is available in different sizes and shapes. French curve is also inscribed in the setsquares. French curve is used to draw non-circular curves, which cannot be drawn with a compass.



French Curve Models

1.1.3.8 Scale

The Scale is made up of wood, transparent celluloid (or) plastic. Metric (or) British system of measurement is

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Flexi Curve

There is an instrument named as flexi curve which is used to draw irregular continuous curved lines in architectural drawings.

Search link: http://www.sciencedirect.com>pii.



marked on the edge of the scale. Generally the size of scale we are using is 300mm length, 30mm breadth and 1mm thick. The measurement are graduated in 1:1 scale.

ACTIVITY 1

Prepare a drawing using irregular curved lines with the help of French curves and flexi curve.

1.1.3.9 Compass

- Compass is used to draw circles and arcs.
- Large Compass is used to draw circles from 30mm to 120mm diameter.
- Bow Compass is used for drawing small circles upto 30mm diameter.



Instrument Box Set







Scales

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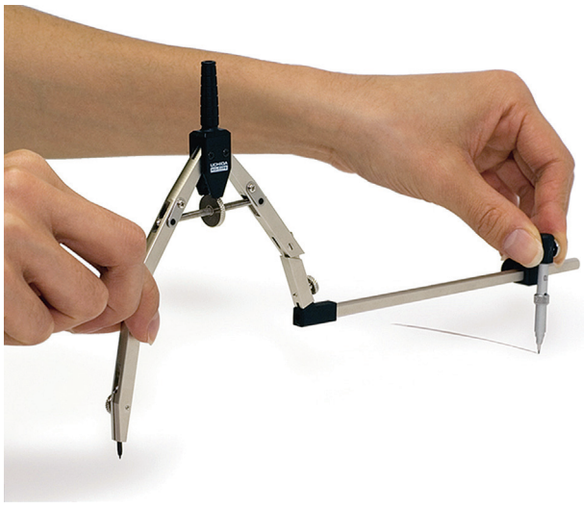

Large Compass



Bow Compass

1.1.3.10 Divider

The divider has two legs hinged at the upper end. It is provided with steel pins at both the lower ends.

Dividers are used for

- Dividing curved or straight lines into any number of equal parts.
- Transfering dimensions from one part of the drawing to another part.



Divider

- Setting dimensions from the scale to the drawing.

1.1.3.11 Drawing Pencils

Drawing pencils are different from ordinary pencils and are in grades HB,H, 2H, etc. Grade HB denotes medium soft. Grades H, 2H etc, denote the degree of hardness in increasing order. Grades B, 2B, etc., denote the degree of softness in increasing orders. There are 18 numbers of quality drawing pencils. The grade of the pencil is decided by the amount of graphite mixed with clay.

Uses:

HB Soft Grade – used for drawing border lines, lettering and freehand sketching.

H Medium Grade – used for drawing visible outlines and visible edges.

2H Hard Grade – used for construction lines, Dimension lines, Leader lines, extension lines, centre lines, hatching lines and hidden lines.

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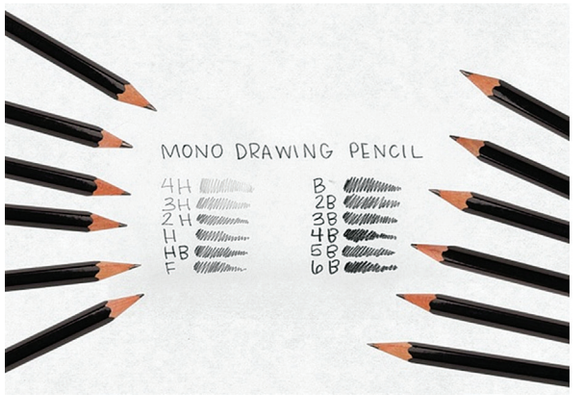
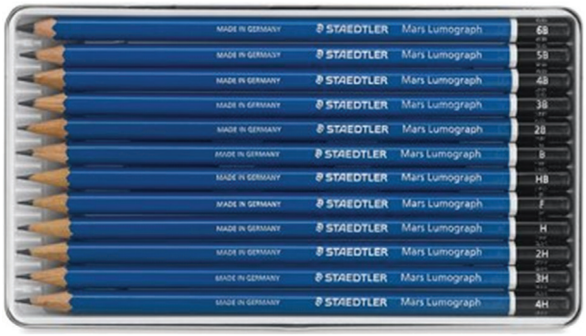
NOTE: Never use ordinary cheap quality pencils on your drawing sheet.



Keep your pencil sharp: A dull pencil produces fuzzy lines. Only a sharp pencil produces black and sharp lines that sparkle with clarity. Lead is sharpened to conical point (or) chisel edge by rubbing on an emery paper. Conical point is used for lettering and freehand sketching. Chisel edged pencil is used for drawing lines.



Micro-tip pencils

Micro-tip pencils / clutch pencils with 0.5mm thick leads of grades HB, H and 2H are preferred than wooden pencils, as they need no sharpening.



Microtip Pencils



What is the birth place of pencil?

Germany was the birth place of the first mass produced pencils in 1662.

The discovery of a large graphite deposit in Borrowdale, England in 1564.

Later, the graphite was inserted into hollowed – out wooden sticks and thus the wood cased pencil was born at Nuremberg, Germany

Search link: http://en.m.wikipedia.org>swiki>pencil. www.historyofpencils.com

1.1.3.12 Pencil Eraser

Pencil eraser ('it is not rubber' call it 'eraser') is used to erase unwanted lines, etc. A non-dusting good quality eraser should be used.

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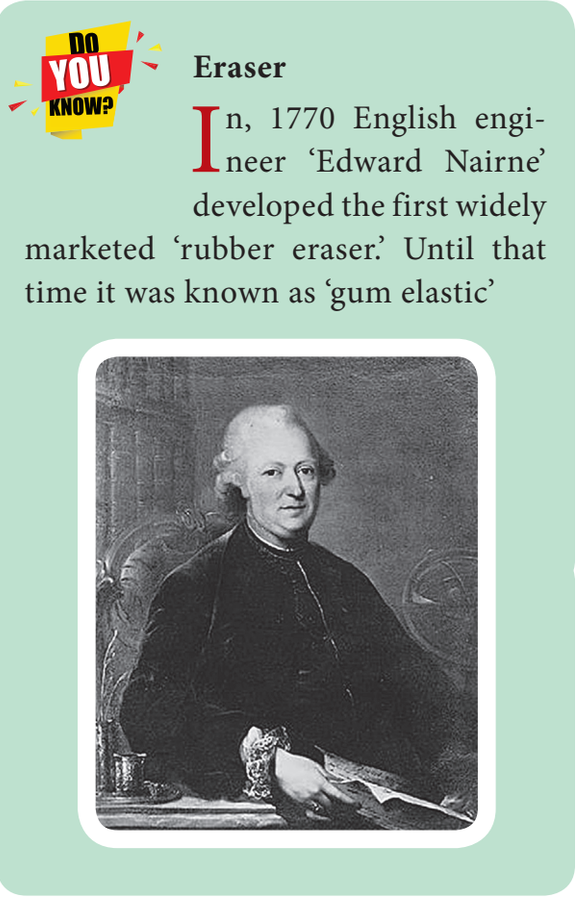
Pencil Eraser



Eraser

In, 1770 English engineer 'Edward Nairne' developed the first widely marketed 'rubber eraser.' Until that time it was known as 'gum elastic'

1.1.3.13 Drawing Sheet

Drawing sheets are of two types:

- Mill made paper
- Hand made paper.

Mill Made Papers are most commonly used for regular work and are available in different sizes and rolls .



Mill Made Paper

Hand-Made Papers have rough surfaces, pale in color and not used for regular work, but meant for charts.



Hand Made Paper

Sizes of Drawing Sheets: The drawing sheets are designated by symbols such as A0, A1, A2, A3, A4 and A5. In which A0 being the largest.

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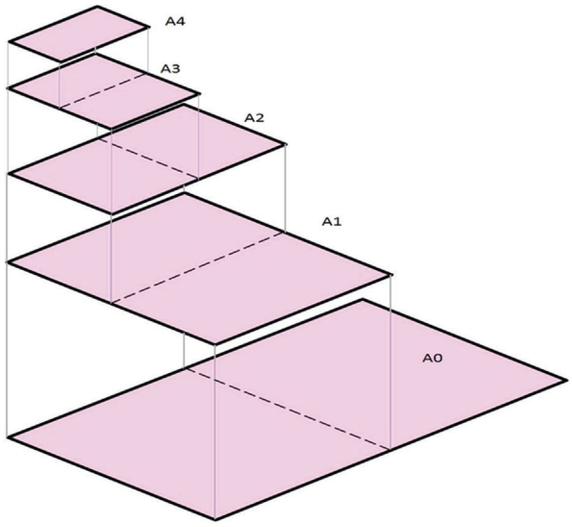
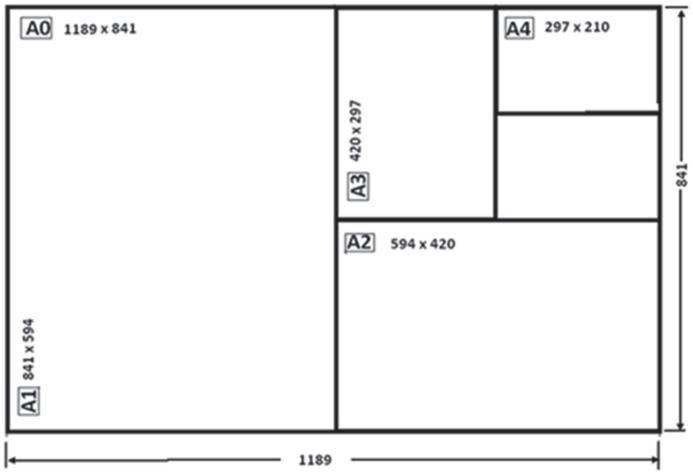
Standard Size of Drawing Sheets

Designation	Trimmed Size in mm	Untrimmed Size in mm
A_0	1189 × 841	1230 × 880
A_1	841 × 594	880 × 625
A_2	594 × 420	625 × 450
A_3	420 × 297	450 × 330
A_4	297 × 210	330 × 240
A_5	210 × 148	240 × 165

Layout and Folding of Drawing Sheet (IS 10711:2001)





Drawing Sheets

ACTIVITY 2

Prepare an album by collecting the picture of all drawing instruments.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. Drawing related to natural sceneries is ……..
   a. Art drawing
   b. Geometry drawing
   c. Engineering drawing
   d. Civil drawing
2. The drawing related to building is ……
   a. Art drawing
   b. Geometry drawing
   c. Civil drawing
   d. Engineering drawing
3. With the help of ……. protractor and set square are used.
   a. Scale
   b. Clinograph
   c. T-square
   d. Drafter
4. The length of 30°–60° set square is .....
   a. 30 cm
   b. 35 cm
   c. 15 cm
   d. 25 cm
5. The lines are equally divided with the help of .....
   a. Divider
   b. Compass
   c. Set squares
   d. Protractor



6. The quality of pencil used to draw object line is .....
   a. 2H
   b. 3H
   c. HB
   d. H
7. The total number of quality drawing pencil is .....
   a. 6
   b. 12
   c. 18
   d. 3
8. Combined instrument of T-square, set squares, protractor and scale is .....
   a. Mini drafter
   b. French curves
   c. Compass
   d. Clinograph

PART II (3 Marks)

Answer in one or two sentences

9. What is meant by Engineering drawing?
10. Mention any three instruments to draw the drawing.
11. What are the instruments used to draw curves?
12. What is the use of compass?
13. Mention any two prescribed sizes of drawing board.

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PART III (5 Marks)

Answer shortly

14. Draw the sketch of a drawing board and mention its parts.
15. What are the uses of 'T-squares'?
16. Describe the protractor with a neat sketch.

PART IV (10 Marks)

Answer in detail

17. Describe the mini drafter with a neat sketch.

Answers

1.(a) 2.(c) 3.(c) 4.(d) 5.(a) 6.(d) 7.(c) 8.(a)

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1.2 LINES, LETTERING AND DIMENSIONING

Learning Objectives

At the end of this lesson you shall be able to

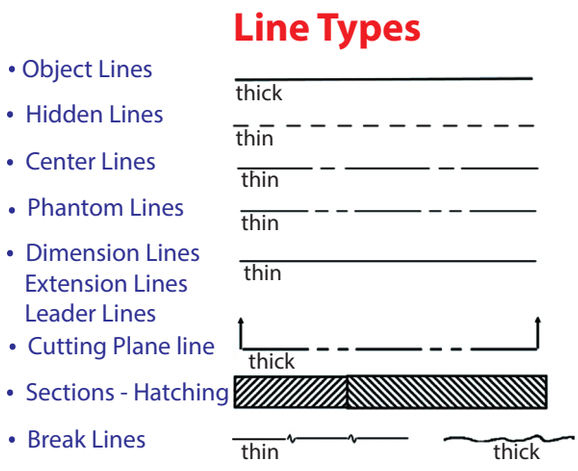
- State the types of line
- Explain the application of different types of lines
- Understand the lettering style
- Define dimensioning
- Dimension the drawings as per standard specification

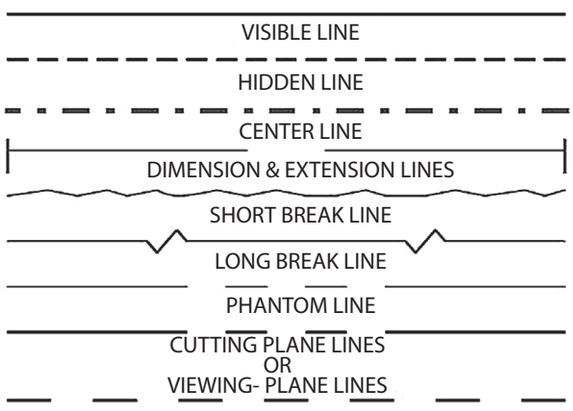
1.2.1 Introduction

Lines: In Engineering drawing, several lines are followed to define the shape of an object. Each and every line has its individual name and sense. All the types of lines and how each and every lines are used in Engineering drawing is discussed in this lesson.

1.2.2 Types of Lines

1. Object line or Outline.
2. Hidden lines or Dotted lines.
3. Centre Line.
4. Dimension line.
5. Arrow heads.
6. Extension line (or) Projection line.
7. Leader Line.
8. Cutting plane line.
9. Sectional line (or) Hatching line.
10. Short break line.
11. Long break line.





1. **Object Line (or) Outline:** When we see an object, the visible edges and their surface boundaries are drawn in a drawing by using this lines to show the shape of the object. H pencil is used for drawing, object line / outline. It should be dark and at the same time thin.

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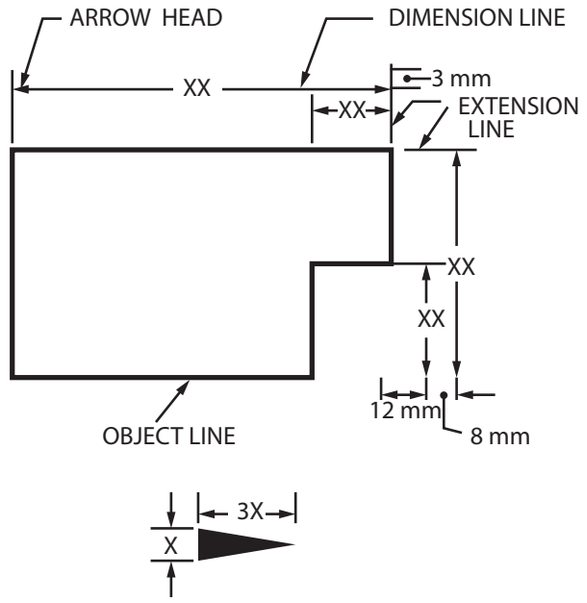
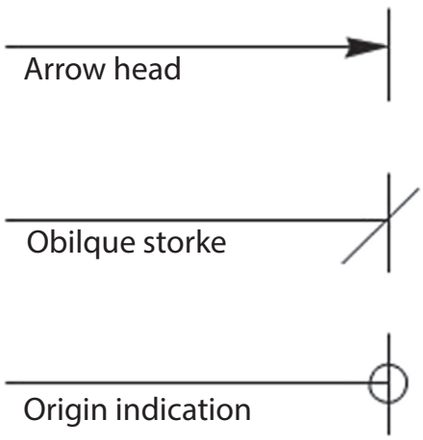
2. **Hidden Lines (or) Dotted Lines:** These lines are used to show the hidden planes and hidden edges of an object. The length of this line may be 2mm to 3mm. The interval between the lines should be 1mm. The point of intersection of these lines with the outlines (or) another hidden line should be clearly shown.
3. **Centre Line**: The centre point of arc, circle are denoted by this line. The axes of symmetrical geometrical objects like cylinder sphere and cone are denoted by this line. Construction of this line is with uniform interval of alternative lengthy line and small line. Interval is 1mm length of the line is 9 to 12mm and small lines in 1.5mm
4. **Dimension Line (D.L)** This line is a continuous narrow line drawn parallel to the edge or surface whose measurement should be shown. It should be placed outside the view. Sometimes in unavoidable situation it may be placed inside the view.



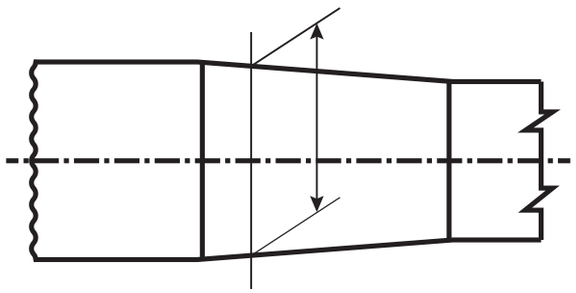
Dimension line is placed at least 12 mm away from the outline of the drawing. It is terminated by arrows at its end.

5. **Arrow Heads**: At both ends of the dimension line, the arrows are marked. Arrow marks are drawn as per the sketch shown. But same type of arrow mark should be used in a sketch .The angle between the arrow mark may be 15° to 90°.

Where space is too small for an arrowhead, the oblique stroke (drawn as a short line inclined at an angle of 45°) or a dot may be substituted as shown in fig.



6. **Extension Line (or) Projection Line:** It is a continuous narrow line drawn perpendicular to the outline to be dimensioned and without leaving a gap from the portion. It is drawn extending slightly beyond the dimension line about 2mm.



7. **Leader Line:**

Leader line is a continuous narrow line, connecting dimensional value or

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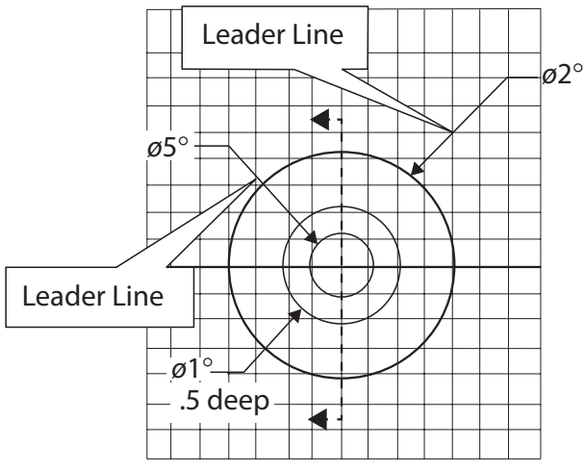
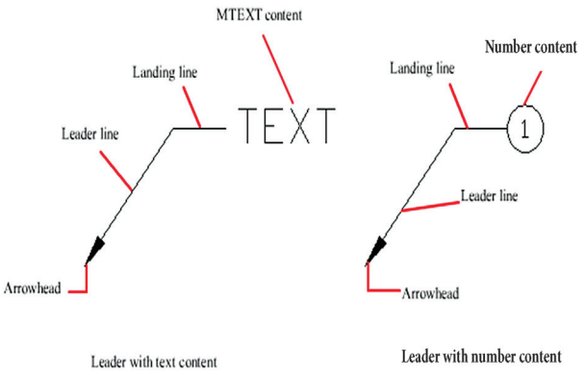
note with the corresponding feature on the drawing. It is drawn at 30°, 45° or 60° with the horizontal and it should be drawn radially to indicate the radius or diameter of a circle or an arc.





1.2.3 Lettering

Letters and numerals are used in Engineering drawing to specify the measurement of object and description of that object. H or HB pencils are used to write letters and numerals.

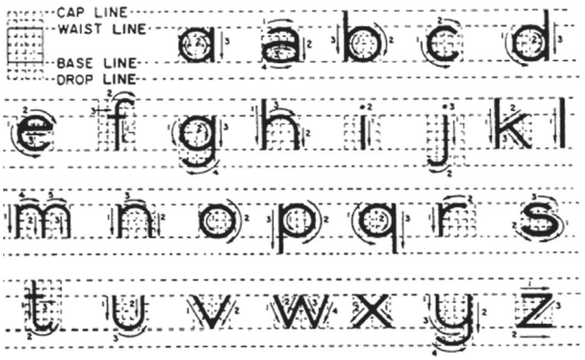
Capital letters are generally used in engineering drawing. But small letters recommended by international standard are also used.

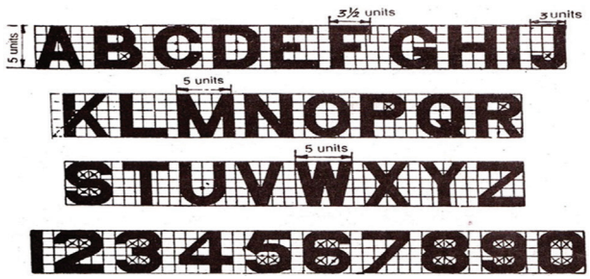
To write letters and numerals, drawing instruments should not be used, as fastness cannot be achieved and also takes more time.

Generally letters and numerals are written in two methods.

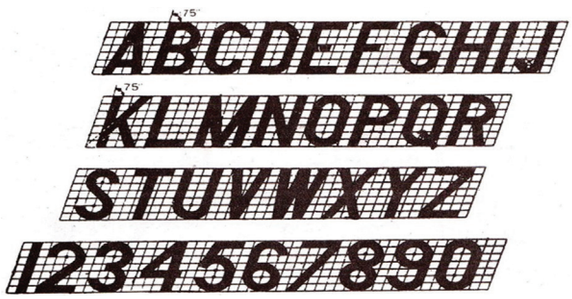
1. Vertical Type
2. Inclined Type

Vertical Type: In vertical type of lettering, the letters and numerals should be written perpendicular to the horizontal level.





Inclined Type: In this type letters and numerals should be inclined to 75° to horizontal level.



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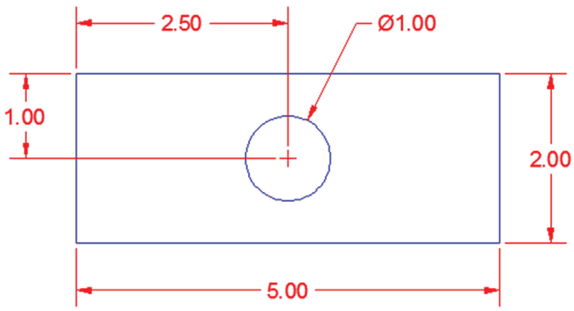
1.2.4 Dimensioning

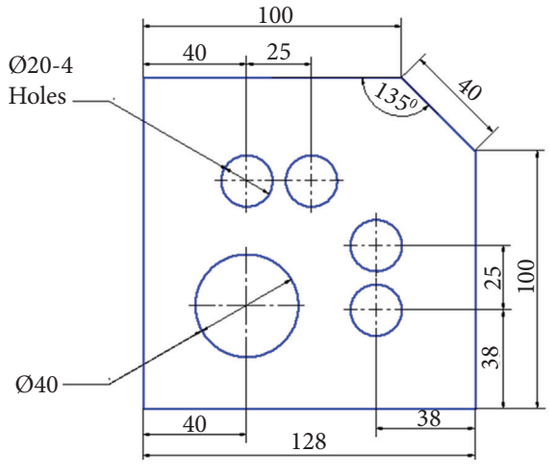
Method of describing the shape and measurement of an object in engineering drawing is called "**Dimensioning**". So many lines, letters, numerals and symbols are used in this dimensioning.



1.2.5 Methods of Dimensioning

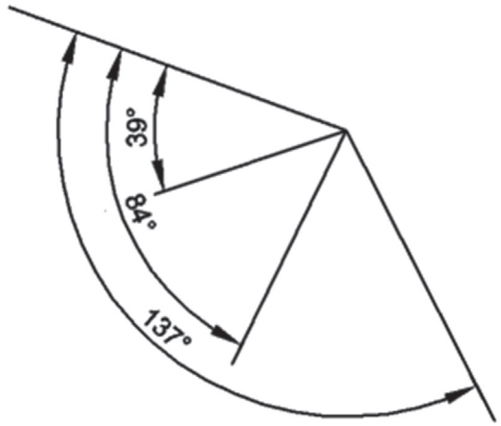
Method-I: Aligned System

In Aligned method of Dimensioning the dimension line should be continuous and dimension should be placed in the middle of the dimension line without touching it.

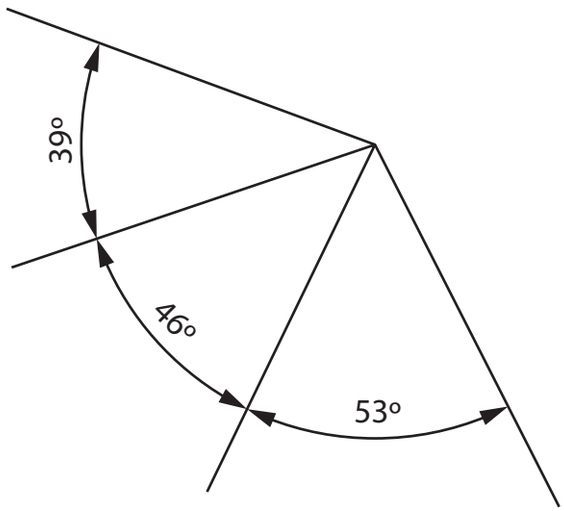


Dimensional values are marked so that they can be read either from the bottom or from the right hand side of the drawing. The above figure shows the method of placing dimensional values at different positions on the dimension lines.

Angular Dimensions: Angular dimensions are oriented as in the following figure



Marking Angles from Baseline



Marking Angles Continuously

Method-II: Unidirectional System

In unidirectional method of dimensioning the dimension line should be cut at center and dimensions should be placed in the middle of dimension lines as shown in the fig below.

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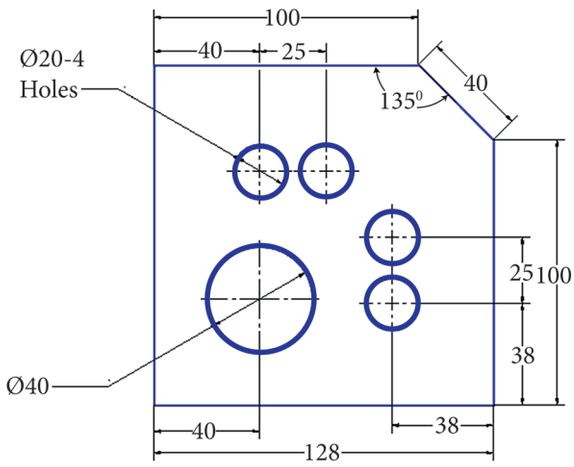
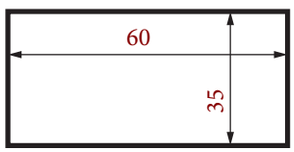
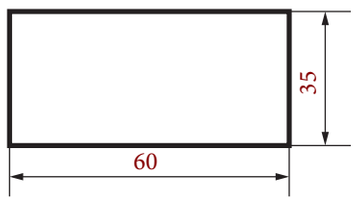
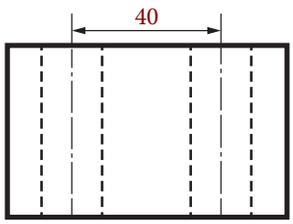
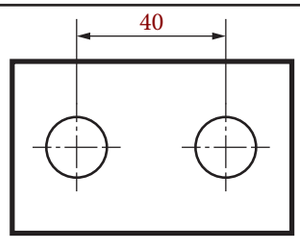


NOTE:

- All dimensions should be noted in mm.
- Only one method of dimensioning should be used in a drawing.
- If the dimension value is less than 1, a zero is placed before the decimal point, example **0.5** and not **.5**
- Decimal point in a dimension should be written in line with the bottom line of the dimension value, example **0.5** and not **0 ˙5**
- Abbreviation for millimetres is not 'mms' but 'mm' only.

1.2.6 Principles of Dimensioning

S1. No	DIMENSIONING RULE	INCORRECT	CORRECT
1	Place the dimensions outside the views.		
2	Location of holes should be dimensioned in top views.		

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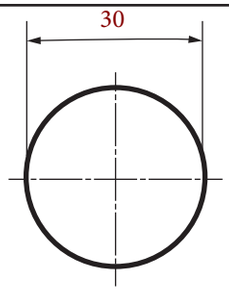
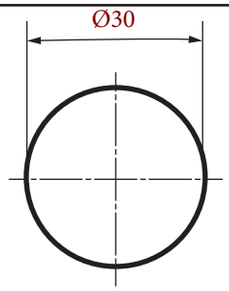
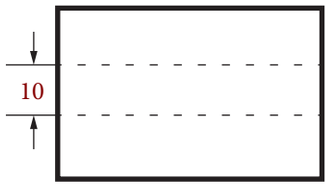
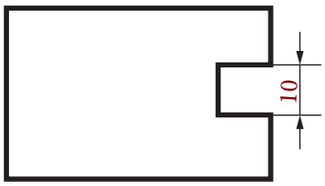
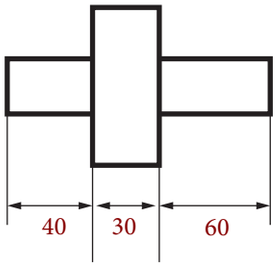
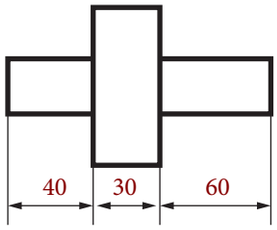
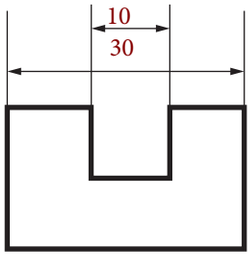
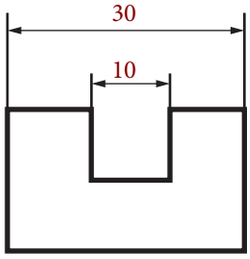
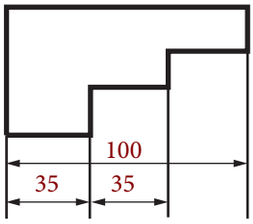
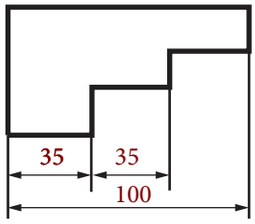
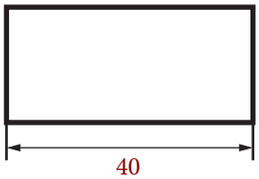
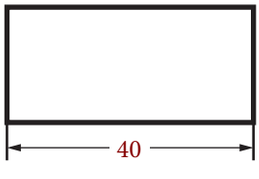
3	A circle should be dimension by its diameter using the symbol Ø.		
4	Dimensions to the hidden lines of a view should be avioded.		
5	Arrange a chain of dimensions in a continuos line.		
6	Larger dimensions should be placed out side the shorter one.		
7	Overall dimension should be placed out side of the intermediate dimensions.		
8	Dimension figures should be approximately centered between the arrow heads.		

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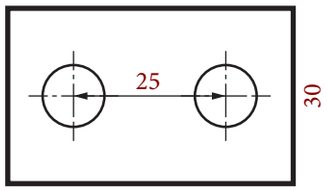
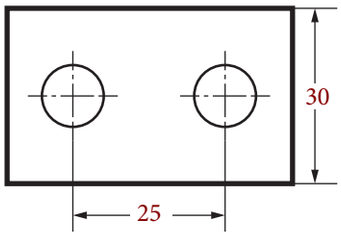
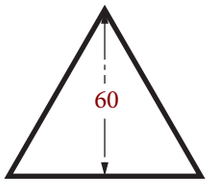
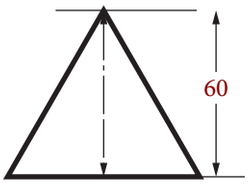
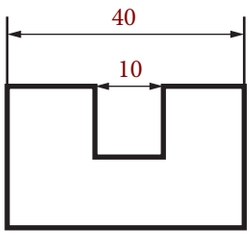
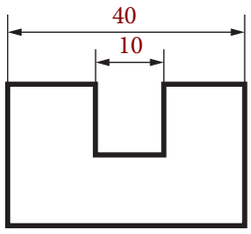
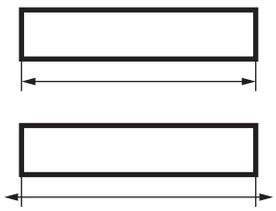
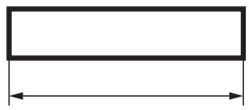
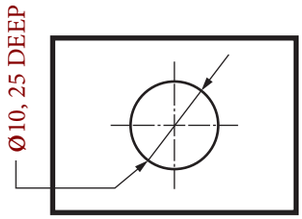
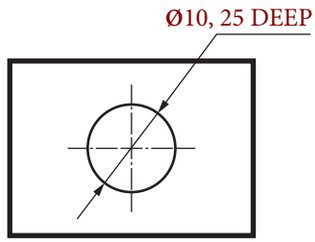
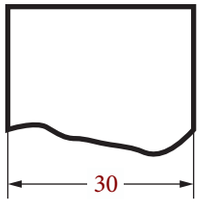
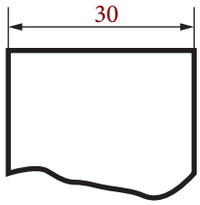
9	An axis line or outline should never be used as dimension line. But the axis line may be used as extension line.		
10	Centre line should not be used as a dimension line.		
11	Do not repeat the same dimension in different views.		
12	Dimension line should be drawn atleast 12 mm away from the outline and from each other.		
13	Arrowheads should touch the Projection lines.		
14	Notes should always be written horizontally.		
15	Dimensions should be given to finished surfaces rather than rough surfaces.		

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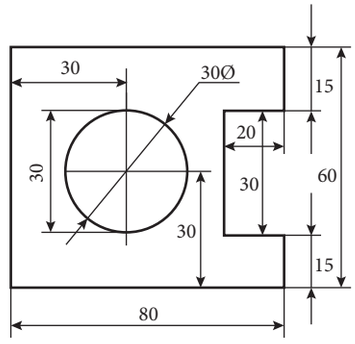
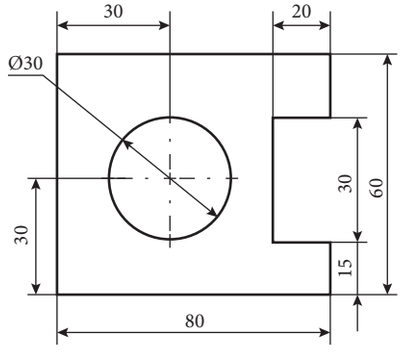
1.2.7 Exercise On Dimensioning:

Example – 1: Read the dimensioned drawing as shown in figure. Redraw the figure in full size. Dimension it as per BIS code. The following mistakes of dimensioning are noted as shown in figure.



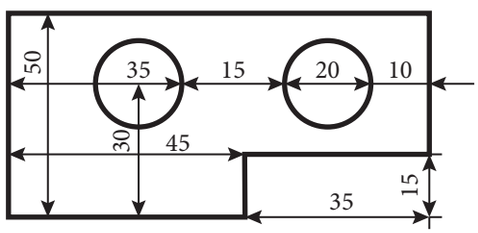
Incorrect



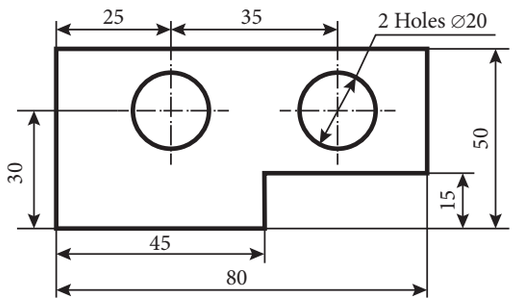
(ii) Correct

1. Most of the dimensions are placed inside the drawing. Place them outside the drawing.
2. Some of the dimension lines are crossing each other. It is not permitted.
3. Diameter of the circle is wrongly given as 30 Ø
4. Axis of the circle is not shown correctly.

Example – 2 : Redraw the figure in full size. Mark the dimensions as per BIS.



(i) Incorrect



(ii) Correct

1. Many dimensions are placed inside the drawing. Mark them outside the drawing.
2. Dimension (50) Line is crossing the dimension (45) line. Also, dimensions (45) line and dimension (30) line cross each other. Also , dimension (50) and dimension (35) line cross each other. Dimension lines should not cross other dimension lines.
3. Dimensional value (50) should be placed in the middle of the dimension line.
4. Centre lines of both the holes should be drawn. Distance between center lines should be marked.
5. Diameters of the holes are not shown properly. Follow the convention of repeated features for the two holes using leader line and Notes (2xØ 20 or 2 holes Ø 20) written horizontally.
6. Extensions of outlines of the drawing are wrongly used as dimension (35 and 15) lines.
7. Dimension (15) line between outside the circles and also the dimension (10) line between the outline of the circle and outline of the drawing are not permissible.
8. Overall measurements should be given. But only overall width of the drawing is shown. Mark the overall length too.

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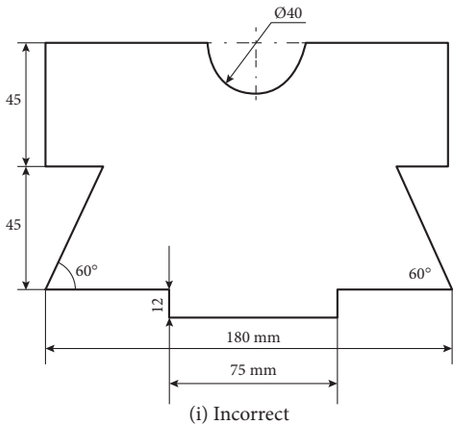
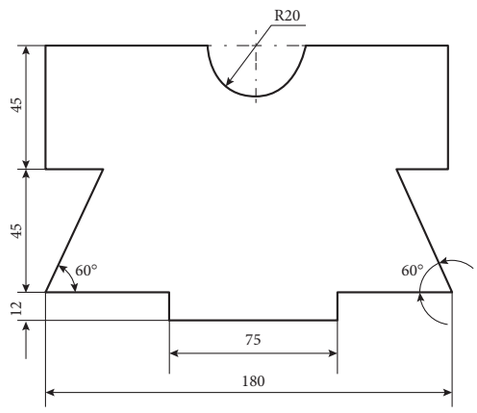
Example – 3 : Redraw the figure to half size. Dimension it as per BIScode.

NOTE : Draw the figure to half size (scale 1:2) Mark actual dimensions on the drawing.



(i) Incorrect



(ii) Correct Scale 1:2

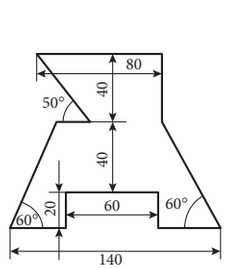
1. Dimension (12) is wrongly marked, since the outline of the object is used as dimension line.

   An outline or a centreline should never be used as a dimension line. However, a centre line may be extended to serve as an extension line.

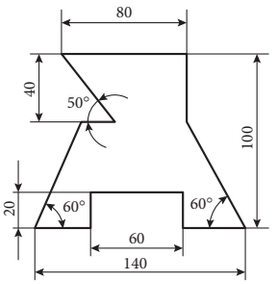
2. Series of dimensions (45, 45 and 12) are not in a continuous line, which is not proper. They should be arranged on a continuous line.
3. The longer dimension (180) is wrongly placed inside the shorter dimension (75)
4. Arc dimension (R23) is wrongly marked as (Ø 46)
5. Angle (60˚) is not properly dimensioned in both the places. The same should be placed by either of the two methods.
6. Unit of dimension mm is marked near the dimensional values (75 and 180), which is not correct. A foot-note stating "ALL DIMENSIONS IN mm" is written in a prominent place near the title block.

ACTIVITY 3

Redraw the figure. Dimension it as per BIS code.



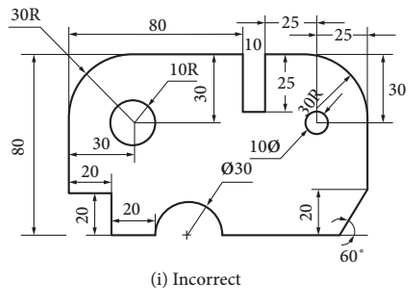
(i) Incorrect



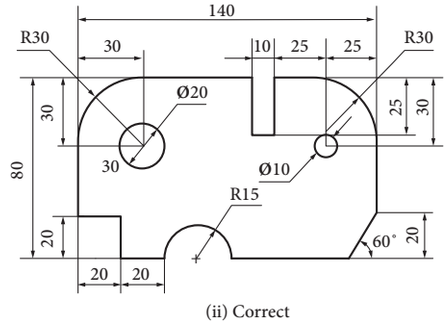
(ii) Correct

ACTIVITY 4

Redraw the figure, dimension it as per BIS code.



(i) Incorrect



(ii) Correct

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. …… letters are generally used in engineering drawing.
   a. Capital b. Slanting
   c. Inclined d. Small
2. Generally, the letters and numerals are written in …… methods.
   a. 5 b. 4 c. 3 d. 2
3. The letters are inclined to ….. to the horizontal plane.
   a. 50° b. 75° c. 60° d. 45°
4. The angle between the arrow mark may be……
   a. 15° to 90°
   b. 20° to 50°
   c. 10° to 30°
   d. 5° to 15°

PART II (3 Marks)

Answer in one or two sentences

5. Write any four types of lines.
6. What is dimensioning?
7. Define Arrow heads.
8. Define oblique stroke.

PART III (5 Marks)

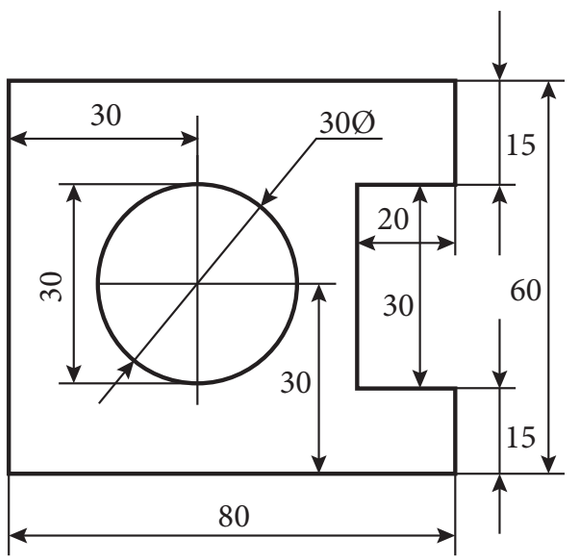
Answer shortly

9. Write briefly about any two types of lines with sketch
10. Define hidden line and centre line

PART IV (10 Marks)

Answer in detail

11. Describe the method of dimensioning in aligned system with sketch.
12. Describe the method of dimensioning in unidirectional system with sketch.
13. Draw the given figure in full size and dimension it as per BIS code.



Incorrect

Answers:

1.(a) 2.(d) 3.(b) 4.(a)

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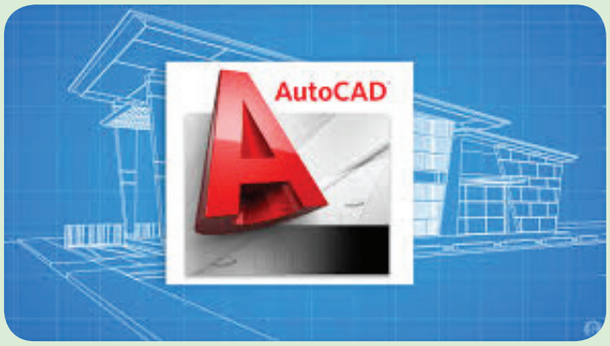
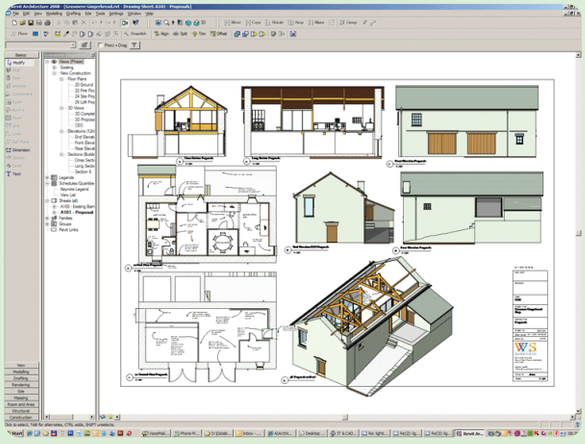
AUTOCAD

Unit - 2
Basic Civil Engineering

2.1 AUTOCAD SOFTWARE



2.2 AUTOCAD BASICS





The future depends on what we do in the present.

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2.1.2 Softwares Used in Civil Engineering
2.1.3 CAD-AutoCAD
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2.1.6 Functional Keys
2.1.7 File Management
2.1.8 Drawing Limits

2.2 AutoCAD Basics

2.2.1 Introduction
2.2.2 Draw Commands
2.2.3 Modify Commands
2.2.4 Text Command
2.2.5 Zoom Command
2.2.6 Dimension
2.2.7 Layer
2.2.8 Editing Commands
2.2.9 Isometric Drawings
2.2.10 Orthographic View

2.1 AUTOCAD SOFTWARE

Learning Objectives

At the end of this lesson you shall be able to

- State the AUTOCAD software and its uses.
- Understand the other softwares in civil engineering.

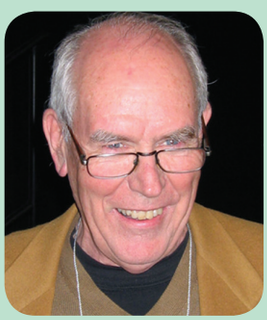
2.1.1 Introduction

In modern world, the use of computers are increasing in almost all the sectors. The computers play an important role in the field of Civil Engineering too. Various softwares are used to save time, energy and simplify the tedious work like building drawing, design, analysis, etc. In this chapter we learn about the softwares used in civil engineering.

DO YOU KNOW?

Who invented CAD?

An American Ivan Sutherland invented CAD in 1961.



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Who discovered AutoCAD?

In 1982, John Walker and 12 other programmers began to work on several computers application. The first to be completed was auto CAD, a software application for computer aided design (CAD) and drafting.



Search Link: http://en.m.wikipedia.org>wiki>autodesk

2.1.2 Softwares Used in Civil Engineering:

1. AUTOCAD
2. STAAD PRO
3. QE PRO
4. ESR, GSR
5. GEO
6. AQUA++
7. KANAL ++
8. MX ROADS
9. ECOTECT
10. SAFE
11. SACS

2.1.2.1 AUTOCAD: AutoCAD software is prepared by an American company called Auto Desk. This software is highly used for the preparation of drawings. This software is used in branches like civil, mechanical, electrical and electronics engineering. Drawing using this software is simple, speed and errorless.

The softwares like Archi CAD, REVIT, SKETCHUP and PHOTO SHOP are also used for drawing.



2.1.2.2. STAAD PRO : This software is used to designing and analysis of a structure.

The softwares SAP, NISA, ANSYS are also used for design and analysis of structure.



2.1.2.3 QE PRO: This software is used for fast and accurate quantity computation from building plans.



2.1.2.4 ESR, GSR: It is a unique software used for structural analysis, design and detailing of overhead water tanks.



2.1.2.5 GEO: This software is used to show the route map, topography of the land, etc.

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2.1.2.6 AQUA ++: Aqua ++ software is used for water distribution and water management.

2.1.2.7 KANAL ++: Kanal ++ software is used for storm water distribution and waste water management.

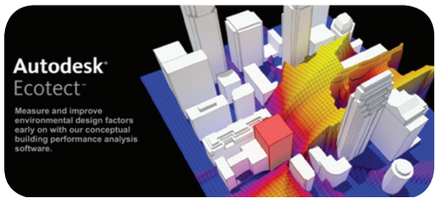
2.1.2.8 MX ROADS: This software is useful to highway designing and 3D modeling, pavement design, etc. The softwares HDM, AUTOPLOTTER, HEADS are also used for highway modeling.



Which organisation developed AutoCAD?

- Auto CAD developed and marketed by Auto Desk.
- Auto CAD was first released in December 1982.
- It releases auto CAD 2018(release 32) in March 2017

2.1.2.9 ECOTECT: This is an environmental analysis tool software. The softwares ENERGY +, IES are also used for pollution free building designs.



2.1.2.10 SAFE/STAAD FOUNDATION: This software is used for the design of foundations. STAAD FOUNDATION software also used for basic and complex foundation designs.

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2.1.2.11 SACS: SACS software is useful for offshore structural analysis and design.



2.1.3 CAD – AutoCAD:

CAD – Computer Aided Design

Before constructing a building the preparation of drawing such as plan, sectional view and elevation is necessary. We can draw the drawing with utmost care, clarity and fast by using the AutoCAD software.



Photoshop

- Photoshop was developed in 1987 by the American brothers 'Thomas' and 'John Knoll'.
- In 1988 he sold the distribution license to the adobe systems.



2.1.4 Advantages of Using AUTOCAD Software in Computer

1. If a drawing is prepared by using AutoCAD, it will be beautiful and clear. This is a good type of drawing compared with manual preparation of drawing.
2. It will take much time while using varieties of lines, colours in manual drawing. But all these are done within a short time in AutoCAD.
3. It is very tough to edit or correct a manual drawing. But corrections can be easily done in AutoCAD.
4. We can show the original appearance of the building with the three dimensional drawings using AutoCAD.
5. According to the desire of building owner, the needs of a house can be shown through AutoCAD drawing which is impossible in manual drawing.
6. We can make some changes in the drawing as per our requirements and several copies may be taken at a time. It is not possible in manual drawing.
7. By joining two drawings, we can make it as a single drawing. It cannot be done in manual drawing.

Thus drawing by using AutoCAD software is more useful than manual drawing.

2.1.5 Units

1. Selection of unit is to be done before drawing a sketch. Eg. decimal, engineering, architectural, fractional or scientific.

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2. Selection of Unit format. Eg. millimeter, centimetre, Feet, inches, etc.
3. Selection of unit for angle. Eg. Degree, min., sec., radians, etc.
4. Drawing area limits should be decided.

2.1.6 Functional Keys:

ESC: 'ESC' key is used to come out from any command.

F1 : This F1 key helps to know about the AutoCAD perfectly. This function key is a help window for AutoCAD.

F2 : This is an AutoCAD text window. This function key is used to open the file and thus it is used to know the commands we used.

F3 : OSNAP function: When a command is under progress, Symbols of midpoint, centre point, perpendicular, etc., of a drawing can be shown by using this OSNAP function.

F7 : SNAP ON / SNAP OFF : Snap is used to control the cursor movement in a drawing. Isometric views can be drawn by using this key.

F8 : ORTHO ON (OR) ORTHO OFF :

ORTHO ON : In this position, 0˚ and 90˚ lines are drawn from one point to another point.

ORTHO OFF: In this position, we can draw the line according to our required angle from one point to another point.

F9 : GRID ON (OR) GRID OFF :

GRID ON: When grid is on, the points of X axis and Y axis, like graph sheet are seen in the window of AutoCAD. But it is not visible in print out. Grid on position is used to draw straight line. Also we can know how far we are selecting the limits of drawing.

GRID OFF: In this grid off position, we cannot see the graph on the window.

F10 : POLAR ON (OR) POLAR OFF :

POLAR ON: In polar on position, when lines are drawn from a point to another point by using line command, the distance of line and angle of line can be known. It can be used to draw the line with required angle.

POLAR OFF: In polar off position, the distance and angle of line are not visible in the window.

2.1.7 File Management:

New: This command is used to draw a new drawing in AutoCAD.



Sketch up

- Sketch up was introduced by @last software, a tech company, co-founded in 1999 by Brad Schell release date august 2000.
- Sketch up developed as a 3D modelling tool for architects, designers and film makers.



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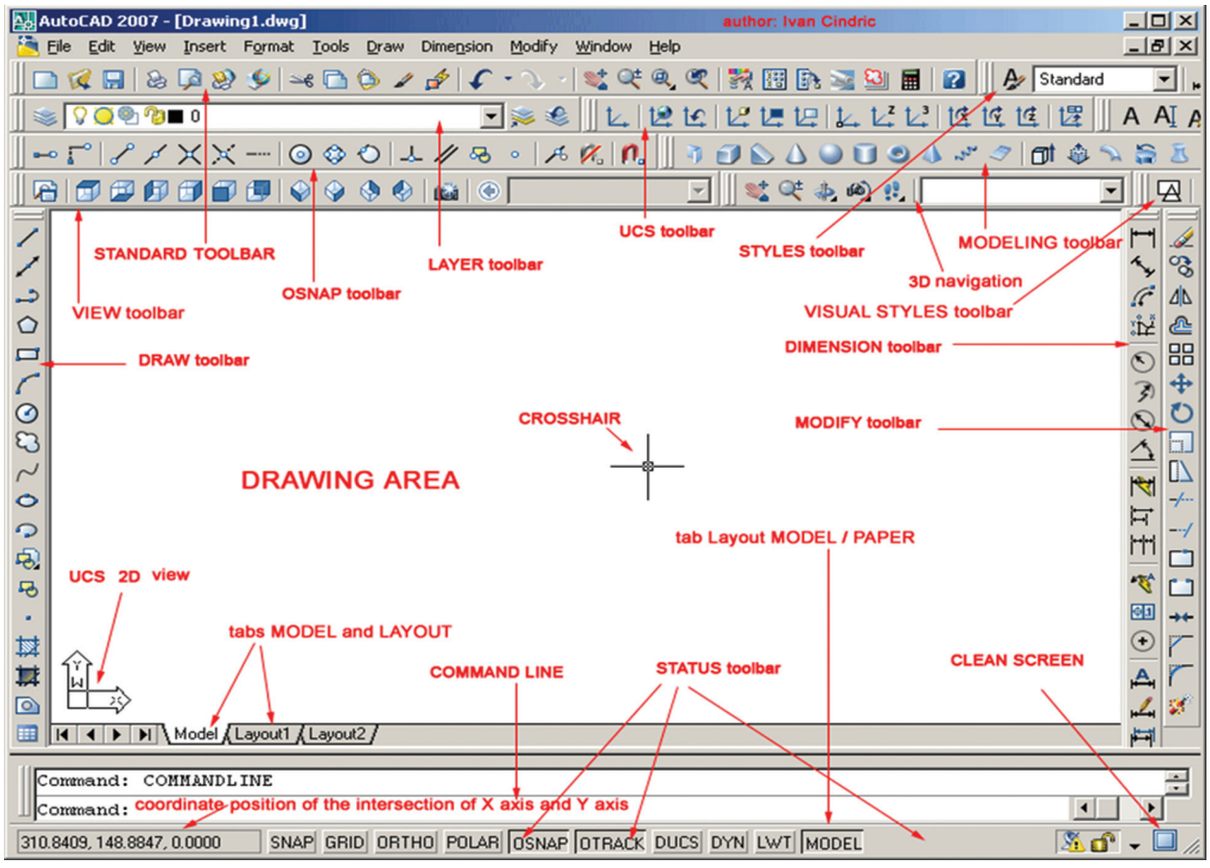

AUTOCAD Window

Open: This command is used to open the saved drawing which is already drawn and saved in the file.

Save: It is used to save the drawing we have already drawn in AutoCAD Window.

Save As: This command is used to change the title of the drawing which is already saved and to save it in another file. It is also used to take the print out of duplicate copy.

Quit: This command is used to come out from AutoCAD.

Plot: This command is used to print the drawing of AutoCAD.

Export: This is used to change or bring the drawing file from AutoCAD file to another file.

Exit: This command is used to come out from AutoCAD to desktop.

2.1.8 Drawing Limits

Before drawing a sketch in AutoCAD, we have to know the limits of the drawing. For this purpose like manual drawing sheets, we have to select the limits such as A1, A2, A3 and A4 size. This measurements should be given in X and Y direction.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. Auto CAD software is developed by an ……. Company.
   a) Italian
   b) Egyptian
   c) American
   d) Australian

2. ……. Software is used for water distribution and water management.
   a) GEO b) AQUA++
   c) ENERGY+ d) STAD PRO

3. In ……..position, 0° and 90° lines are drawn from one point to another point.
   a) Snap on
   b) Grid on
   c) Polar on
   d) Ortho on

4. …… command is used to print the auto CAD drawing
   a) EXPORT b) NEW
   c) PLOT d) QUIT

5. The ……functional key is a help window for Auto CAD.
   a) F1 b) F2 c) F3 d) F4

IPM3B

PART II (3 Marks)

Answer in one or two sentences

6. What is Auto CAD?
7. State any three softwares used in civil engineering.
8. What is the difference between 'Ortho on' and 'Ortho off'.

PART III (5 Marks)

Answer shortly

9. Write short notes on any three functional keys.
10. Explain about 'UNITS' in Auto CAD.

PART IV (10 Marks)

Answer in detail

11. What are the advantages of using AutoCAD to draw drawing?

Part – I Answers

1. (c) 2. (b) 3. (d) 4. (c) 5. (a)

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2.2 AUTOCAD BASICS

Learning Objectives

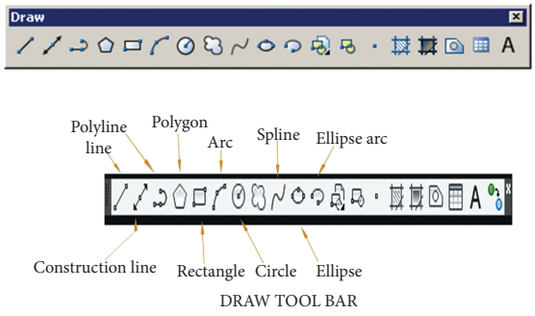
At the end of this lesson you shall be able to

- State the draw commands, modify, text & dimension commands, layer & editing commands and its uses.
- Draw the engineering drawing using commands.

2.2.1 Introduction

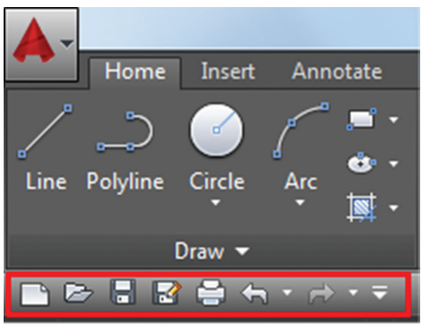
To draw a drawing using AutoCAD software so many commands are required. For this, there was a necessity of compulsory typing in the command box. But, in the latest or modified software of Auto CAD 2000, 2002, 2004, 2007, 2010 the highly used commands are given in toolbar or icon. Let us know the required commands to draw a building drawing.

2.2.2 Draw Commands

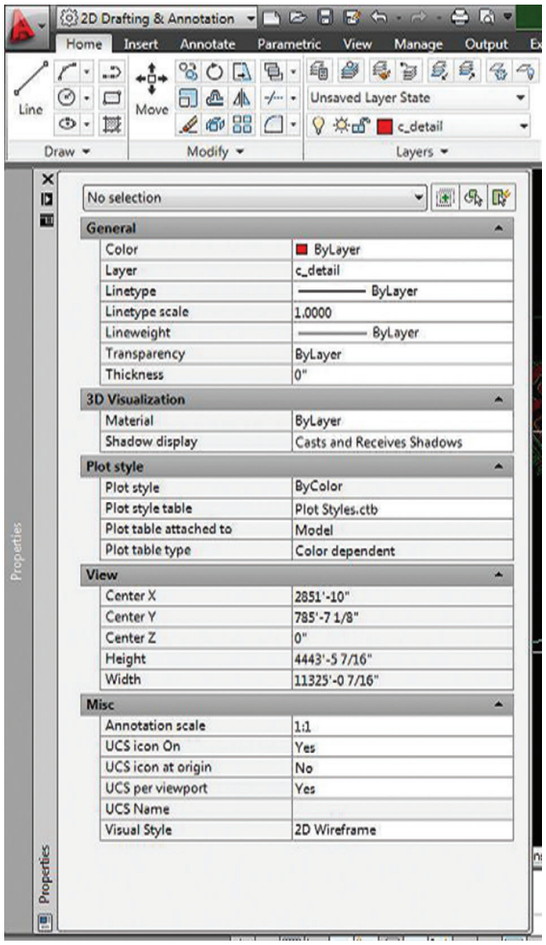


DRAW TOOL BAR

2.2.2.1 Line



Lines are drawn using line command. The line toolbar is used to draw the line (or) type 'line' and enter (or) type 'l' and enter. Instead of giving enter, we can also click the right button in the mouse.



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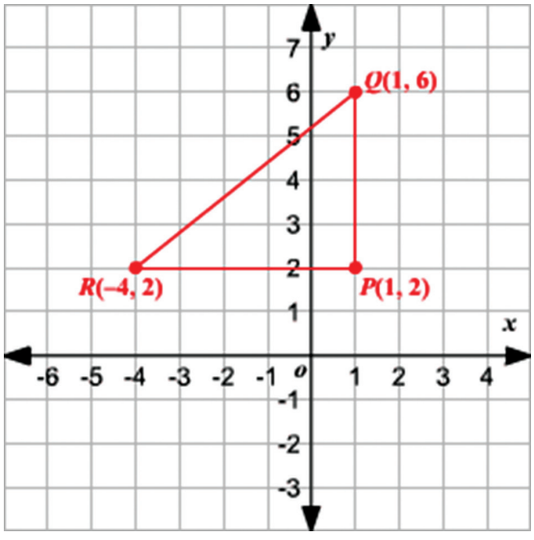
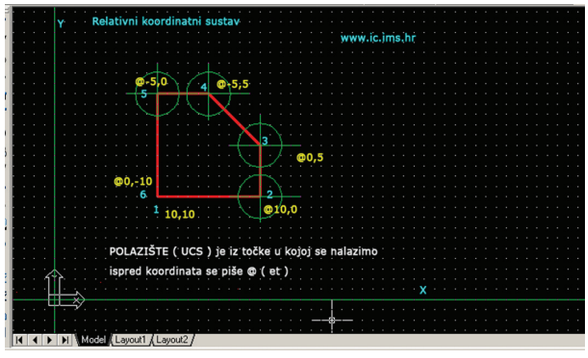
Lines are Drawn in Three Methods.

1. Absolute co-ordinate method.
2. Relative co-ordinate method.
3. Polar co-ordinate method.

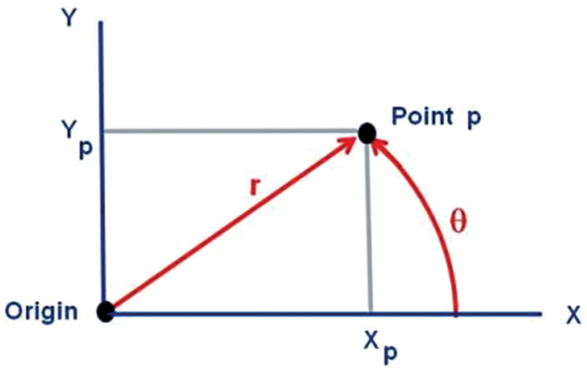
1. **Absolute Co-Ordinate Method:** In this method, we have to give the statement of points from origin.



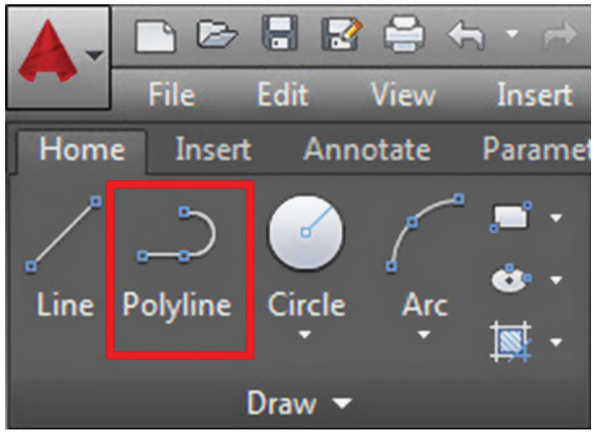
2. **Relative Co-Ordinate Method**: In this method, we have to give the co-ordinates of the starting point towards X-axis and Y-axis or distance of Y axis from the point.



3. **Polar Co-Ordinate Method**: In this method, sketch is drawn by giving the angle of direction and distance from starting point to the next point.



2.2.2.2 Polyline



Polyline means many characteristics of a line. It can be drawn by using the polyline toolbar or by typing PL and pressing ENTER key.

Special Charecteristics of Polylines:

1. Polyline has a single characteristic feature.
2. We can enlarge the size and thickness of line.
3. With polyline, we can draw different shaped drawings with a single characteristic feature.

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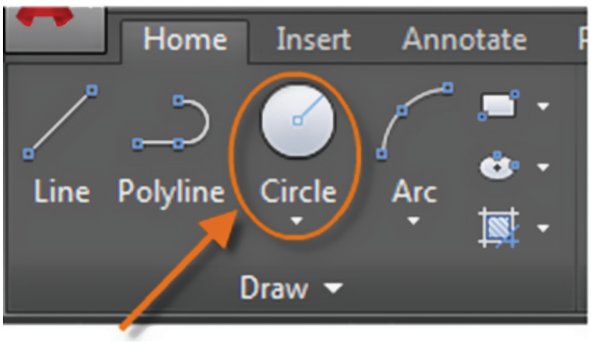
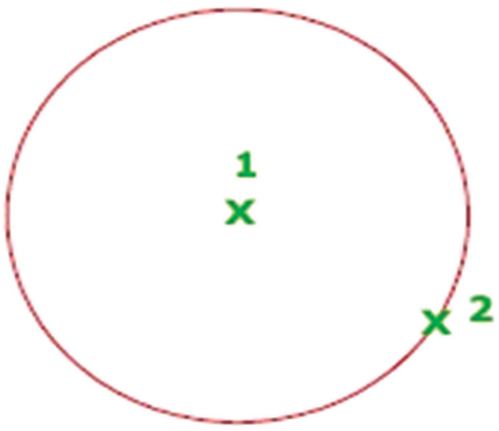
4. The line drawn by polyline can be easily changed.
5. One line can be joined with another line with (straight line + curved line) a single characteristics.
6. Structure of several lines drawn with a polyline is called an object. This command is highly useful to draw circumference and hatching.

2.2.2.3 Circle

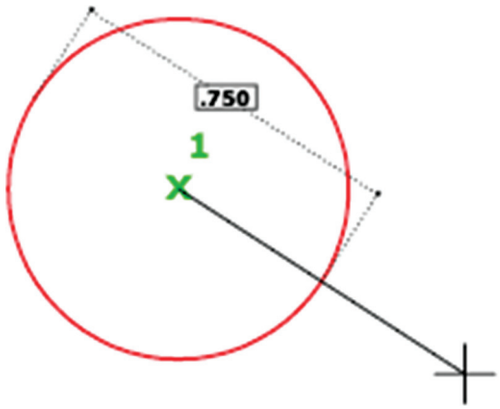


Generally, if there is a centre and radius, we can draw a circle. There are five methods to draw a circle.

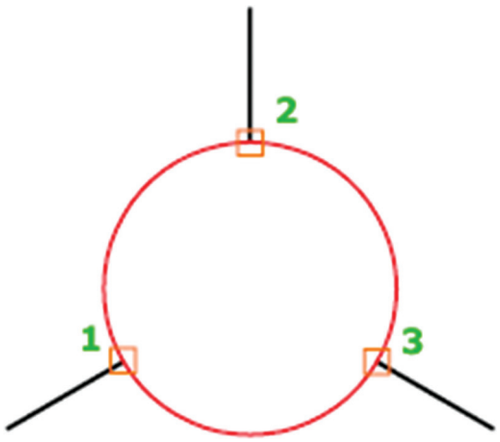
- **Centre Point Radius Method:** To draw a circle in this method, the centre point and radius should be given.



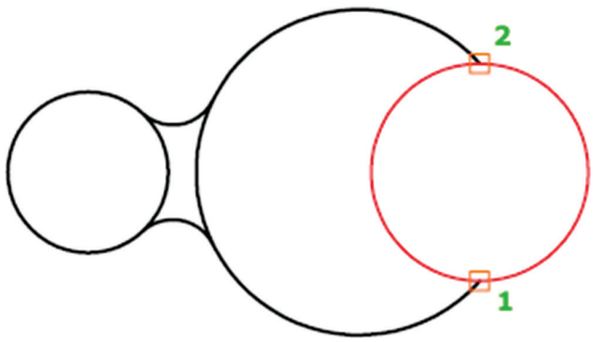
- **Centre Point Diameter Method:** In this method, the centre point and the diameter of the circle should be given to draw the circle.



- **Three Point Method:** To draw a circle in this method, three points in the circumference of the circle should be given.



- **Two Point Method:** Two points in the circumference of the circle should be given to draw a circle in this method.



- **Tangent Radius Method:** To draw a circle in this method, the radius and the tangent position should be given.

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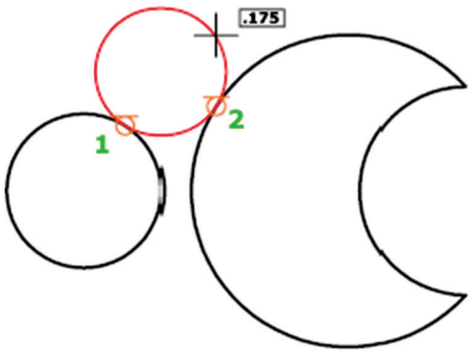
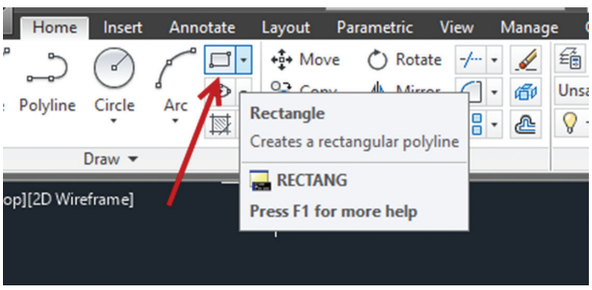


ACTIVITY 1

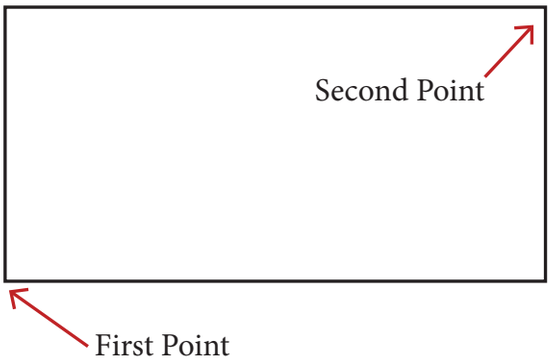
Draw some circles using circle command and take print outs.

2.2.2.4 Rectangle



There are two dimensional measurements available for rectangle such as length and breadth (or) length and depth. When we are drawing by AutoCAD, we are not using these measurements. Instead of measurements, the rectangle is drawn with diagonal.

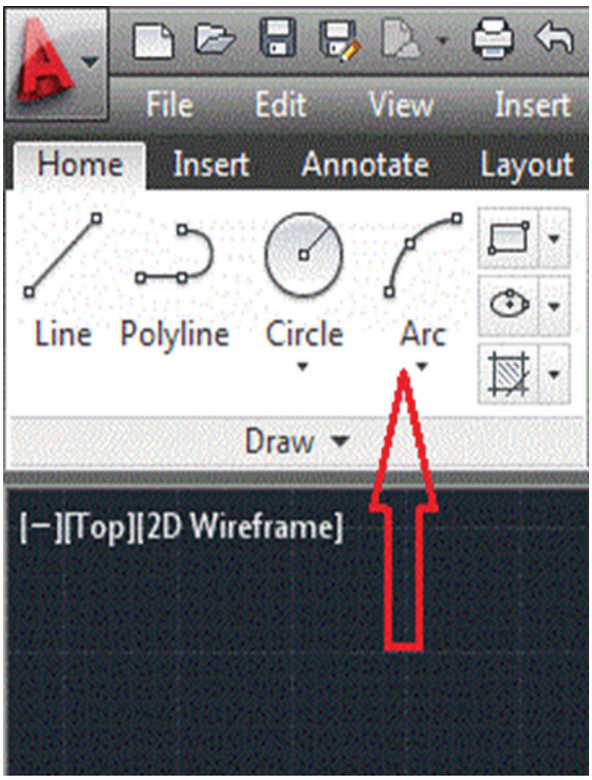
We have to give the values of lower edge of left side and opposite corner of the rectangle. Two corners are noted as first corner and other corner respectively.



ACTIVITY 2

Draw some rectangles in various sizes and take print outs.

2.2.2.5 Arc



Part of a circumference of a circle is called as an arc. It is curved in shape. Three points are required to draw an arc. We can also draw the arc with the centre point of arc, angle of arc and radius of arc. There are six methods to draw an arc.

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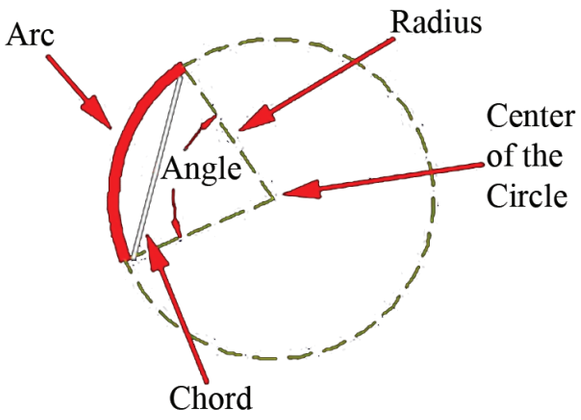
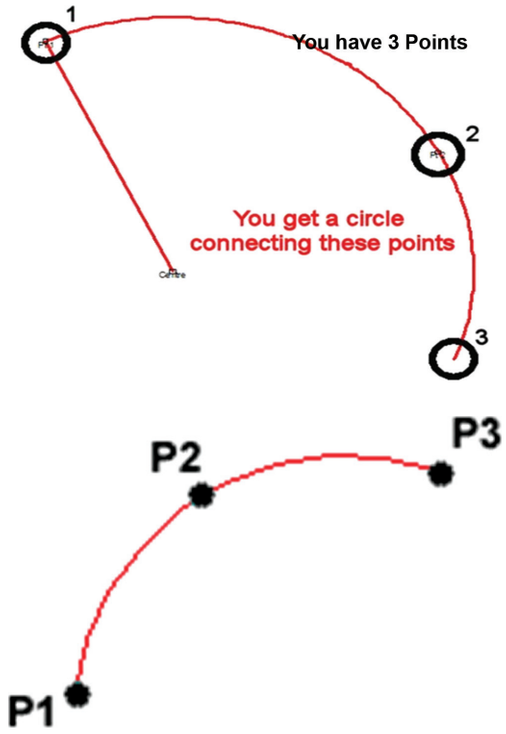
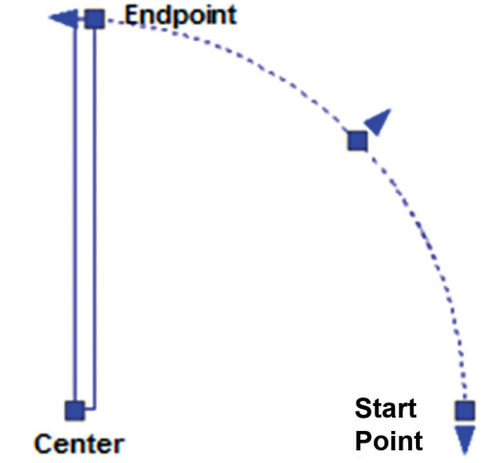


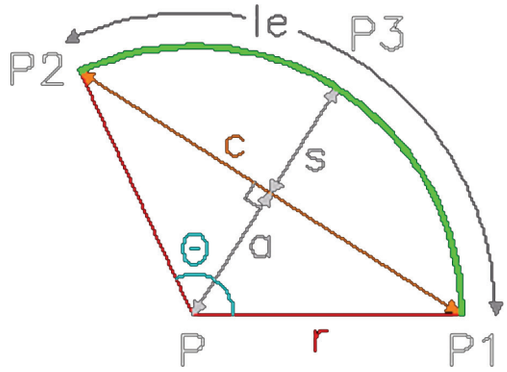
a) Three Points Method



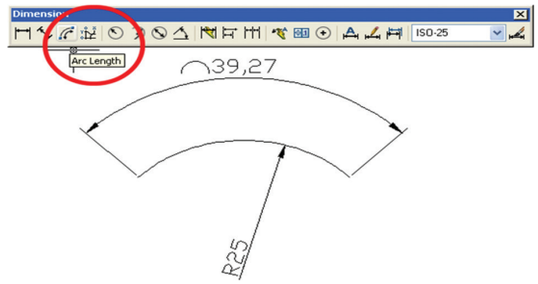
b) Start, Centre and End Point Method



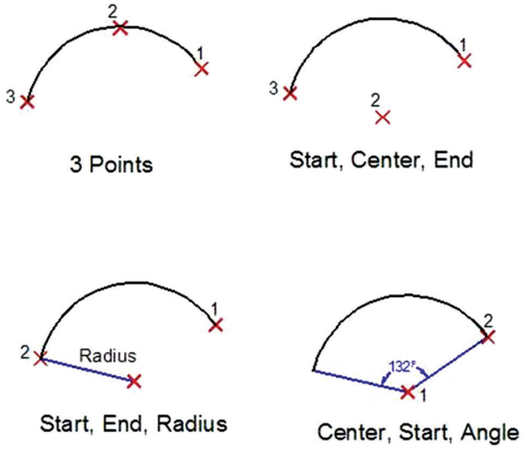
c) By Start, Centre and Included Angle



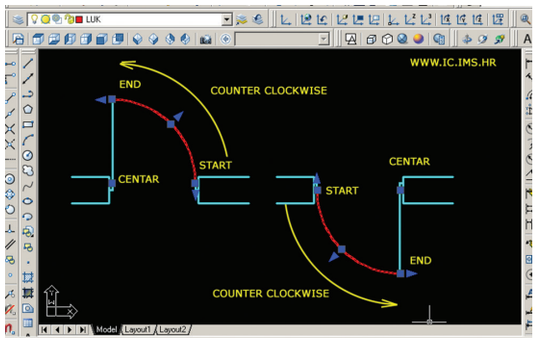
d) By Start, Centre and Length of Chord



e) By Start, End and Radius



f) By Start, End and Direction



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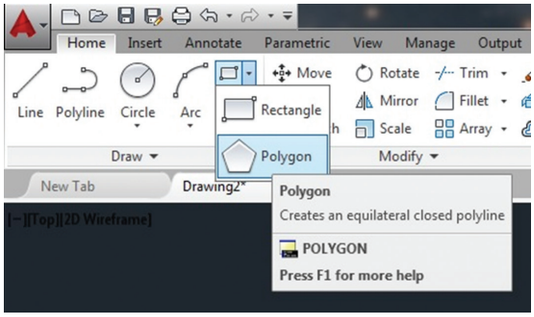
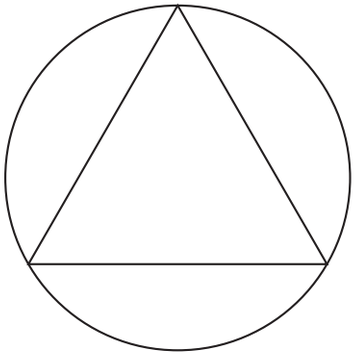
ACTIVITY 3

Draw some arcs by using any one method and take print outs.

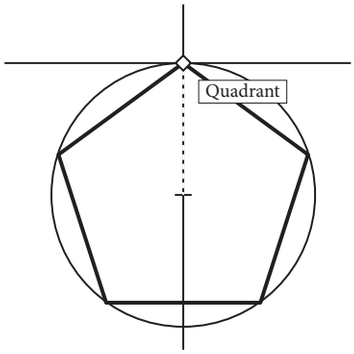
2.2.2.6 Polygon



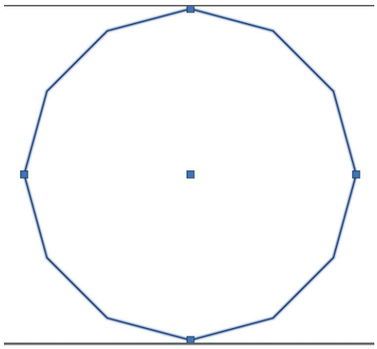
A closed drawing drawn with several angles (or) with several sides is called as polygon. In this, angle (or) sides should be equal in measurement. Polygons of 3 to 1024 sides can be drawn.



3 Sides Polygon (Triangle)



5 Sides Polygon (Pentagon)

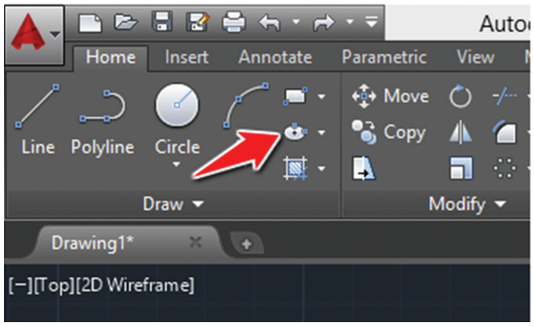


Polygon With 12 Sides (Dodecagon)

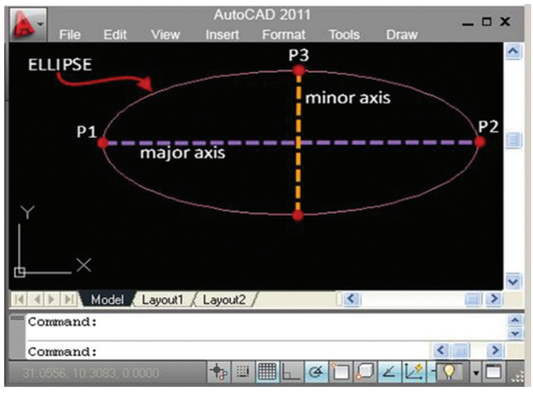
ACTIVITY 4

Draw some polygons of different number of sides and take print outs.

2.2.2.7 Ellipse



Ellipse is a closed curve drawn by two different axes. One axis is noted as major axis and another is noted as minor axis. It is noted that half of the distance of minor axis is axis distance. With this point, we can draw the ellipse in 4 methods.



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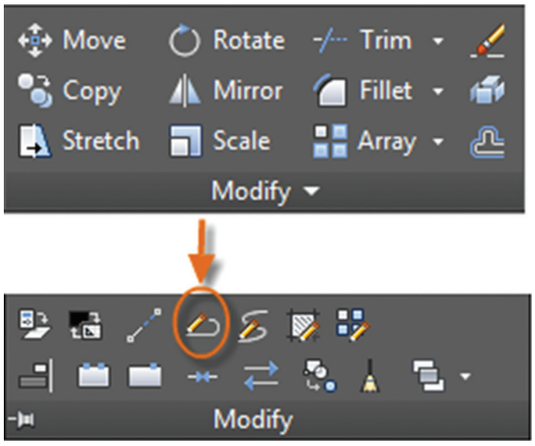
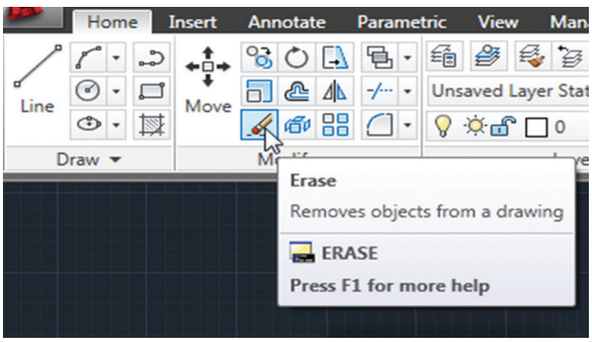
ACTIVITY 5

Draw an ellipse and take print out.

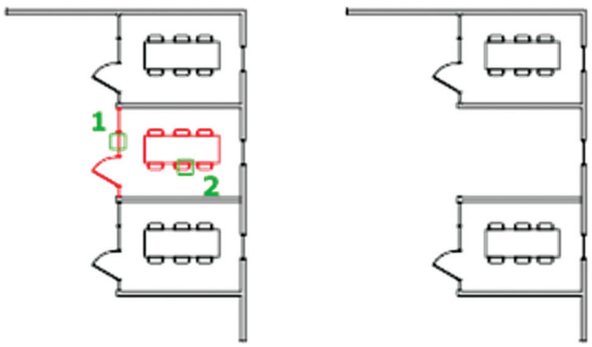
2.2.3 Modify Commands



2.2.3.1 Erase Commands

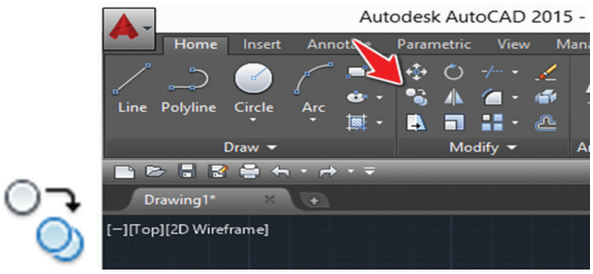


By using this command, objects of one (or) several lines are removed (or) erased.

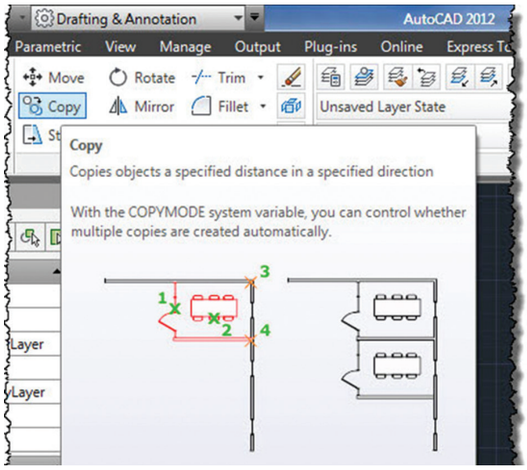


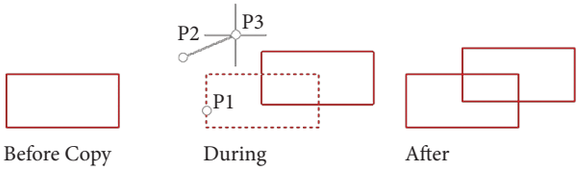
Before Erase **After Erase**

2.2.3.2 Copy

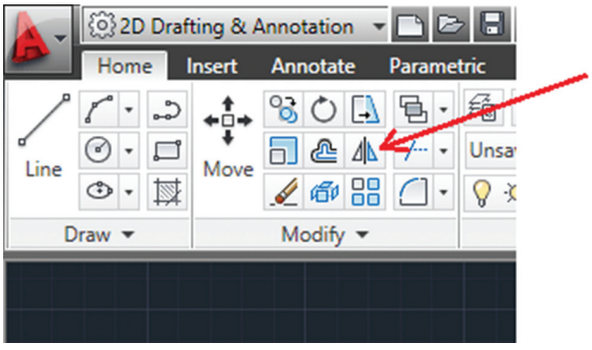


The object should be drawn before duplicating the object. Then the base point of the object is selected and the duplicate object is fixed at the displacement point.





2.2.3.3 Mirror



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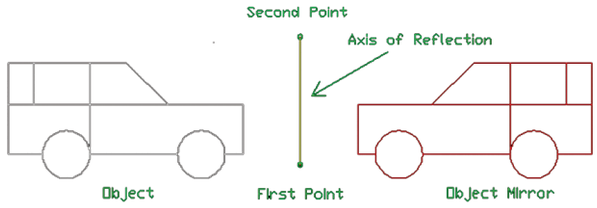
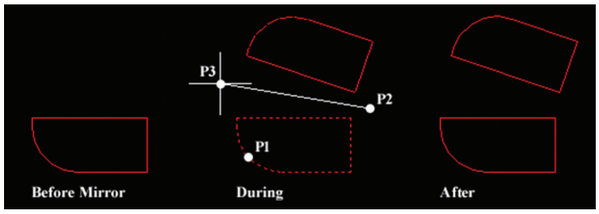
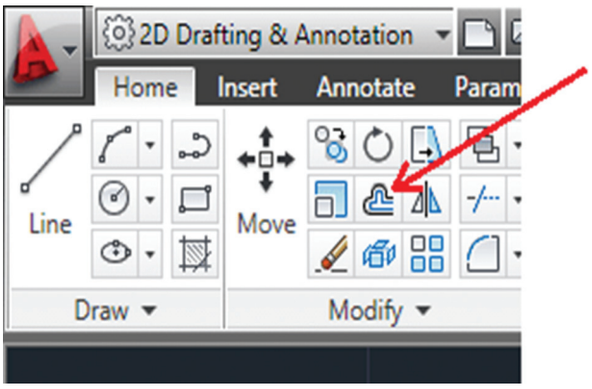
If an object is placed in front of a mirror, the object reflects in the mirror. Like this, if we draw mirror line at an object, the object will reflect in reverse direction.

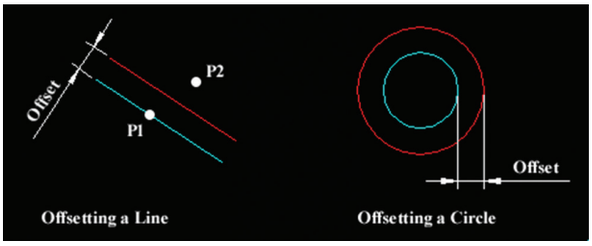
We can draw quickly the symmetrical figures by using this mirror command. Hence it reduces the time taken for drawing.



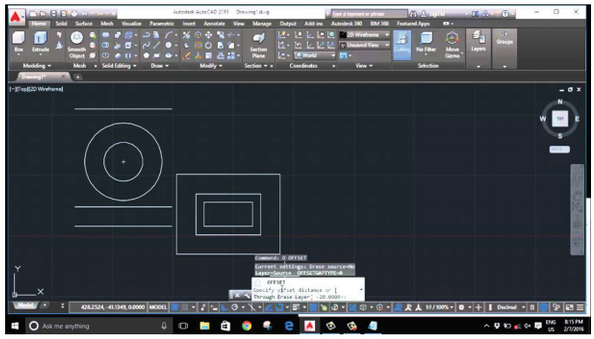


2.2.3.4 Offset

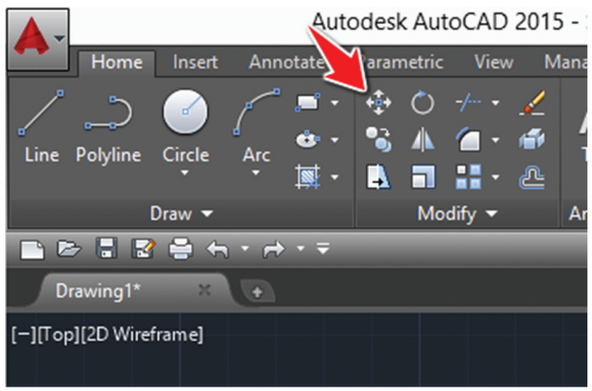




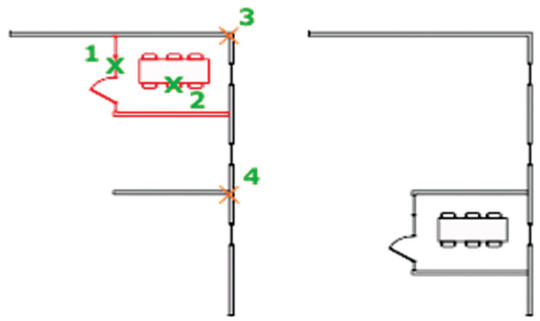
By using this command, curves, circles, rectangles are drawn parallel to some distance.



2.2.3.5 Move



When an object is moved from one place to another place, it is called as moving. It is similar to copy command. The only difference is, old object and duplicate object will be in copy command. But, the old object will not be there in move command.



Before Move **After Move**

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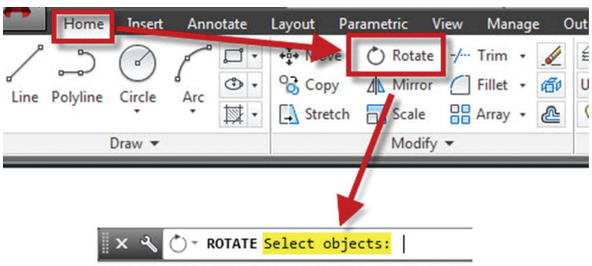
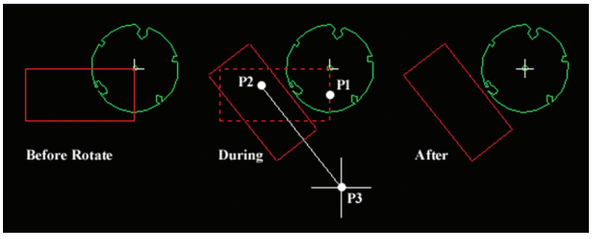
2.2.3.6 Rotate

ROTATE



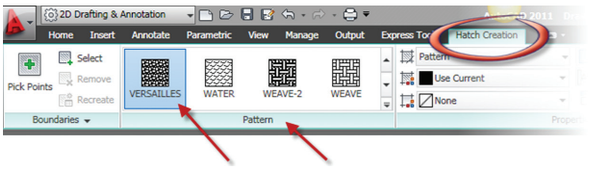
Hit <enter> after selecting objects

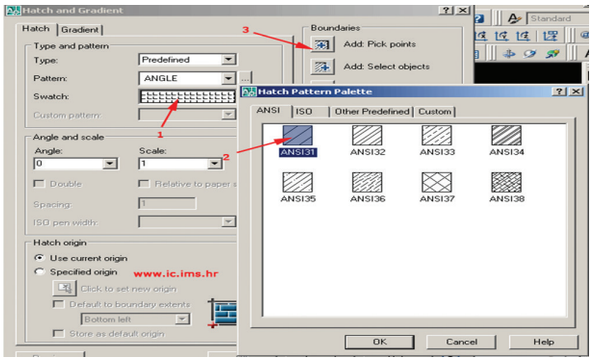
We have to use rotate command to rotate all the drawn objects or a single object. The object may be rotated from one position to another in a particular angle we need.

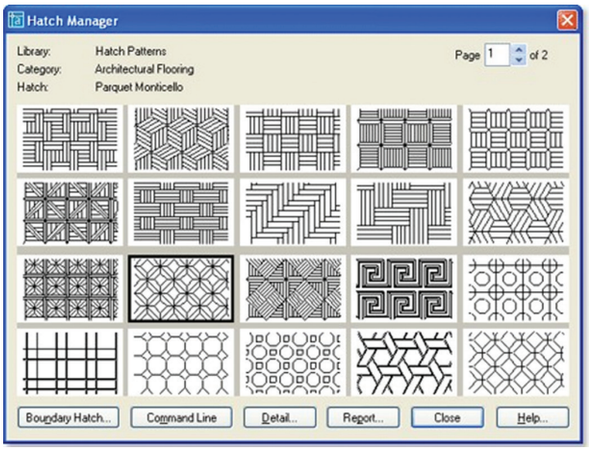


2.2.3.7 Hatching

This command is used to construct a sectional view of the drawing object and to show the inner parts of the objects in detail. Object will be filled by several patterns as shown in figure.

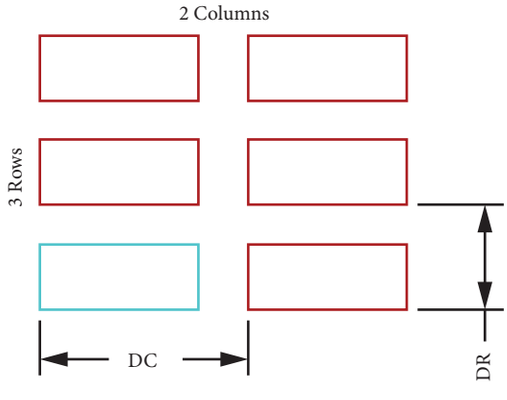






2.2.3.8 Array

Classifying an object in uniform order is called array command. This may be formed by square, rectangular (or) circular classification. Array of square formation is called square array. Array of rectangular formation is called as rectangular array.



Rectangular Array

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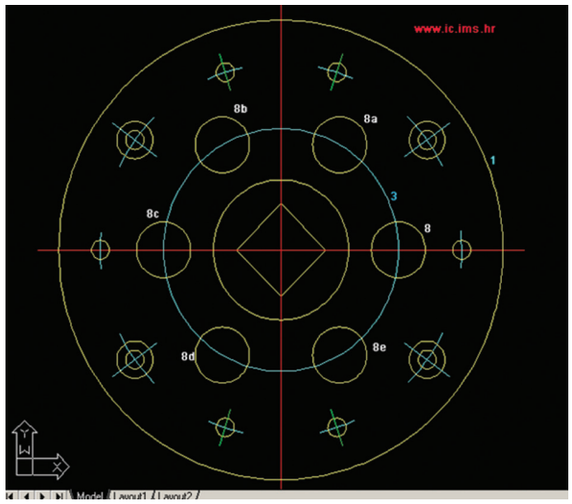
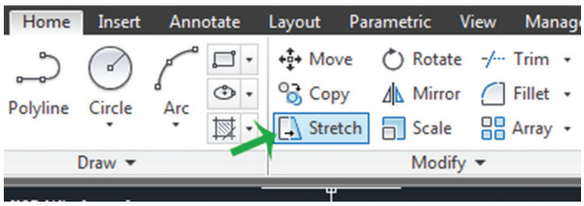
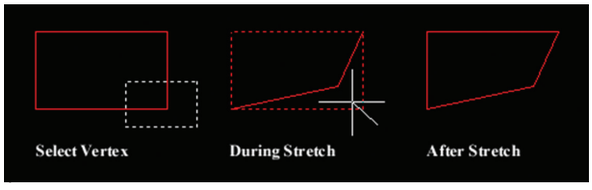


Array of circular formation is called circular array.

2.2.3.9 Stretch



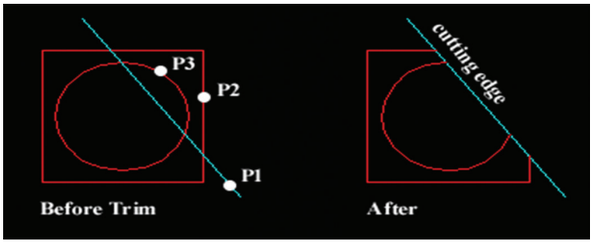
This command is used to extend or reduce an object. Any form of an object can be extended or reduced in stretch command. We can stretch the objects of curve, polyline, solid by using this command



2.2.3.10 Trim

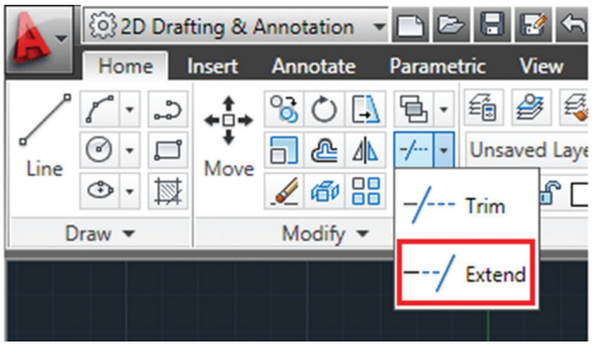


After drawing an object, the unnecessary lines are removed from the particular place by using this command. We can trim the form of circle, curve, polyline by using this command.

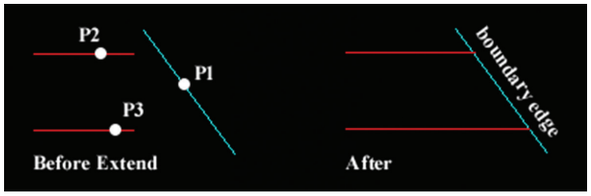


2.2.3.11 Extend

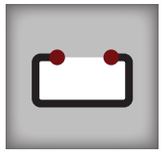




This command is used to extend a line. If we select the boundary edge, that line will be extended upto the selected boundary even though if there is any object in the centre.



2.2.3.12 Break



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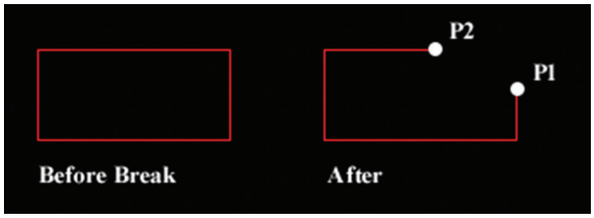
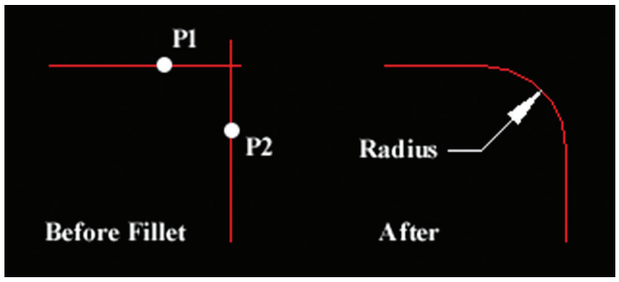
This break command is used to break the middle portion (or) edge of a line. By using this command we can break a line, circle, ellipse or polyline.



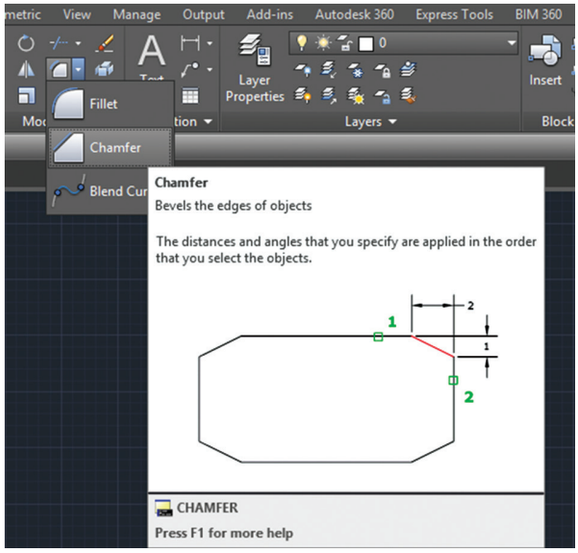
2.2.3.13 Fillet

Fillet helps to convert sharp edges of square, rectangle or polygons to round edges. The rounded edge of different radius can be drawn using this command.

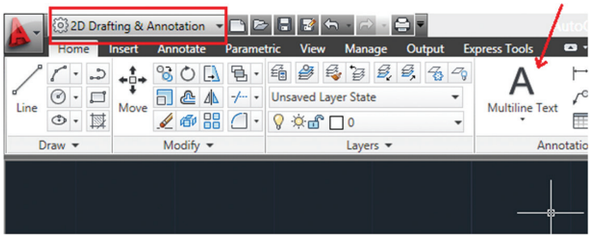


2.2.3.14 Chamfer

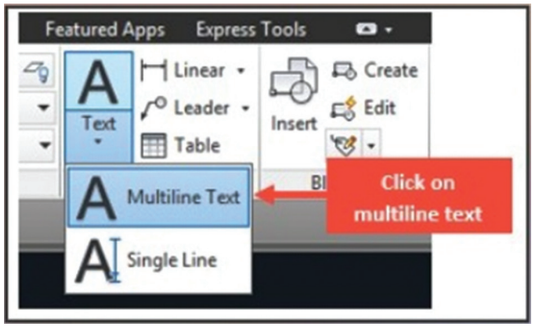
This command is used to bevel the edges of objects. The distances and angles are applied to the object in the specified order.



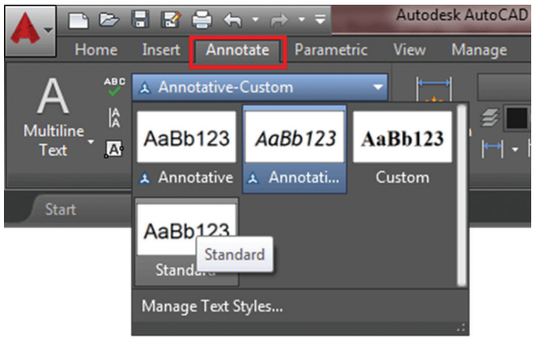
2.2.4 Text Command

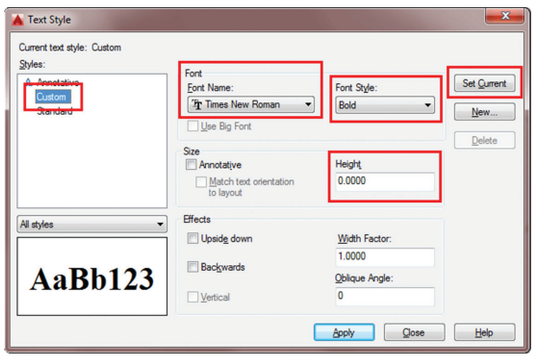


By using this command, letters and numerals are typed by using the keyboard. Instead of this command, D text command is available. Dynamic Text is called D Text.



2.2.4.1 Text Style





This command is used to select the type of text. We can select standard text

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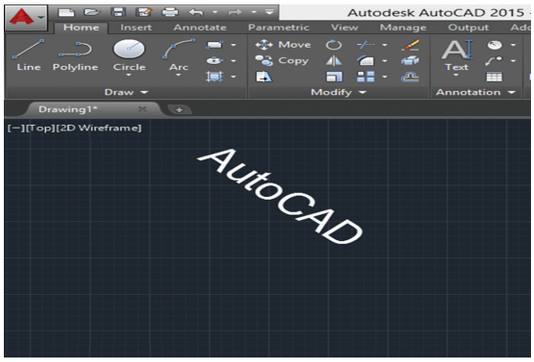
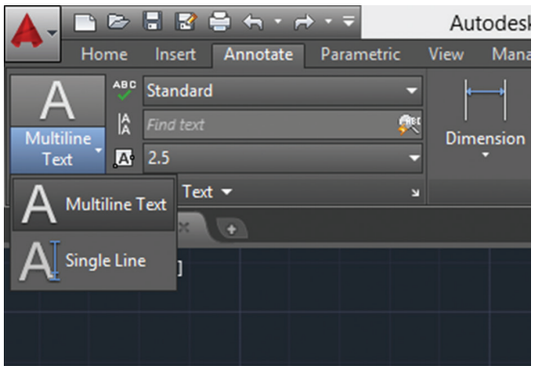
style (or) annotative text style from this command.

2.2.4.2 Single Line Text

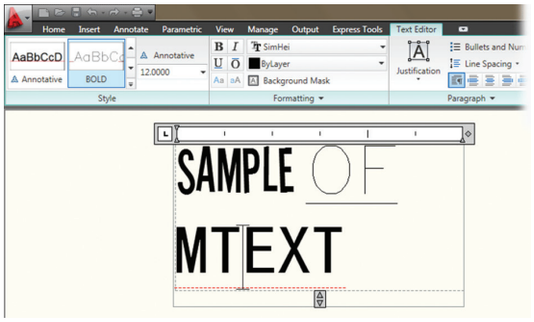


Single line text is used for small content and to write short words.

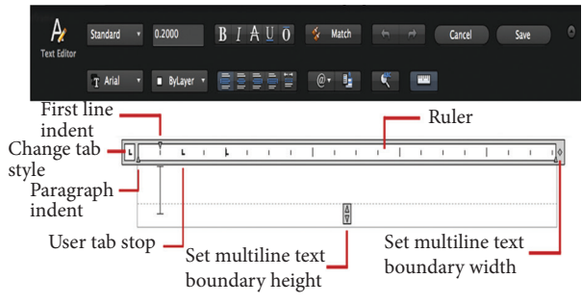
2.2.4.3 M Text



M text command is used to form the typed words into a sentence. This command will decide the text boundary. The typed sentences are included in the boundary. The lines are formed as a single object.

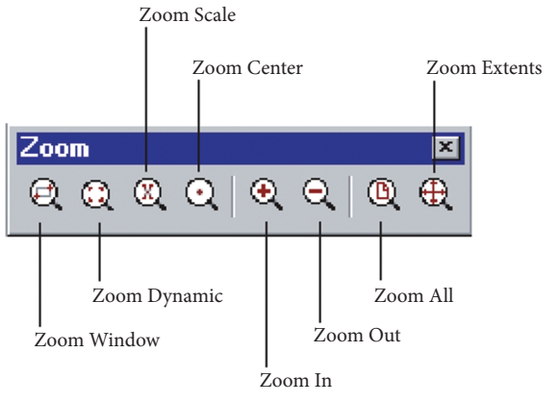


2.2.4.4 Editing Text



If there is any spelling mistake in the typing, it may be corrected by using this command.

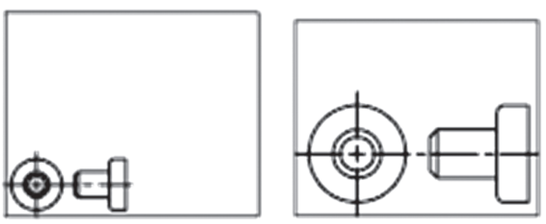
2.2.5 Zoom Command





This command is used to see the object by magnifying (or) reducing it.

i) Zoom Extent



before Zoom Extents

after Zoom Extents

ii) Zoom Window

iii) Zoom Dynamic

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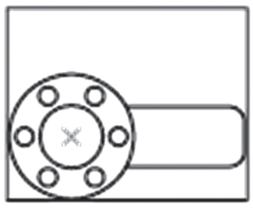
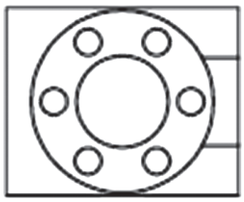
iv) Zoom Center

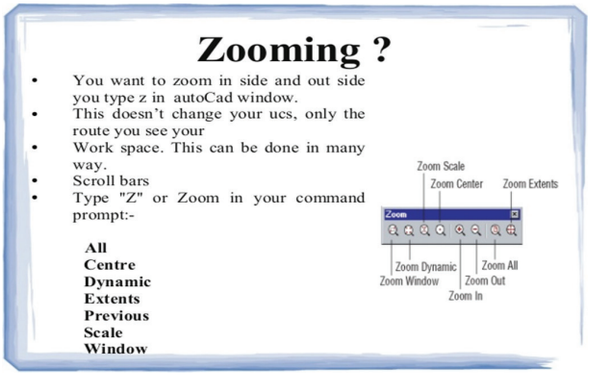


before Zoom center

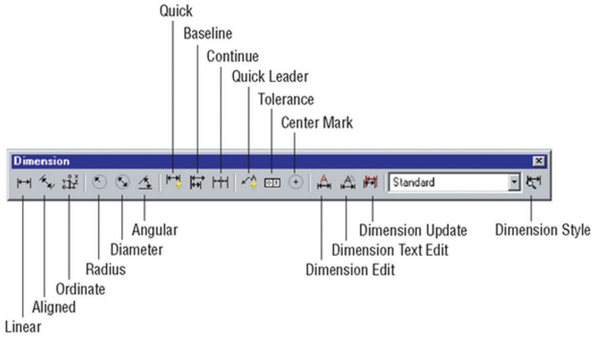


after Zoom center, magnification increased

v) Zoom All



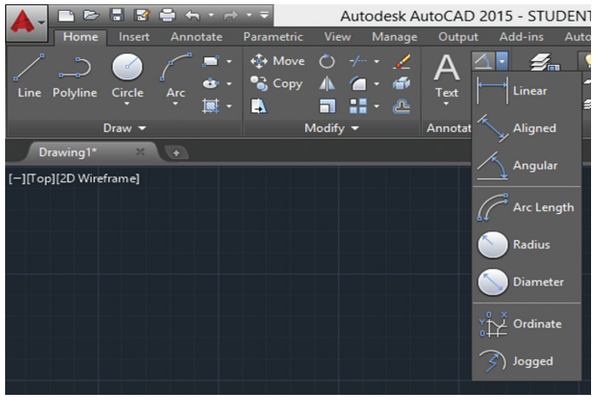
2.2.6 Dimension



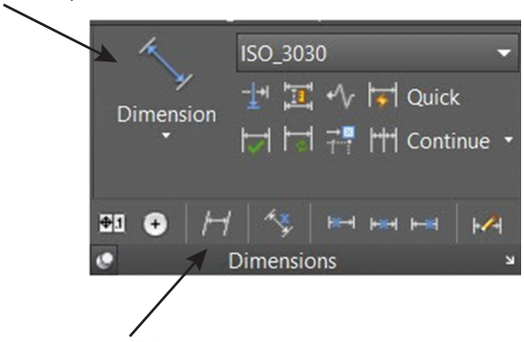
This command is used to dimensioning an object. If an object is drawn without measurements, then the drawing will not attain its fulfillment. If we furnish the details such as length, breadth, depth, angle, radius, diameter of the object, then the object gets nature of producing formation.

2.2.6.1 Methods of Dimensioning

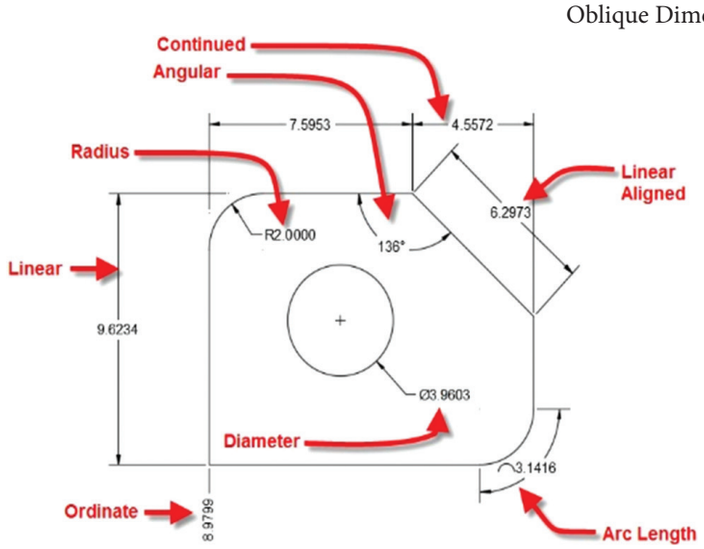
In the classification of dimensioning there are linear, angular, radius, diameter and co-ordinates are available. Some of the dimension variable used in dimensioning is shown in the figure below.



For best results use the Aligned Dimension style for Isometric Dims.



Oblique Dimension Button



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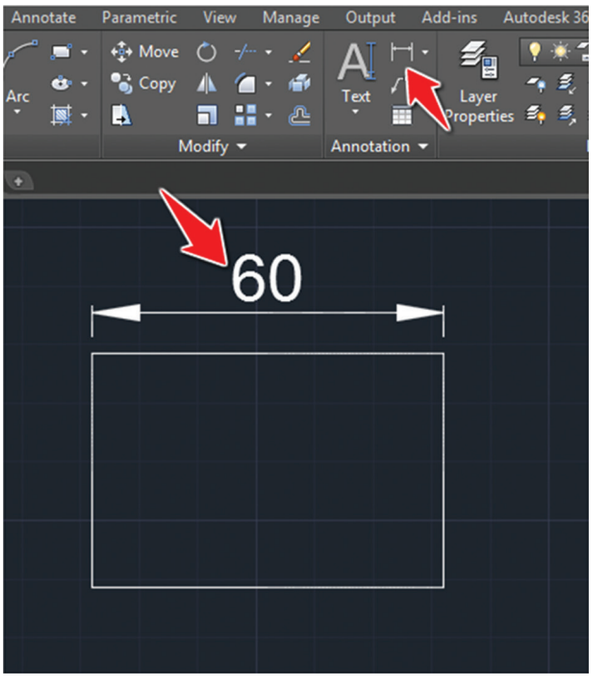
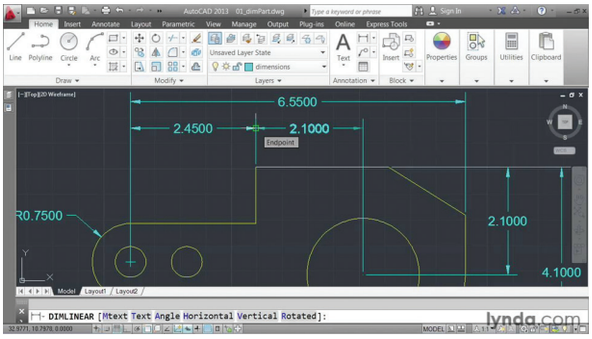
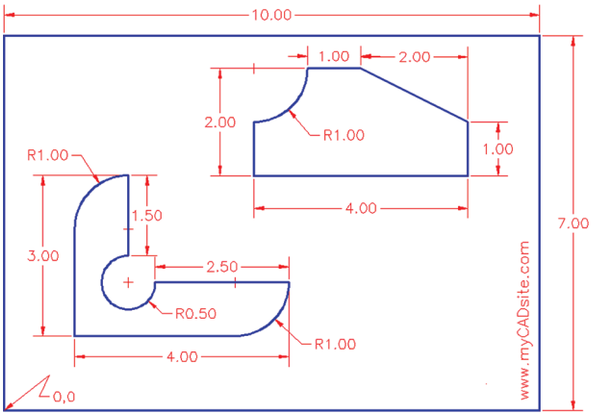
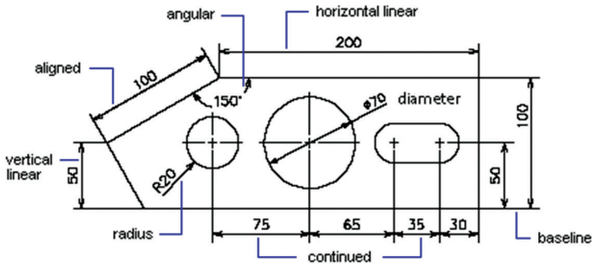


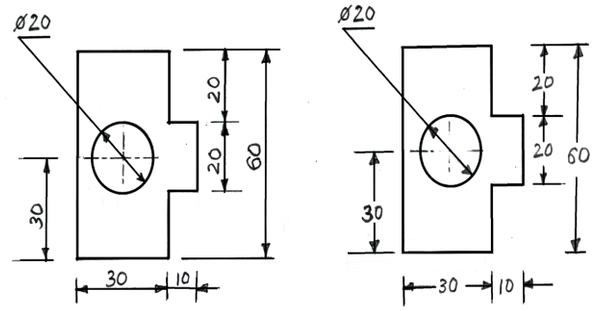


Dim Linear



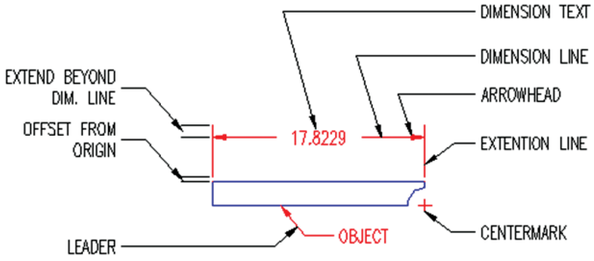


Dim Linear, Dim Angular, Dim Aligned, Dim Radius, Dim Diameter, Dim Baseline, Dim Continued.



Systems of Dimensioning

2.2.6.2 Dimension Line



Dimension line is a single line. Side measurements of the objects are indicated with arrow mark from one end to another end. The vertical line from both end of the object is called extension line.

2.2.6.3 Dimension Text

Selection of actual size of the side of an object by AutoCAD is called dimension text.

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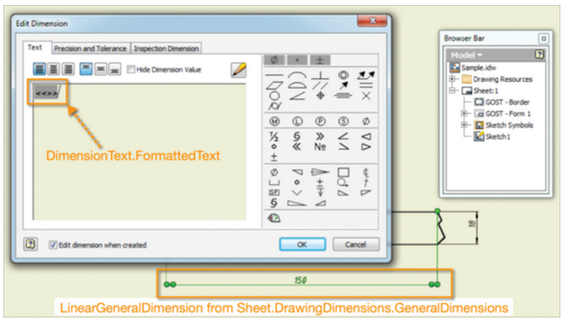
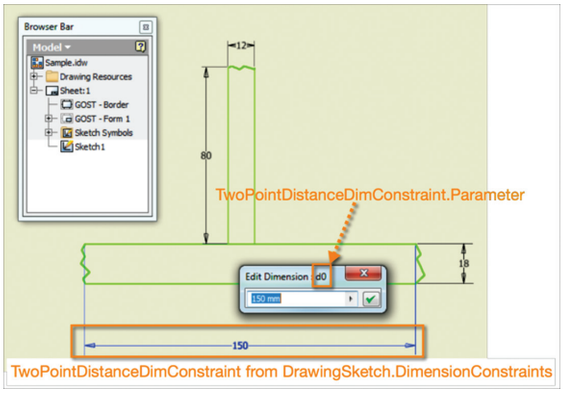
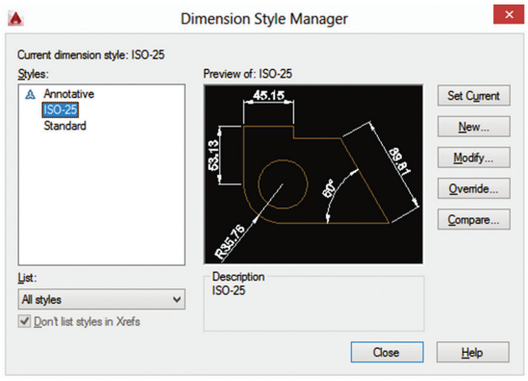


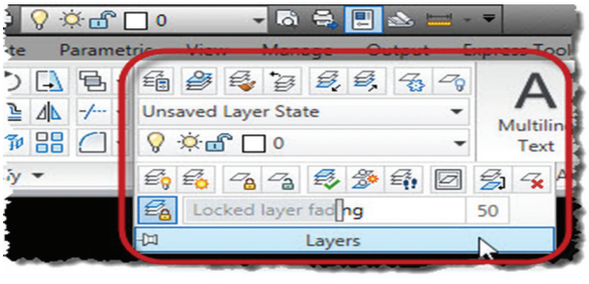


2.2.6.4 Dimension Style

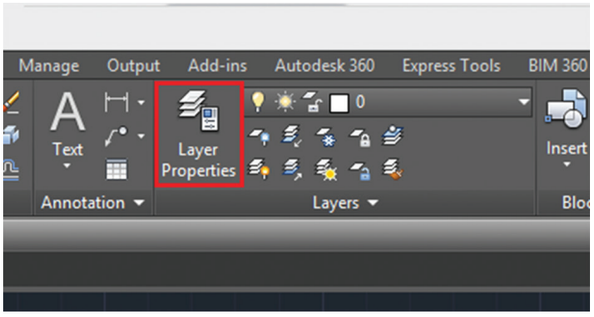


This command is used to select style for dimension.

2.2.7 Layer



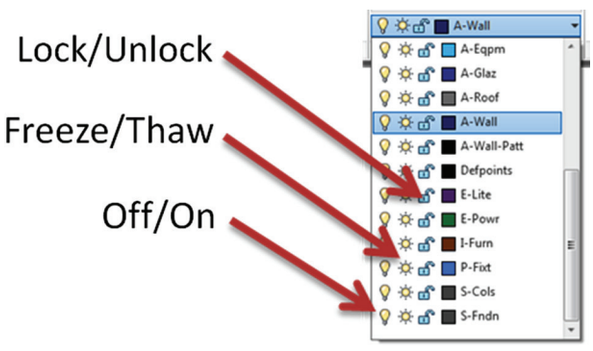
It is very tough to understand a drawing, if we should show the full details of the object in the same drawing. When we prepare the manual drawing, we will give the details in several places of the object. If we want more information another drawing is to be drawn.



To eliminate this problem, drawings are drawn in the layer method in AutoCAD. In this method, we can take print out of the object with required details.

2.2.7.1 Layer On / Off

This characteristic is used to switch off the unnecessary layer. When we switch off the particular layer, the drawing drawn in that layer will not be visible to our eyes. Also that drawing cannot be printed or plotted. That layer may be switched on when required.



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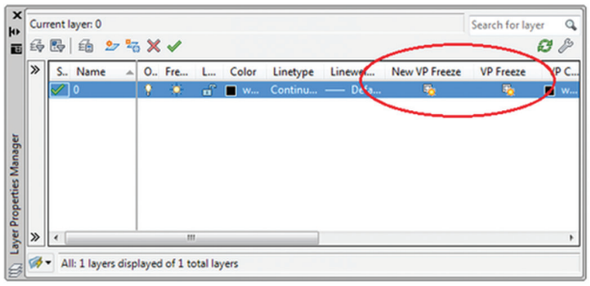
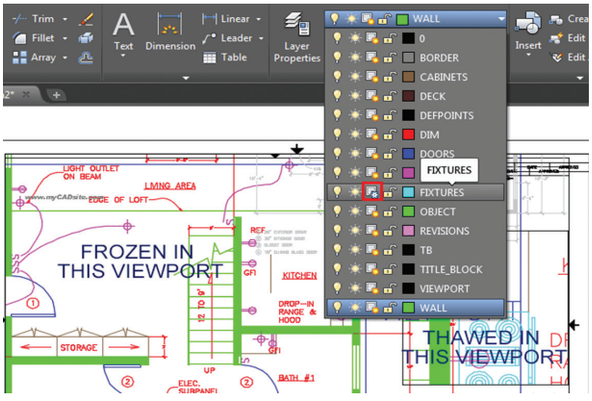
2.2.7.2 Freeze



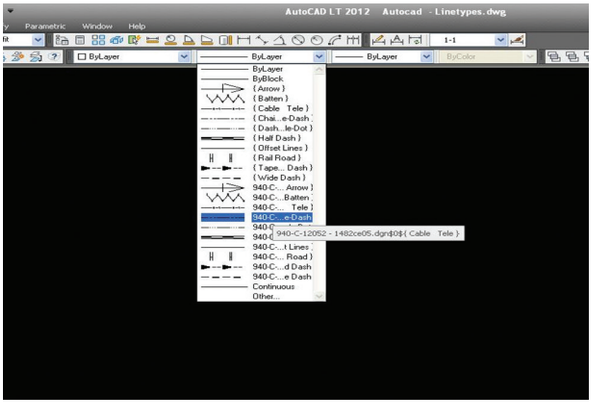
When we freeze a layer, the objects in that layer are hidden and printing is also not possible.

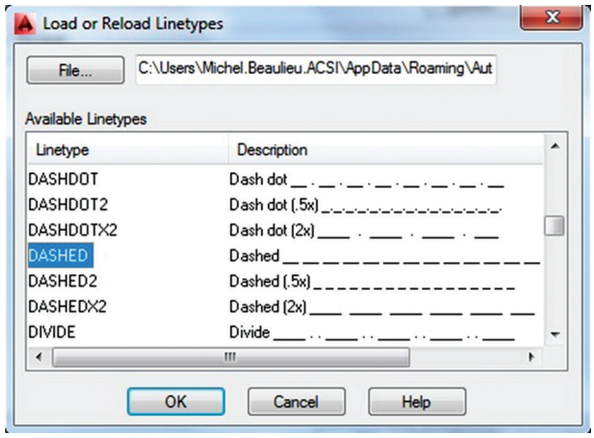
2.2.7.3 Thaw

Opposite form of freeze take is thaw take. To operate the freezed layer again, thaw is used.



2.2.7.4 Line Type

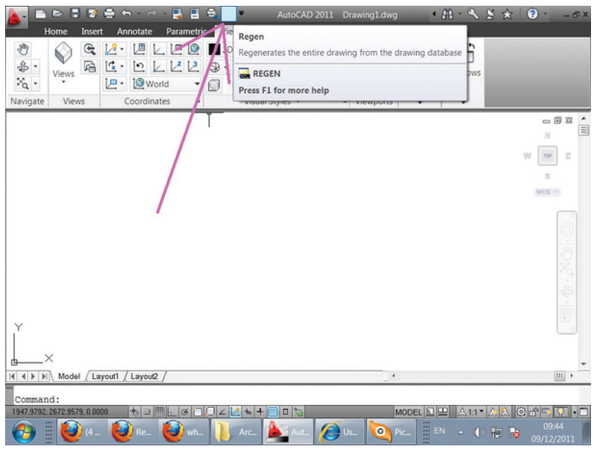




If we press this (line type) option several types of lines will appear in model structure. We can select types of lines such as centre line, continuous line, hidden line and dashed line, etc.

2.2.8 Editing Commands

2.2.8.1 Regen



To renew a drawing which is already drawn, this command is used. Sometimes the drawn object can be seen flat, when we draw a circle or an arc. Regen command is used to remove this flat formation.

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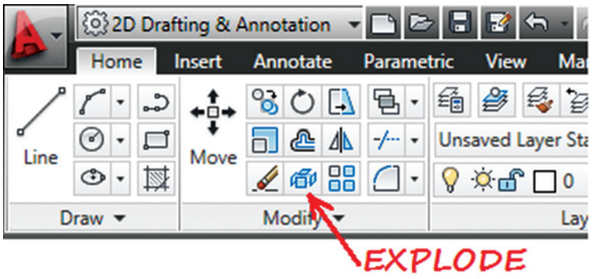
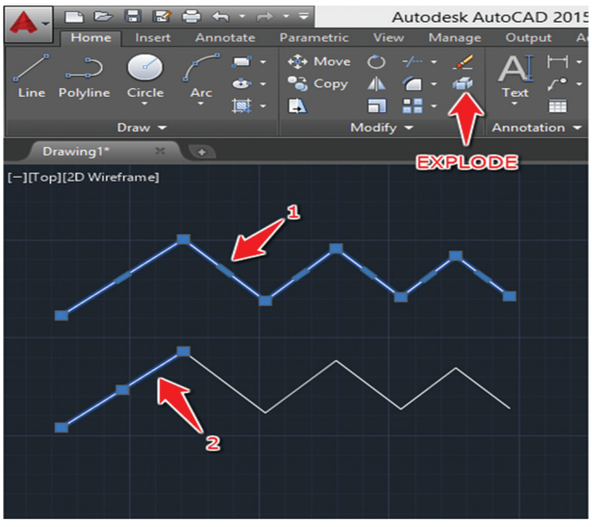
2.2.8.2 Explode

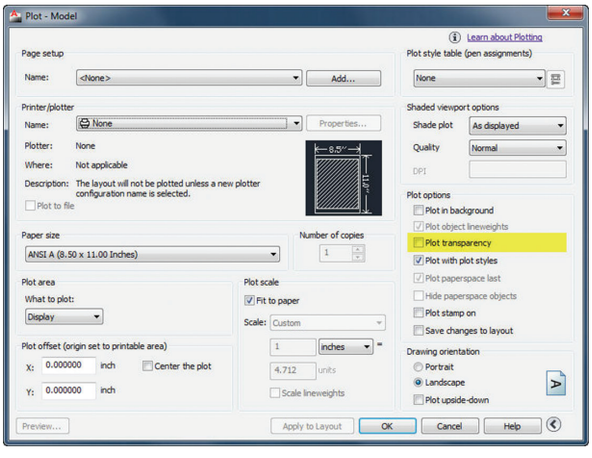






Objects of polyline, polygon can be changed into individual object by using this command.

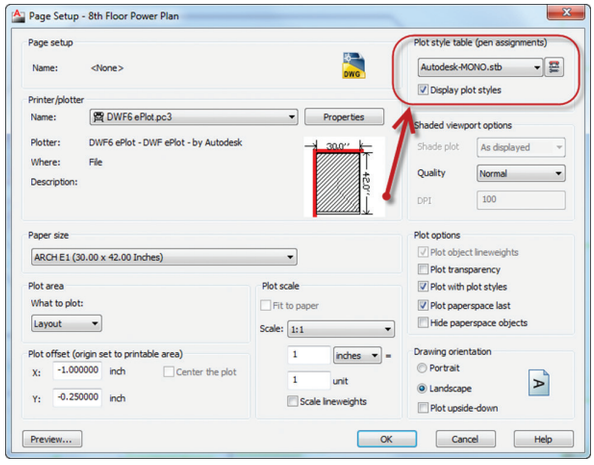
2.2.8.3 Print



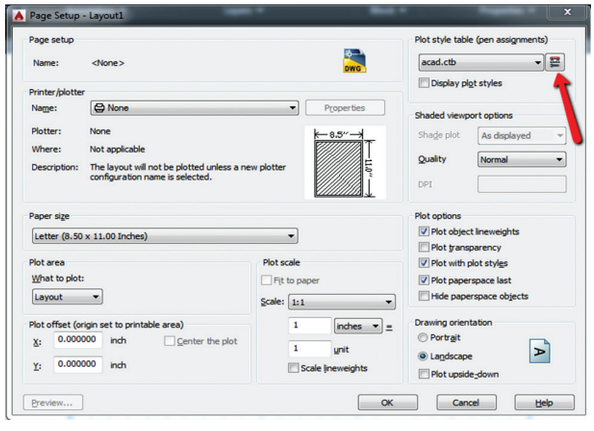
To copy the drawing we have drawn in ordinary sheet (or) tracing sheet, this command is used. There are two methods in copying such as printing and plotting. Printing is to take print by using dot matrix, inkjet and laser printer. With this normally we can take print out in A3 or A4 sheet.

2.2.8.4 Plot

Plot is nothing but taking tracing sheet print out using Indian ink by plotter instrument. These printouts taken in tracing sheets is used to make several copies by blue printing. Plotting can be made upto A0 size. Now-a-days photo print plotting can be carried out using color plotters.



2.2.8.5 Paper Size and Orientation



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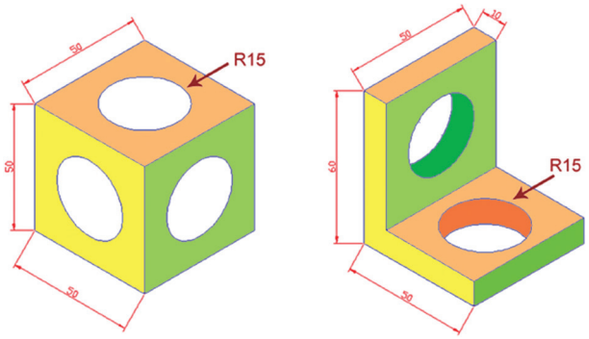
In this part we can decide the size of paper and orientation for plotting or tracing. The sizes of paper are A_4, A_3, A_2, A_1, A_0. The orientation for drawing may be landscape or portrait.

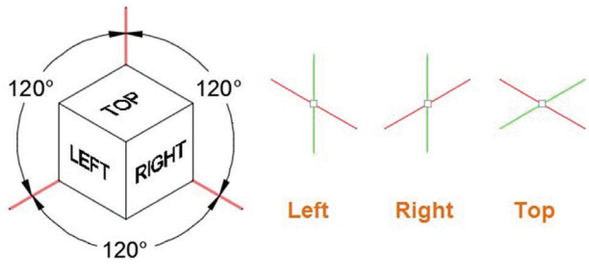
2.2.9 Isometric Drawings:



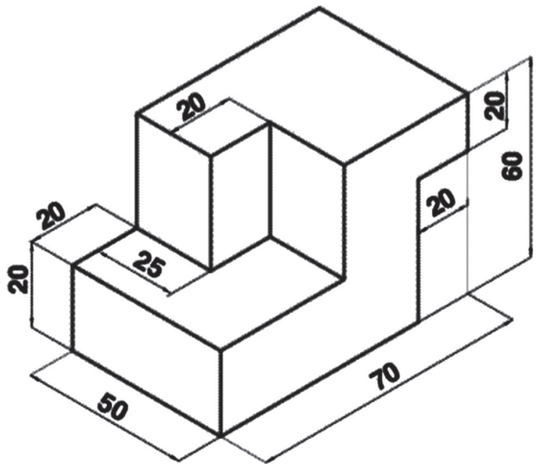
Object drawn by isometric drawing will be in visualizing shape. Full details of object with various view/angle is shown in orthographic projection. We can give full details only when an object is drawn both in orthographic and isometric views.

2.2.9.1 Isometric Projections

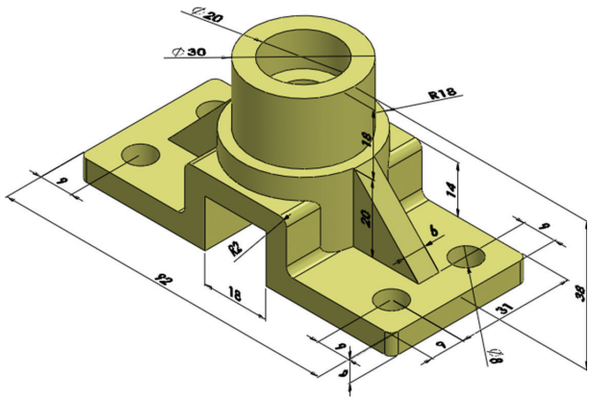
Isometric view means equal sized view. That is we can see the views of the 3 axis of an object in 120°.



The drawing should be drawn to full fize in this method. We should not use hidden line to show the inner part which are not visible.



The drawing should be drawn using 3 axes in this method.



ACTIVITY 6

Draw isometric views of a square and a rectangle by using AutoCAD and take print out.

Axis drawn in horizontal position at 30˚ is called right horizontal axis and the axis drawn at 30˚ to the left side horizontal position is called left horizontal axis. In between these axes, an axis at 90˚ is called vertical axis.

We have to change these three axes when we draw isometric drawing. That is, the cursor is moved to right axis and lines

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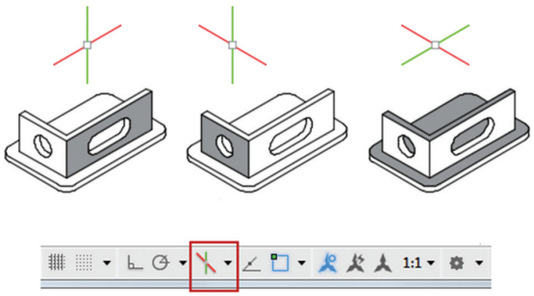
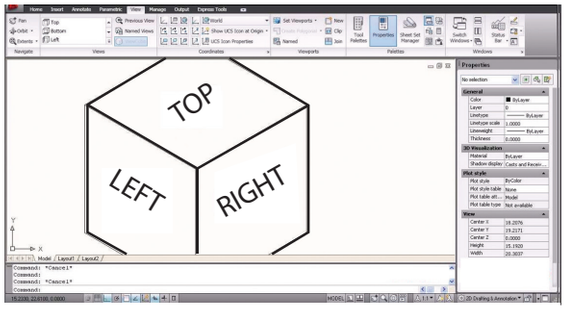
are drawn in one side. Then the cursor is moved to left axis and lines are drawn in another side. Like this upside lines are drawn by moving to vertical axis.

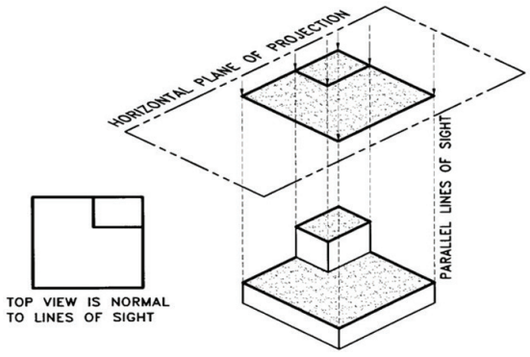


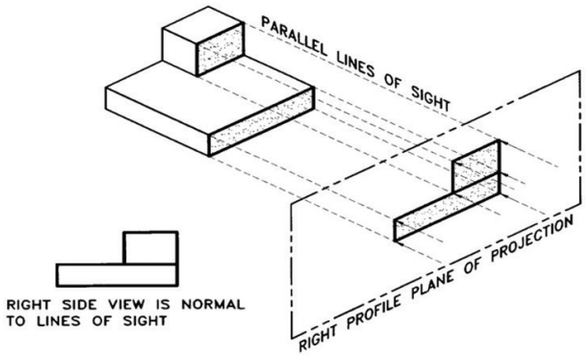
When isometric drawing is drawn the axes are changed and planes are drawn parallel to that axis. These are called isometric plane.

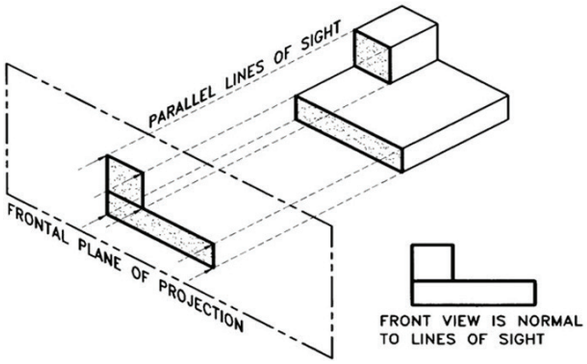
So, Isometric drawings are drawn with three planes of right side plane, left side plane and top plane.

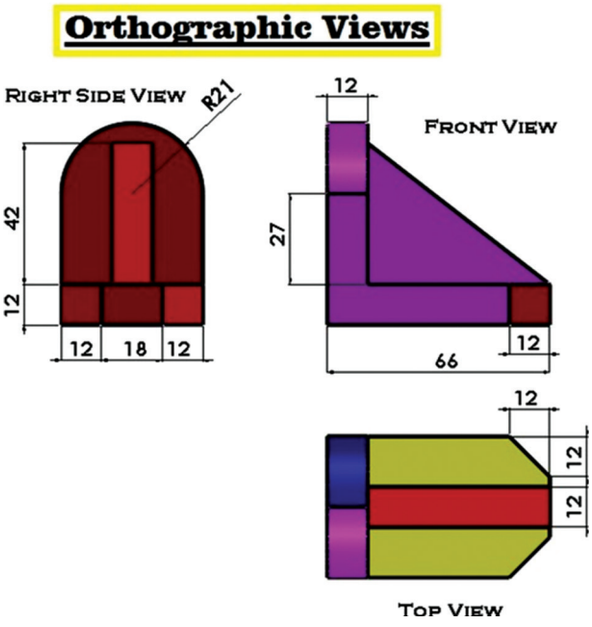


2.2.10 Orthographic View









Orthographic views are multiple views of a single object. It is a two dimensional drawing of three dimensional object using two or more additional views of the object in the 3 axes. (x, y and z)

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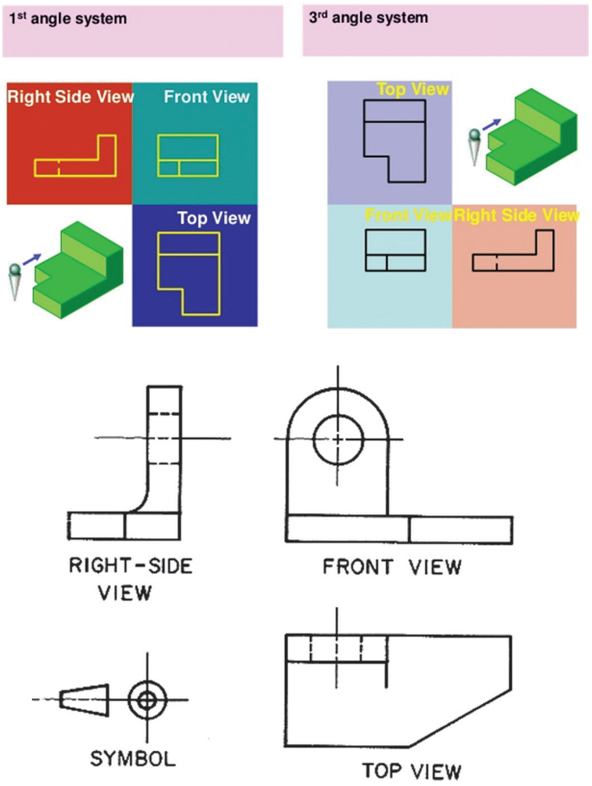
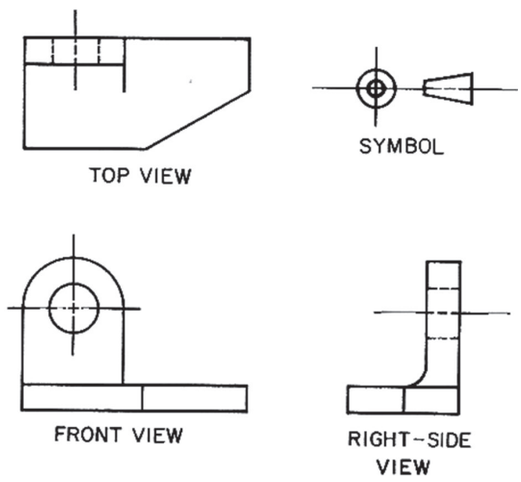
ORTHOGRAPHIC VIEWS

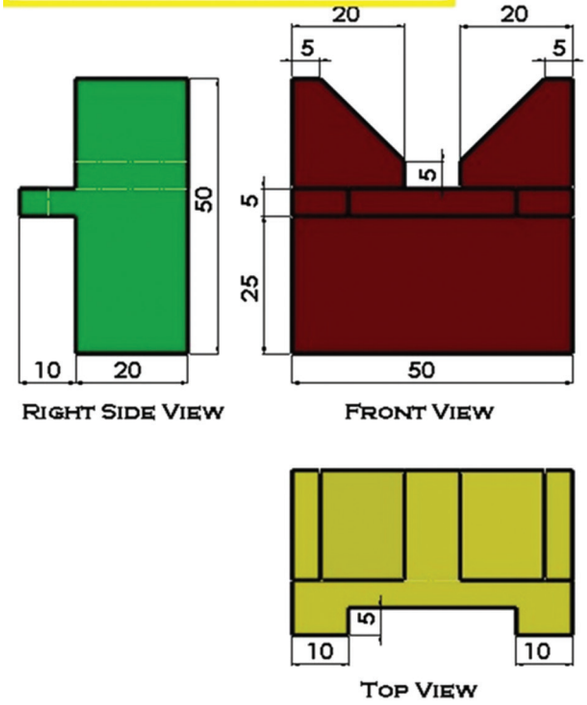


(a) FIRST-ANGLE PROJECTION



(b) THIRD-ANGLE PROJECTION

Orthographic Views



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Model Questions

PART I (1 Mark)

Choose the correct answer

1. There are ….. methods in Auto CAD to draw a circle.
   a) Three
   b) Four
   c) Five
   d) Six

2. Polygons of maximum ……. sides can be drawn in Auto CAD.
   a) 512
   b) 624
   c) 1024
   d) 836

3. By using ….. command parallel lines should be drawn.
   a) MIRROR
   b) OFFSET
   c) ARRAY
   d) STRETCH

4. To extend or reduce on object….. command is used.
   a) STRETCH
   b) TRIM
   c) COPY
   d) MOVE

5. ……. Command is used to round the edges of square or rectangle.
   a) Extend
   b) Chamfer
   c) Fillet
   d) Dimension



6. The command ….. is used to see the object by magnifying (or) reducing it.
   a) ZOOM
   b) ARRAY
   c) DISTANCE
   d) BREAK

7. Opposite form of freeze take is ……. take.
   a) Layer
   b) Thaw
   c) Export
   d) Regen

PART II (3 Marks)

Answer in one or two sentences

8. What is meant by hatching command ?
9. Write notes on : ROTATE command.
10. What are the methods of drawing a line in Auto CAD?
11. List the isometric planes?
12. Write short notes on polygon command.

PART III (5 Marks)

Answer shortly

13. What are the methods of drawing circles in Auto CAD?
14. State the methods of drawing arc in Auto CAD?
15. What are the types of Zoom command?
16. List any five modifying commands.
17. What are the special characteristics of a polyline?

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PART IV (10 Marks)

Answer in detail

18. Explain any five draw commands in detail.
19. Explain any five modifying commands.
20. Explain about isometric projections in Auto CAD.

Answers

1. (c) 2. (c) 3. (b) 4. (a) 5. (c) 6. (a) 7. (b)

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BUILDING MATERIALS

6SKFN

Unit - 3
Basic Civil Engineering

3.1 STONES



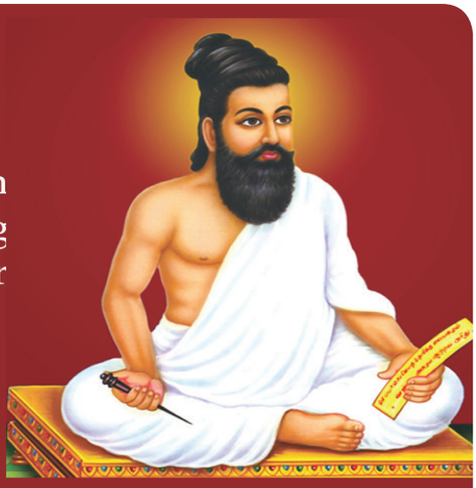
3.2 BRICKS



3.3 SAND



The roof of Peace rest upon
the walls of understanding
-Thiruvalluvar



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- 3.3.4 Test for Sand
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3.1 STONES

Learning Objectives

At the end of this lesson you shall be able to

- Define stone
- Understand the classification of rocks
- Explain the characteristics of good building stone

3.1.1 Introduction

In many places, stones are more freely available than any building material. They are derived from rocks.



The stones for building are obtained by quarrying rocks. Such stones are very irregular in shape and size. They are therefore dressed for proper bedding, thin joints and speedy construction. When such stones are laid with cement or lime mortar in a systematic manner, they form a structural mass which can resist load without disintegration.

3.1.2 Classification of Rocks

Rocks are classified in three ways. They are,

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1. Geological classification
2. Physical classification
3. Chemical classification

3.1.2.1 Geological Classification

According to this classification, rocks are of 3 types. They are:

i) Igneous rocks
ii) Sedimentary rocks
iii) Metamorphic rocks

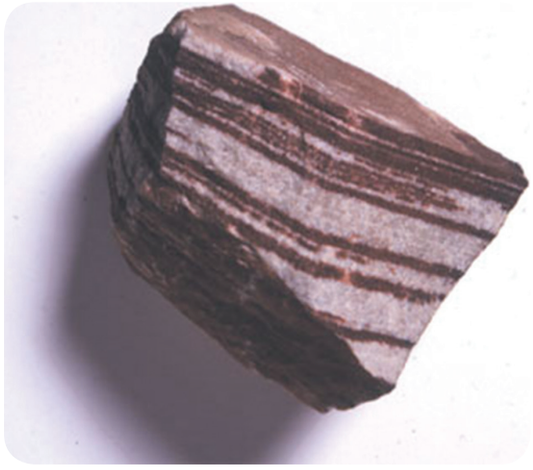
i) **Igneous Rocks** : Stones obtained from these rocks are very strong and durable. It is the result of cooling and consolidation of molten lava released by volcanoes. E.g. Granite, Basalt.



ACTIVITY 1

Collect images of recent volcanoes around the world and make an album.

ii) **Sedimentary Rocks**: They are formed by gradual deposition of broken pieces of rocks which are disintegrated by atmospheric actions. It is migrated from one place to another place and deposited at the bottom of rivers or lakes. These deposits harden due to water pressure. E.g. Limestone, Sandstone



iii) **Metamorphic Rocks:** They are igneous or sedimentary rocks. The change in colour, structure and texture are due to

DO YOU KNOW?

Which is the largest active volcano?

- The largest most active volcano on earth is 'Mauna Loa' in Hawaii(U.S.A), measured about 60 miles long and 30 miles wide (1800 sq. miles).'
- It has erupted 33 times since 1843 in the past 175 years



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either pressure or heat or both. Eg. Marbles, Slates.





Which is the active volcano in India

- The only confirmed active volcano in India is Barren Island of Andaman Islands.
- It is located 135 kms north-east of the territory's capital, Port Blair.
- This volcano erupted more than 10 times, with the most recent one being in 2017.



Search link: http://en.m.wikipedia.org>wiki>barrenisland

3.1.2.2 Physical Classification

This classification is based on general structure of rocks. According to this classification rocks are of three types. They are:

i) Stratified Rocks
ii) Unstratified Rocks
iii) Foliated Rocks

i) **Stratified Rocks**: Sedimentary rocks are distinctly stratified rocks. They are formed by series of parallel layers. E.g. Limestone, Sandstone, Slates.



ii) Unstratified Rocks : Igneous and sedimentary rocks affected by movements of earth are of this type of rocks. They cannot be split into thin slabs. E.g. Granite, Marble.



iii) Foliated Rocks : These rocks have a tendency to split up in a definite direction

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like leaves of a book. Such foliated structure is very common in metamorphic rocks. E.g. Gneiss.



3.1.2.3 Chemical Classification

This classification is based on their chief constituents. Chemically, rocks are of three types.

They are :

i) Silicious Rocks
ii) Calcareous Rocks
iii) Argillaceous Rocks

i) **Silicious rocks** : These rocks have silica or sand as their main constituent. They are hard and durable. E.g. Sand stone, Granite



ii) **Calcareous Rocks** : These rocks have calcium carbonate as their main constituent. E.g. Lime stone, Marble.



iii) **Argillaceous Rocks** : In these rocks clay predominates. E.g. Slate, Laterite.



ACTIVITY 2

Collect different rocks, name them and display them in your class room.

Most number of Volcano in the world - The top two among them are,

- United States -173
- Russia -166

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3.1.3 Uses of Stones



Stones are widely used in many permanent engineering works on account of their strength and durability.

The principal uses of stone in construction are:

1. As material for foundation
2. As aggregate for concrete making



3. As material for road construction



4. As thin slabs for Pavings



5. In Ornamental Works



6. As Wall, Columns, Beams and Lintels in Buildings.





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7. Limestone for manufacture of cement
8. As roofing tiles in the form of slates



3.1.4 Characteristics of Good Building Stones

Following are the characteristics of good building stone:

1. **Crushing Strength** : For a good structural stone, the crushing strength should be greater than 100 N/mm^2.
2. **Appearance** : The stones which are to be used for face work, should be decent in appearance and they should be capable of preserving their colour uniformly for a long time. The colour of the stones for face work should be chosen by keeping in mind the general get up of the surrounding area.
3. **Durability :** A good building stone should be durable. The various factors contributing the durability of a stone are its chemical composition, texture, resistance to atmosphere and other influences, location of the structure, etc.

   The important atmospheric agency which affect the durability of a stone is alternate conditions of heat and cold due to difference in temperature.
4. **Dressing of Stones**: Stones should be such that they can be easily carved, moulded out and dressed. Dressing of stones results in economy of construction.
5. **Fracture :** For a good building stone, its fracture should be sharp, even, bright and clear with grains, well cemented together. A dull, chalkey and earthly fracture of a stone, reduces the life span of the building.
6. **Hardness** : The co-efficient of hardness, as worked out in hardness test should be greater than 17 for a stone to be used in road work. If it is between 14 and 17, the stone is said to be of medium hardness.
7. **Attrition** : In attrition test, if wear is more than 3%, the stone is not satisfactory. If it is equal to 3%, the stone is just tolerable.
8. **Fire Resistance** : The minerals composing stone should be fire resistant in such a way that the shape is preserved when a fire occurs.
9. **Seasoning :** The stones should be well seasoned before putting into use. The stones obtained fresh from a quarry, contain some moisture which is known as the quarry sap. The presence of this moisture makes the stone soft.
10. **Specific Gravity** : For good building stone, the specific gravity should be greater than 2.7 or so.
11. **Texture** : A good building stone should have compact, fine, crystalline structure free from cavities, cracks or patches of soft or loose material. These stones with such texture are strong and durable.
12. **Water Absorption** : All the stones are more or less porous, but for a good stone, percentage of water absorption by weight should not exceed 0.60 after 24 hours immersion in water.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. Rock is the result of cooling and consolidation of ….. released by volcanoes.
   a) Lime stone
   b) Molten lava
   c) Marble
   d) Sand stone

2. Sedimentary rocks are distinctly…….
   a) Stratified rocks
   b) Un stratified rocks
   c) Foliated rocks
   d) Silicious rocks

3. The crushing strength for building stone should be greater than ……..
   a) 40 N/mm^2
   b) 25 N/mm^2
   c) 100 N/mm^2
   d) 75 N/mm^2

4. Percentage of water absorption by weight after …… hours should not exceed 0.60 in stones.
   a) 12
   b) 6
   c) 18
   d) 24

5. The hardness should be greater than …… for a stone in road work.
   a) 17
   b) 20
   c) 14
   d) 24

PART II (3 Marks)

Answer in one or two sentences

6. What are the classification rocks?
7. Write the geological classification of rocks.
8. Write about Igneous rocks?

PART III (5 Marks)

Answer shortly

9. What are the uses of stones?
10. Write any five requirements of good building stones.

PART IV (10 Marks)

Answer in detail

11. Explain the requirements of good building stones?

Part – I Answers

1. (b) 2. (a) 3. (c) 4. (d) 5. (a)

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3.2 BRICKS

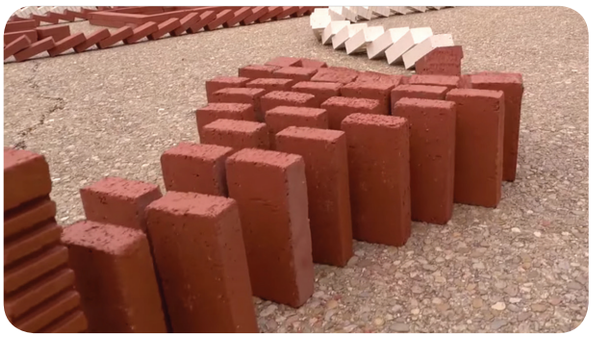
Learning Objectives

At the end of this lesson you shall be able to

- Define brick
- Explain the brick size and weight
- Describe the method of manufacturing of bricks
- Classify the bricks
- Explain the properties of good brick
- Know about the hollow block

3.2.1 Introduction

Clay bricks were used by humans from very early dates. First, it was used without burning as sundried bricks. Burnt brick was a common building material among the Egyptians. Now a days, they are made from specially selected and matured brick earth. It is used to construct the building because of its good bearing capacity, long life and strength. Bricks are made up of blending a good clay, moulded to a rectangular shape of uniform size, dried and burned. As bricks are in uniform size they can be beautifully laid in masonry work.



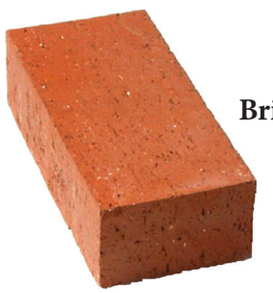
DO YOU KNOW?

When and where the first brick was used?

- The earliest bricks were sun dried and made from mud.
- It was used in 8000 BC in southern Turkey around the city of Jericho.
- In Mesopotamia (modern Iraq) the first true arch of sun baked brick was made about 4000 BC.
- Ceramic or fried (burned) bricks were used as early as 3000 BC in early Indus valley cities.

3.2.2 Definition

Bricks are obtained by moulding clay in rectangular moulds, then by drying and burning them. In places where stones are not easily available, bricks are used in construction. These are preferred because of its durability, strength, reliability, lowcast, etc.



Brick

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ACTIVITY 3

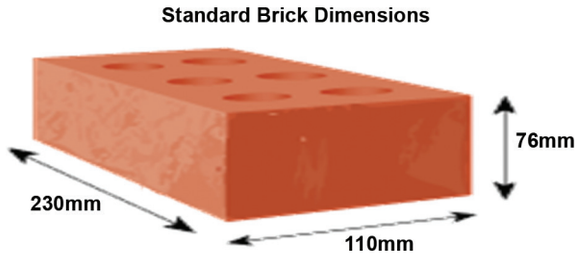
Collect the photos of ancient brick buildings and modern brick buildings and make an album.

3.2.3 Size and Weight of Brick

The Bricks are prepared in various sizes. The custom in the locality is the governing factor to decide the size of brick. Such bricks which are not standardised are known as traditional bricks.

BIS has recommended the bricks of uniform size. Such bricks are known as Modular bricks. The actual size of modular bricks is 190mm × 90mm × 90mm. With mortar thickness (10mm) the nominal size of modular brick is 200mm × 100mm × 100mm.

But practically to match with the beam width, a brick or block of width 230mm is used widely in construction industry. 115 mm is considered for half brick. The brick of size 230 mm × 110mm × 110 mm or 230mm × 110mm × 76mm is generally used in construction industry.



It is found that the weight of $1m^3$ of brick earth is about 1800 kg. Hence the average weight of brick will be about 3.0 to 3.5 kg.

The size of Indian brick we are using is 228mm × 107mm × 69mm.

3.2.4 Brick Earth

Bricks are easily moulded from plastic clays also known as brick clay or brick earth.



Composition of Good Brick Earth

According to IS 2119-1975 the clay or mixture of clay selected should preferably confirm the following composition.

Clay = 20 – 30% by weight
Silt = 20 – 35% by weight
Sand= 35 – 50% by weight

Constituents of Brick Earth

Following are the constituent of good brick earth.

i) Alumina :

It is the chief constituent of clay. A good brick earth should contain 20 to 30% of alumina. This constituent imparts plasticity to earth. So that it can be moulded easily. If alumina is present in excess, raw bricks shrink and warp during drying and burning.

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ii) Silica :

A good brick earth should contain about 50 to 60% of silica. Silica exists in clay either as free or in combined form. As free sand, it is mechanically mixed with clay and in combined form, it exists in chemical composition with alumina. Presence of silica prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks. Durability of bricks depends on the proper proportion of silica in brick earth. Excess of silica destroys the cohesion between particles and brick will become brittle.



iii) Lime :

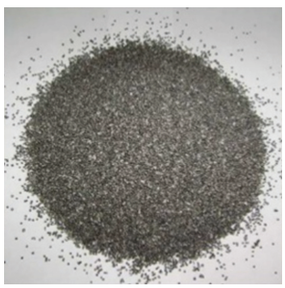
A small quantity of lime is desirable in finely powdered state to prevents shrinkage of raw bricks. Excess of lime causes the brick to melt and hence its shape is lost.

iv) Oxide of Iron :

A small quantity of oxide of iron to the extent of 5 to 6 % is desirable to impart red colour to bricks. Excess of iron oxide makes the bricks dark blue or blackish.

v) Magnesia :

A small quantity of magnesia in brick earth imparts yellow tint to bricks, and decrease shrinkage. But excess of magnesia leads to the decay of bricks.



The ingredients like iron pyrites, alkalies, pebbles, organic matter should not be present in good brick earth.

3.2.5 Manufacture of Brick

The following are various steps involved in the preparation of bricks :

1. Preparation of clay
2. Moulding
3. Drying
4. Burning

3.2.5.1. Preparation of Clay

The preparation of clay involves the following operations:

a) Unsoiling : Top layer of 20 cm depth is removed as it contain impurities.

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b) **Digging :** Clay dug out from ground is spread on level ground about 60 cm to 120 cm heaps.

c) **Cleaning :** Stones, pebbles, vegetable matter, etc., are removed and the lumps are converted in to powder form.

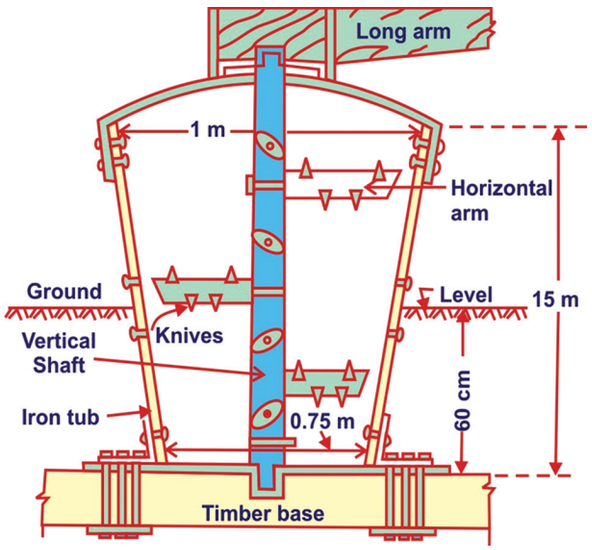
d) **Weathering :** Clay is to be exposed to atmosphere from few weeks to full season.

e) **Blending :** Clay is made loose and any ingredient to be added to it is spread out at top and it is turned up and down in vertical direction.

f) **Tempering:** Clay is brought to a proper degree of hardness. Then water is added to the clay and the whole mass is kneaded or pressed under the feet of men or cattle.



For large scale, tempering is usually done in pug mill as shown in the fig.



Pug Mill

Process : Clay with water is placed in pug mill from the top. When the vertical shaft is rotated by using electric power, clay is thoroughly mixed up by the actions of horizontal arms and knives. When clay has been sufficiently pugged, hole at the bottom of tub is opened and the pugged earth is taken out from ramp.

3.2.5.2. Moulding

Clay which is prepared from pug mill is sent to the next operation of moulding.

Following are the two ways of moulding :

1. Hand Moulding
2. Machine Moulding.

1) Hand Moulding :

Moulds are rectangular boxes made of wood or steel which are open at top and bottom. Steel moulds are more durable and used for manufacturing bricks on large scale as shown in fig. Bricks prepared by hand moulding are of two types.

a) Ground Moulding
b) Table Moulding

a) Ground Moulding :

Ground is first made level and fine sand is sprinkled over it. Mould is dipped in water and placed over the ground to fill the clay. Extra clay is removed by wooden or metal strike, after the mould is filled. Mould is then lifted up and raw brick is left on the ground. Mould is then dipped in water every time. Lower faces of

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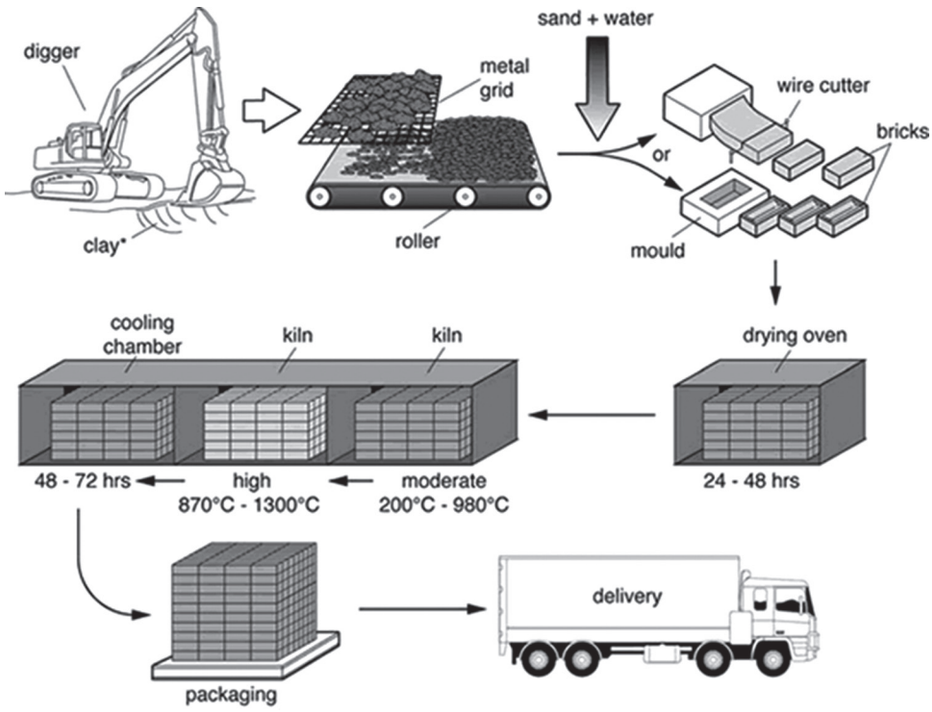
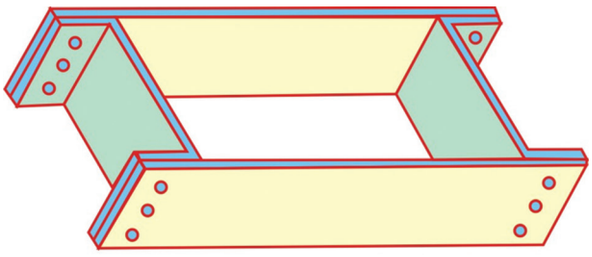
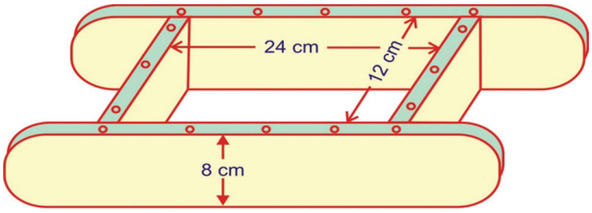


ground moulded bricks are rough and it is not possible to place frog on such bricks. Ground moulded bricks of better quality and with frogs on their surface are made by using a pair of parallel boards and a wooden block.



Steel Mould



Wooden Mould



Hand Moulding



Wooden Mould

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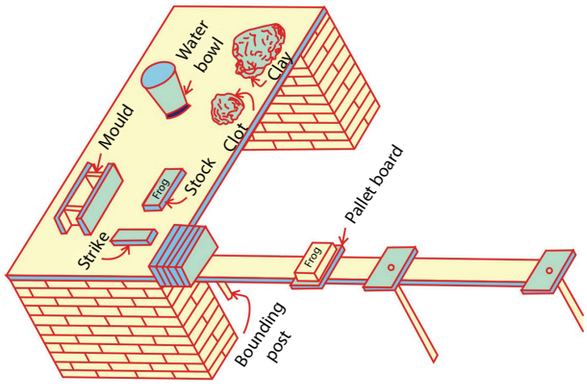
B) Table Moulding :

Process of moulding these bricks is just similar to ground moulded bricks.These are moulded on a table of size about 2m × 1 m. The clay, mould, water pots, stock board, strikes and pallet boards are placed on the table. The bricks are moulded on the table and sent for the further process of drying.



However the efficiency of moulder decreases gradually because of standing at the same place for long duration. The cost of brick moulding also increases when table moulding is adopted.



2) Machine Moulding :

This method proves to be economical when bricks in huge quantity are to be manufactured at the same spot. It is also helpful for moulding hard and string clay. These machine are broadly classified into two categories

a) Plastic Clay Machine.

b) Dry Clay Machine.

a) Plastic Clay Machine :

This machine containing rectangular opening of size equal to thickness and width of a brick. Pugged clay is placed in the machine and as it comes out through the opening, it is cut into strip of standard length by wires. So these bricks are called **"Wire cut bricks"**.



b.) Dry Clay Machines :

In these machines, strong clay is first converted into powder form and then water is added to form a stiff plastic paste. Such paste is placed in mould and pressed by machine to form hard and well shaped bricks. These bricks are heavier than ordinary hand moulded bricks. They carry distinct frog and exhibit uniform texture.

3.2.5.3. Drying

The damp brick, if burnt, are likely to be cracked and distorted. Hence, moulded bricks are dried before they are taken for the next operation of burning.

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Bricks are laid along and across the stock in alternate layers. The drying of brick is done by the following means:

a. **Artificial Drying:** Drying by tunnels usually 120°c about 1 to 3 days.
b. **Circulation of Air:** Stacks are arranged in such a way that sufficient space is left between them for free circulation of air.
c. **Drying Yard**: Special yards should be prepared slightly higher level to prevent the accumulation of rain water.



d. **Period of Drying :** Usually three to ten days for bricks to dry.

3.2.5.4. Burning

This is very important operation in the manufacture of bricks. It imparts hardness and strength to brick and makes them dense and durable. The bricks should be burnt properly.

If bricks are over burnt, they will be brittle and hence break easily. If they are under burnt, they will be soft and cannot carry loads.

During burning, when the temperature of about 650°c is attained, the organic matter contained in the brick is oxidized and also the water of crystallization is driven away.

When the temperature of about 1100°c is reached, the particles of the earth bind themselves together resulting in the increase of strength and density to bricks. Further heating is not desirable and if the temperature is raised beyond 1100°c great amount of fusible glassy mass is formed and the bricks lots its shape.

Bricks are burnt in clamps or kilns.



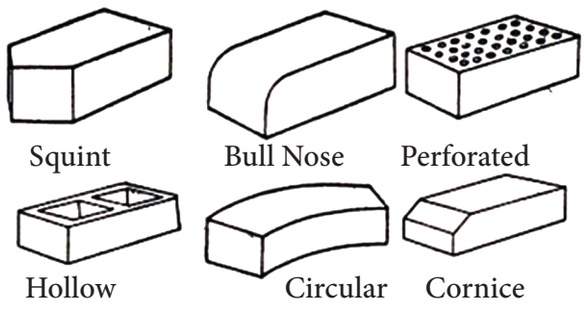
Clamp

3.2.6 Classification of Brick

According to use, bricks are classified into five categories.

They are,

i) Ordinary Bricks
ii) Engineering Bricks (special bricks for carrying heavy loads)
iii) Facing Bricks
iv) Fire Bricks
v) Special bricks (special shapes)



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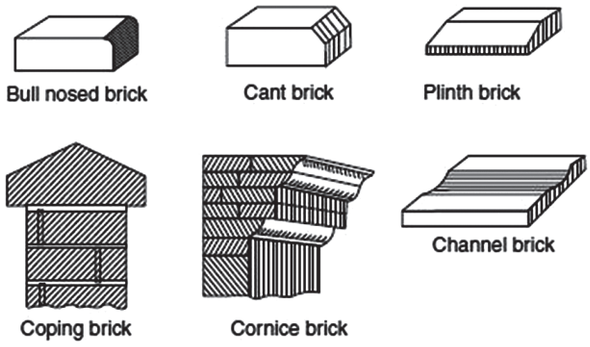

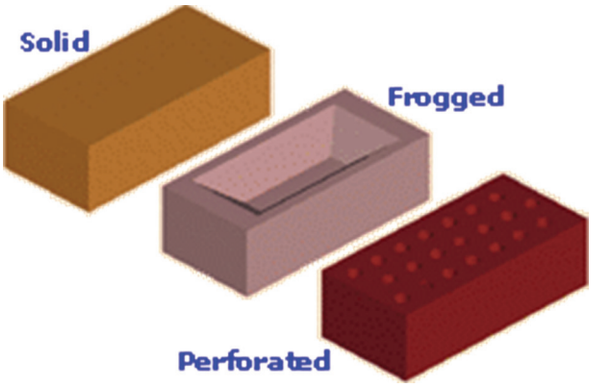

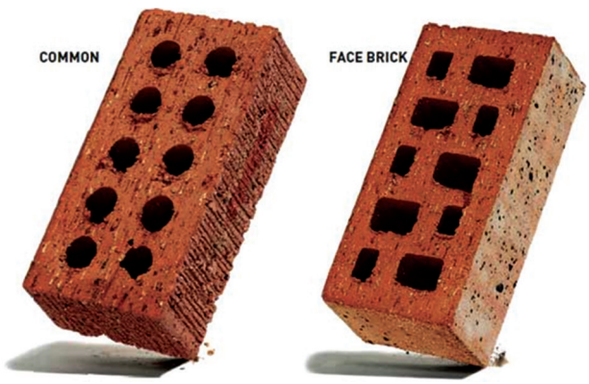

According to general physical requirements bricks are classified into three categories. They are,

1) Class I
2) Class II
3) Class III

The bricks belongs to these three classification, differ in their general requirements and water absorption property.

As per IS classification, bricks are classified according to their compressive strength. They are 10, 7.5, 5.0 and 3.5 having compressive strength of 10 N/mm^2, 7.5 N/mm^2, 5 N/mm^2 and 3.5 N/mm^{2}respectively.



3.2.7 Properties of Good Bricks

- Good bricks should be of compact structure, free from cracks and flaws such as air bubbles, lumps and stones.
- They should be regular in shape and of uniform size with plane faces and sharp edges.
- Length should be equal to twice the width plus the thickness of mortar joints. (Length = (2 × Width) + thickness of mortar joints).
- The colour should be uniform and of deep red or copper colour.
- When soaked in water for 24 hours, a good brick should not absorb more than 20% of its own weight.
- A well burnt brick should be hard and when scratched with the finger nail, no impression should be formed.
- On striking it with each other, it should give a clear ringing or metallic sound.
- When struck against one another or thrown on end on a hard ground from a height of 1m, the bricks should not break.

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➢ The crushing strength should not be less than 55 kg/cm^2.

3.2.8 Hollow Blocks

Concrete blocks are now-a-days used for masonry construction. These blocks are available in three types namely solid blocks, hollow blocks and cellular blocks.

The normal concrete blocks are called as solid blocks.

If the percentage of voids is more than 25% then it is called as hollow blocks, if the percentage of voids is less than 25% it is called as perforated blocks.

Cellular blocks are generally referred as light weight aerated concerte blocks.





When was the first brick house built?

It was built in California in 1847.

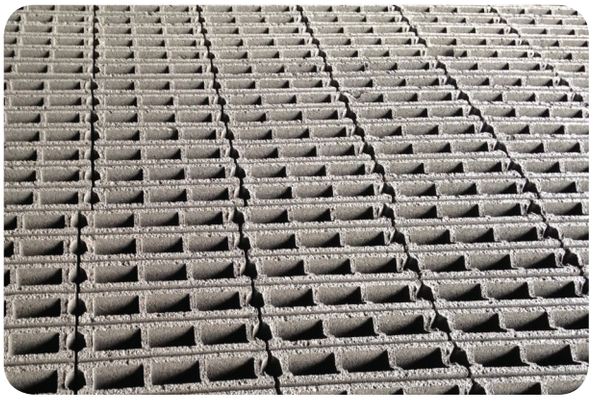
Search link: http://www.youtube.com> watch first brick house



ACTIVITY 4

Visit a brick manufacturing unit near by your school and prepare report with photos.

Concrete blocks are usually made large in size. So that the block work is faster and consume less cement in joints than the brick work. Specially made hollow blocks are also used to construct load bearing walls. Such works are useful in reducing the dead load of masonry in buildings.



3.2.8.1 Manufacturing of Hollow Blocks

The concrete mix for concrete blocks shall not be richer than one part of cement to six parts of volume of combined aggregate. Lean mixes upto 1:8 are also commonly used. The choice of aggregates for manufacturing these block is of utmost importance as cost of aggregates account for a large part of the total cost. Hence "Baby jelly" aggregates that are not generally used for conventional concrete work are found of much use in making these concrete blocks.

3.2.8.2 Classification of Hollow Blocks

Hollow concrete blocks are classified by IS into the following three grades.

A) **Grade A :** These blocks are used for load bearing walls. They should have a minimum density of 1500 kg/m^3. They should

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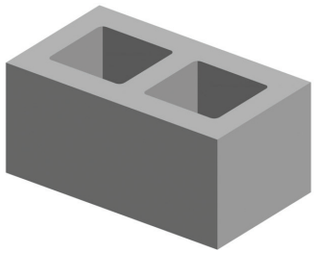
be manufactured for minimum specified compressive strength of 3.5, 4.5, 5.5 and 7.0 N/mm^2 in 28 days.



B) Grade B : These are also used for load bearing walls. They may have a density below 1500 kg / m^3 but, not less than 1000 kg/m^3. They are made for specified compressive strength of 2.0, 3.0 and 5.0 N/mm^2 in 28 days.



C) **Grade C :** These are used for non-load bearing walls, and its density is not less than 1000 kg/m3. They are made for specified strength of 1.5 N/mm^3 in 28 days.



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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The actual size of modular brick is …….
   a) 200mm × 200mm × 100mm
   b) 100mm × 100mm × 100mm
   c) 190mm × 90mm × 90mm
   d) 115mm × 100mm × 230mm

2. The size of bricks used in construction industry is ……
   a) 230mm × 100mm × 100mm
   b) 230mm × 90mm × 90mm
   c) 230mm × 110mm × 76mm
   d) 200mm × 100mm × 110mm

3. The size of Indian brick we are using is ……
   a) 190mm × 90mm × 90mm
   b) 228mm × 107mm × 69mm
   c) 200mm × 100mm × 100mm
   d) 100mm × 100mm × 100mm

4. Weight of brick is ……
   a) 2.00 to 3.00 kg
   b) 5.00 to 10.00 kg
   c) 10.00 to 15.00 kg
   d) 3.00 to 3.50 kg

5. Quantity of Alumina in a good brick earth is ……
   a) 20 to 30%
   b) 40 to 50%
   c) 10 to 50%
   d) 25 to 55%



PART II (3 Marks)

Answer in one or two sentences

6. Define : Bricks.
7. What is nominal size of modular bricks?
8. What is burning of bricks?
9. Write any three raw materials in brick earth.
10. What are the classification of Hollow blocks?

PART III (5 Marks)

Answer shortly

11. Write short notes on drying of bricks.
12. What are the steps involved in the manufacture of brick?
13. Write shorts notes on hollow blocks.

PART IV (10 Marks)

Answer in detail

14. What are the properties of good brick?
15. Explain the composition of good brick earth.
16. Explain any two steps of manufacturing of bricks.
17. Explain the manufacturing process of Hollow blocks.

Part – I Answers

1. (c) 2. (c) 3. (b) 4. (d) 5. (a)

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3.3 SAND

Learning Objectives

At the end of this lesson you shall be able to

- Define river sand and manufactured sand (M-sand).
- Compare M-sand and river sand.

3.3.1 Introduction

Sand is a building material used in construction for preparing mortar, concrete and also for filling under floor, basements. It is technically named as fine aggregate. It is used in concrete to fill up the voids leaved by coarse aggregates.

Now-a-days, it is practically impossible to get river sand in large quantities. Hence, M sand (manufactured sand) is introduced in this field to overcome this deficiency.

3.3.2 River Sand

Sand is generally composed of rounded particles and may or may not contain clay or other impurities. It is obtained from the banks and beds of rivers.



3.3.3 Manufactured Sand (M Sand)

M Sand is defined as a crushed fine aggregate produced from broken granite blocks. Production of M sand generally involves crushing, screening and possible washing.



Search link: http://www.youtube.com/watch/m-sand



(a) Cement (b) Fly ash (c) River sand

(d) M-Sand (e) 19mm Coarse aggregate (f) 6mm - 12mm aggregate

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3.3.4 Test For Sand

The following are some of the tests conducted to know the quality of sand.

1) Sieve analysis
2) Bulking of sand
3) Voids Ratio
4) Porosity
5) Bulk density



- The chemical name and formula of sand is silicon dioxide and SiO_2.
- Sand is uncountable. It contains particles from 62.5 micron (0.0625mm) to 2mm in diameter.



ACTIVITY 5

Collect some types of sand available nearby your town and display it in your class room.



3.3.5 Comparison of River Sand & M Sand

S.No	Parameters	River Sand	M-Sand
1	Process	Naturally available on river banks.	Manufactured in factory
2	Shape	Smoother texture with better shape. Demands less water.	Angular and has rougher texture. Angular aggregates demands more water. Water demands can be compensated with cement content.
3	Moisture content	Moisture is trapped in between the particles which is good for concrete purpose.	Moisture is available only in water washed M sand.
4	Concrete Strength	Lesser concrete strength compared to M – sand.	Higher concrete strength compared to river sand.
5	Silt Content	Minimum permissible silt content is 3%.Anything more than 3% is harmful to the concrete's durability. We can expect 5 – 20% silt content in medium quality river sand.	Zero silt. Hence good for construction works.
6	Over sized materials	1 – 6 % of over sized materials can be expected, like pebble, stones, etc.	Since it is artificially manufactured, there is no over sized materials.

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7	Marine Products	1 – 2% like sea shells, etc.	0%
8	Eco friendly	Harmful to environment. Eco imbalances, reduce ground water level and river water gets dried up.	Though M sand uses natural coarse aggregates to form, it causes less damage to environment as compared to river sand.
9	Applications	Recommended for RCC plastering and brick / block work.	Highly recommended for RCC purposes and brick / block works.
10	Quality	No control over quality since it is naturally occurring. Same river bed sand can have differences in silt content.	Better quality control since manufactured in a controlled environment.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. …… is defined as a crushed fine aggregate produced from broken granite blocks.
   a) Brick
   b) Wood
   c) Stone
   d) M-Sand

PART II (3 Marks)

Answer in one or two sentences

2. Define : River Sand.
3. Define: M-Sand.
4. What are the tests conducted on sand?



PART III (5 Marks)

Answer shortly

5. Write any three comparison between river sand and M-sand.

PART IV (10 Marks)

Answer in detail

6. What are the difference between river sand and M-sand?

Part – I Answers

1. (d)

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BUILDING MATERIALS

Unit - 4
Basic Civil Engineering

4.1 CEMENT



4.2 MORTAR



4.3 CONCRETE





Education is the most powerful weapon which you can use to change the world.

- Nelson Mandela

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4.1 CEMENT

Learning Objectives

At the end of this lesson you shall be able to

- Know the types of cement.
- Explain artificial cement and its types.
- Know the field tests for cement.
- State the properties of Portland cement.
- Understand the storage of cement and grades of cement.

4.1.1 Introduction

Cement is the most important material in building construction. To a layman the term cement means Portland cement. Cement is manufactured from lime stone and clay. It is available in powder form, when mixed with water can set to a hard mass even under water.

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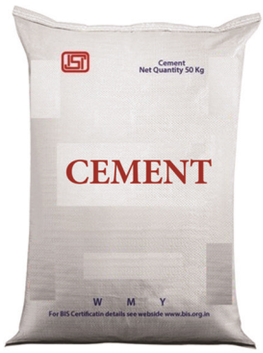



4.1.2 Types of Cement

Generally cement is classified into two categories. They are,

1) Natural Cement
2) Artificial Cement

4.1.2.1 Natural Cement

Natural cement is obtained by burning, crushing and powdering the molecular stones of natural silica and lime. This stone contains 20% to 40% of clay alias silica. It is also known as **"Roman cement"**.

4.1.2.2 Artificial Cement

Artificial cement is obtained by adding lime and clay in correct proportion and burning it at high temperature. This burnt mixture is called "**Clinker**". Gypsum is added to clinker and grinded in powdered form. This grinded powder is known as "**Cement**". Colour of artificial cement is alike the stones in Portland of United Kingdom. Hence it is called "**Portland cement**". In the year 1904, artificial cement is manufactured in India. In general, the weight of one cement bag is 50 kg.

4.1.3 Types of Artificial Cement

In addition to ordinary Portland cement, following are the other varieties of cement.

1. Hydrophobic cement
2. Pozzolana cement
3. Quick setting cement
4. Rapid hardening cement
5. White cement
6. Colour cement
7. Acid resisting cement
8. Blast Furnace slag cement
9. High alumina cement
10. Low heat cement



Artificial cement was invented by Louis Vicat in 1817.



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11. Sulphate resisting cement

Hydrophobic Cement



Acidol, Napthalene soap, oxidised petroleum, etc., are used as the additional ingredients to decrease the wetting ability of cement grains. These substances form a thin film around cement grains. The fine pores in concrete are uniformly distributed. Thus frost and water resistance of the concrete are increased considerably.

Pozzolana Cement



DO YOU KNOW?

Portland cement was invented by an English man named 'Joseph Aspdin' in the year 1824 (19th century).



Pozzolana denotes volcanic powder. It is cheap, attains compressive strength with age, offers great resistance to expansion and possesses lighter tensile strength. It is used to prepare mass concrete of lean mix works and for laying concrete underwater.

Quick Setting Cement



Quick Setting cement is produced by adding a small percentage of aluminium sulphate to the ingredients of cement during

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grinding. The setting action starts within five minutes after the addition of water. It becomes hard in less than thirty minutes. This cement is used to lay concrete under static water or running water.

Rapid Hardening Cement



Rapid Hardening cement attains high hardness in minimum days. The initial setting time and final setting time of this cement is like ordinary cement. Increase in lime content, very fine grinding and burning at high temperature are the reasons for the quick setting. The cost of this cement is more than Portland cement. Construction work is done quickly due to its quick setting and hardening property.

White Cement



White Cement is a variety of ordinary cement. It is prepared from raw materials which are practically free from oxides of iron, manganese or chromium. It is white in colour. It is used for floor finish, plaster work, ornamental work, etc. It is more costly than ordinary cement.

Colour Cement





Colour cement is manufactured by mixing 5% to 10% of colouring agents with ordinary cement. Strength of this cement is affected when more than 10% of colouring pigment is added. Green colour is obtained by adding chromium oxide. Blue colour is obtained by adding cobalt. Yellowish brown, red, yellow colours are obtained by adding iron oxide in different proportions. Black colour is obtained by magnesium oxide. This cement is used to make artificial stones, external decoration, coloured cement flooring, etc.

4.1.4 Field Tests For Cement

To know the quality of cement, the following tests are conducted in cement.

1. Manufacturing date and Colour test.
2. Physical properties
3. Presence of lumps
4. Block test
5. Glass plate test

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4.1.4.1 Manufacturing Date and Colour Test

If the cement bags stocked for long period it loses its strength. Hence, the manufacturing date of the cement bag should be checked. The colour of cement should be uniform. It is light green mixed with grey colour.

4.1.4.2 Physical Properties

When cement felt between fingers is rough, and is warm when hand is inserted in a bag of cement, it indicates adulteration.

4.1.4.3 Presence of Lumps

Cement inside the bag should not be harden due to moisture. If it is hard, such cement should be rejected.

4.1.4.4 Block Test

A cement block of size 200 mm × 25mm × 25mm is made and it is immersed in water for 7 days. It is then placed 150 mm apart between supports. The cement is good, if this block shows no sign of failure when 34kg weight is loaded on it.

4.1.4.5 Glass Plate Test

A thick paste of cement with water is made on a piece of glass plate and keep it in water for 24 hours. The paste should set hard with the glass plate when it is taken out.

4.1.5 Required Properties of Portland Cement

- Initial setting time should not be less than 30 minutes.
- Final setting time should not be more than 10 hours.
- After 3 days, compressive strength should not be less than 16 N/mm^2.
- After 7 days, compressive strength should not be less than 22 N/mm^2.
- After 3 days, tensile strength should be 2 N/mm^2.

DO YOU KNOW?

The first bridge built using artificial cement is Souillac Bridge over Dordogne River in 1824 at France.



ACTIVITY 1

Do the block test and glass plate test conducted in cement in your class room.

- After 7 days, tensile strength should be 2.5N/mm^2.
- The residue should not be more than 10% when sieved in I.S 90 micron sieve.
- Should not expand more than 19 mm in Le-Chatlier test.

4.1.6 Grades of Cement

There are three grades of cement.

1) Grade 33 as per IS 269 (1989).
2) Grade 43 as per IS 8112 (1989).
3) Grade 53 as per IS 12269 (1987).



Now a days the cement of grade 43 is easily available.

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The grades 43 and 53 in cement mainly corresponds to the average compressive strength attained after 28 days in mega Pascals (Mpa) of at least 3 mortar cubes (area of the face 50cm^2) composed of one part of cement with three parts of standard sand.

4.1.7 Storage of Cement



- Cement packed in bags should be stored in a place that it may not come into contact with water, moisture and even with moist air.
- Cement bags are stored in storage sheds on damp proof raised floors.



DO YOU KNOW?

Over two billion tons of cement is produced each year.

Ancient Chinese used cement to hold bamboo together in boats and in the Great Wall of China.

- The bags should be kept 60cm away from the walls.
- Not more than 10 bags should be stacked on one stock.
- Cement should not be stored for more than one year.
- In case of long storage for a period more than a year it should be covered with "tarpaulin" which renders water proof.



- If different brands of cement are stacked they should be stacked separately.
- For mass storage, cement should be stored in silos in loose form.



Silos

ACTIVITY 2

Visit any loose cement storage plant nearby your town and submit a report with photos.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The artificial cement is manufactured in India in the year …
   a. 1900
   b. 1940
   c. 1904
   d. 1914
2. The other name of natural cement is …
   a. Roman cement
   b. Sand
   c. M- sand
   d. Artificial cement
3. The weight of cement bag is…
   a. 10kg
   b. 50kg
   c. 100kg
   d. 75kg
4. Colour cement is manufactured by mixing ..... of colouring agents with ordinary cement.
   a. 25% to 50%
   b. 50% to 100%
   c. 1% to 60%
   d. 5% to 10%
5. While storage the cement bags should be stored ..... away from the wall.
   a. 120cm
   b. 60cm
   c. 15cm
   d. 90cm

MR6X9

PART II (3 Marks)

Answer in on or two sentence

6. What are the general types of cement?
7. What are the field tests conducted in cement?
8. Brief about the block test conducted on cement.
9. List any five types of artificial cement.
10. List the grades of cement.

PART III (5 Marks)

Answer shortly

11. Write briefly about artificial cement.
12. Write about any two types of artificial cement in brief.

PART IV (10 Marks)

Answer in detail

13. What are the required properties of portland cement?
14. Explain about storage of cement.

Part – I Answers

1. (c) 2. (a) 3. (b) 4. (d) 5. (b)

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4.2 MORTAR

Learning Objectives

4.2 MORTAR

At the end of this lesson you shall be able to

- Know mortar and its types.
- Understand the properties of good mortar.
- Understand the preparation of cement mortar.
- Know the precaution in using mortar.
- Know the uses of mortar.

4.2.1 Introduction

Mortars are used in masonry for joining stones, bricks, blocks, etc., and are designated by the mix used.

4.2.2 Definition

The term mortar is used to indicate a paste prepared by adding required quantity of water to a mixture of binding material like cement or lime and fine aggregate like sand.



4.2.3 Properties of Good Mortar

i) It must have the required strength.

ii) It must be workable.

iii) It must be durable.

iv) Compatible with the types of painting work.

v) It should stiffen early.

vi) It must have good bond with bricks and stones.

vii) It should prevent seepage of rain water.

viii) It should be cheap.

ix) It should have water retentivity.

4.2.4 Types of Mortar

Based on the kind of binding material used, the mortar is classified into 4 types. The binding material is chosen based on the expected working condition, hardening temperature, moisture condition, etc.

They are,

1. Lime Mortar
2. Cement mortar
3. Combination or gauged mortar
4. Mud mortar

4.2.4.1 Lime Mortar

In lime mortar, lime is used as binding material and it may be fat lime, hydraulic

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lime or lime with surkhi in different proportions. Lime mortar has the properties like high plasticity, can be placed easily, good cohesiveness, durability and hardens slowly. It is generally used in lightly loaded parts of building above ground level.

4.2.4.2 Cement Mortar

In cement mortar, cement is used as binding material. Proportion of cement to sand varies from 1:2 to 1:6 or more. Cement mortar is used where a mortar of high strength and water resisting property are required such as underground construction, water saturated soil, etc.

4.2.4.3 Combination Mortar or Gauged Mortar

To improve the quality of lime mortar, cement is sometimes added to it. This is known as gauging. It makes lime mortar more strong and dense.

4.2.4.4 Mud Mortar

In this type of mortar clay and sand are mixed together and used in the construction of temporary sheds.



- Gypsum based mortars have already been used 10,000 years ago.
- Lime came into operation in 6000 BC but it had been used first by romans as a constituent to produce mortar.

4.2.5 Preparation of Cement Mortar

Cement Mortar needed for small works is mixed by hand and for large works is mixed by mixer machine.

4.2.5.1 Hand Mixing



Cement and Sand



Dry Mixing



Wet Mixing



Prepared Mortar

Sand is measured by boxes and cement by weight of bags. The specified quantity of sand is spread first and then cement is spread over it. They are dry mixed again and again

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by a shovel or spade till the mix is of uniform in colour. Then water is added and the whole mass is mixed for ten to fifteen minutes.

4.2.5.2 Machine Mixing



In machine mixing, cement and sand are just mixed in a concrete mixer and then water is added gradually. Mixing is carried out for more than one minute till the mixture is brought to a plastic condition.

Mortars within two hours can be used after retempering by adding water to restore the consistency. After two hours the mix should not be used.

ACTIVITY 3

Visit a construction site near by your school and collect details about mixing of mortar.

4.2.6 Uses of Mortar

1. To bind the building units such as bricks, stones, etc.
2. To carry pointing and plaster work on exposed surface of masonry.
3. To form an even bedding layer for building units.
4. To form joints of pipes.
5. To improve the appearance of structure.
6. To prepare moulds.
7. To serve as a matrix to hold coarse aggregates, etc.

4.2.7 Precautions to be taken in Using Mortar

The following precautions are to be taken while making use of mortar.

i) After preparation, it should be consumed as early as possible.

ii) The cement mortar should be consumed before its initial setting time starts.

iii) It is advisable to prepare mortar of one bag of cement at a time.

iv) It is advisable to stop the work in frosty weather.

v) The building units should be soaked in water before mortar is applied.

vi) The construction work should be cured by sprinkling water to avoid rapid drying.

vii) The mortar should not contain excess water and it should be as stiff as it can be conveniently used.

4.2.8 Required Strength of Mortars In Masonry

Strength of mortars to be used for joining bricks, stones, blocks, etc., should depend on the strength of the materials. There is no advantage in using over strong mortar. It should be sufficiently strong to resist erosion, abrasion and other factors affecting durability. The following list gives the ratio of common cement – sand mortars used in practice in Tamilnadu.

1. Damp proof course - CM 1 : 2
2. General Brick work - CM 1 : 6
3. Stone masonry – CM 1:6
4. Arch work - CM 1:3
5. Pointing work- CM 1:1 to 1:3
6. Brick work plaster - CM 1:5
7. RC Plasterwork (like ceiling) - CM 1:3 to 1:4

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. …… is used in masonry for binding stones and bricks together.
   a. Mortar
   b. Concrete
   c. Adhesives
   d. Chemicals

2. The mortar is mixed for ….. minutes in hand mixing.
   a. 30 to 45
   b. 10 to 15
   c. 5 to 10
   d. 20 to 25

3. It is advisable to prepare cement mortar for ….. at a time.
   a. 5 bags
   b. 2 bags
   c. 3 bags
   d. 1 bag

4VDBW

PART II (3 Marks)

Answer in one or two sentences

4. Define mortar.
5. List the types of mortar.
6. Define mud mortar.
7. List any three ratios of cement mortars used in practice.

PART III (5 Marks)

Answer shortly

8. Write about any two types of mortar.
9. What are the uses of mortar?

PART IV (10 Marks)

Answer in detail

10. What are the properties of a good mortar?
11. Explain the preparation of cement mortar.
12. What are the precautions to be taken in using mortar?

Part – I Answers

1. (a) 2. (b) 3. (d)

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4.3 CONCRETE

Learning Objectives

At the end of this lesson you shall be able to

- Know concrete and its ingrediants.
- Understand about water cement ratio.
- List the types of concrete, its uses and properties.
- Know the preparation of cement concrete.
- Understand the precautions to be taken while transportation and placing of concrete.
- Know the grades of concrete.

4.3.1 Introduction

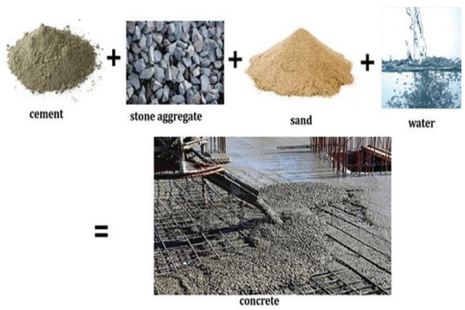
Cement concrete is a major building material used in modern building constructions. It is used in all parts of a building like foundations, superstructure and roofs. It is prepared at site by hand mixing or machine mixing. Nowadays it is also available as a factory made product known as **"Ready Mix Concrete" (RMC)**.

4.3.2 Definition

Concrete is a composition of coarse aggregate, fine aggregate, binding material and water in such proportions that the whole sets into a monolithic mass.

When cement concrete is used without reinforcement, it is called **"Plain Cement Concrete" (PCC)**. If it is reinforced with steel, it is called **"Reinforced Cement Concrete" (RCC)**.

4.3.3 Ingredients of Concrete



The ingredients of concrete are,

1. Binding material (cement or lime)
2. Fine aggregate (river sand or M-sand)
3. Coarse aggregate (broken bricks or broken stone)
4. Water
5. Admixtures in cement

4.3.3.1 Binding Material

Cement or lime are used as the binding material. They bind the individual units of fine aggregate and coarse aggregate

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by virtue of its properties of setting or hardening in combination with water. It helps to fill the voids and imparts density to concrete.

4.3.3.2 Fine Aggregate

Sand or crushed stone sand (M sand) are used as fine aggregate to fill the voids leaved between coarse aggregates and thereby reduce the quantity of cement.

4.3.3.3 Coarse Aggregate

Broken stone or broken brick acts as main filler and forms the main bulk of concrete. The aggregates should be clean, dense, hard, strong and durable.

4.3.3.4 Water

Water facilitates the spreading of cement over the aggregates and regulates the consistency. Water used should be clean. Sea water should not be used as it retards setting of concrete.

4.3.3.5 Admixtures in cement

There are also certain other additives known as "**Admixtures**" added to improve the quality of concrete required for various constructions. Some of them are,

i) Plasticizers.
ii) Superplasticizers.
iii) Accelerators.
iv) Retarders.
v) Pozzolanic material.
vi) Air entraining agents.
vii) Fibres.
viii) Polymers.
ix) Silica fume.



Plasticizers



Superplasticizers



Accelerators

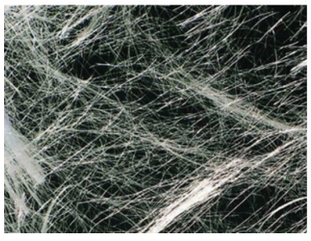


Retarders


Pozzolanic material



Air entraining agents


Fibres


Polymers



Silica fume

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4.3.4 Water – Cement Ratio

"Water-cement ratio" is defined as the ratio of the weight of mixing water to the weight of cement used in the concrete. The strength of concrete increases with decrease in water-cement ratio.

Water reacts with cement chemically and causes setting and hardening of concrete. It is found theoretically that water required is about 0.50 to 0.60 time the weight of cement.

4.3.5 Preparation of Cement Concrete

Cement concrete is prepared either by hand mixing or machine mixing depending on the requirement. The materials are mixed thoroughly, so that a uniform distribution of materials is obtained. The thorough mixing ensures that cement in the form of a film completely covers the surface of aggregate.

4.3.5.1 Hand Mixing

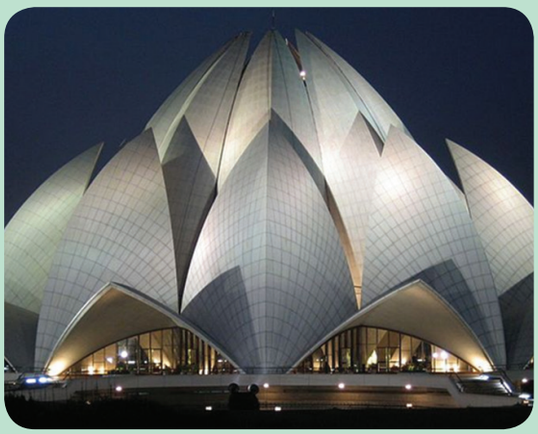


Mixing by hand is done either in a steel pan or on a pucca water tight platform. First, the sand and cement in the specified proportions are mixed thoroughly. Then, this mixture is spread evenly on a stack of coarse aggregate. It is turned over twice in dry state. Then the measured quantity of water is added and the mixture is mixed thoroughly to get a uniform mix. The prepared mix shall be consumed in 30 minutes after adding water. Hand mixing is best for small works.

DO YOU KNOW?

In India the buildings made out of white concrete is Bhai lotus temple (constructed in1986) located in Delhi.

Search link: http://en.m.wikipedia.org>wiki>lotustemple



4.3.5.2 Machine Mixing



Tilting Drum Concrete Mixer

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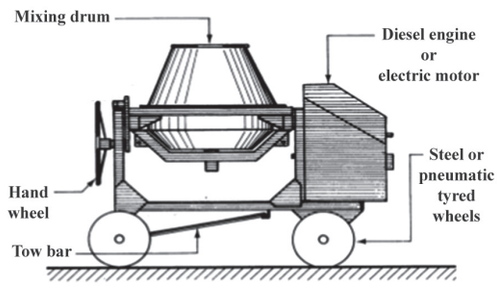
Machine mixing is useful in large works. It is cheaper in the long run. The mixing is done in concrete mixer either of tilting drum type or non-tilting drum type. Water should be added in the mixer at the same time or before the other materials are placed. The mixing time should be at least one minute and preferably two minutes. The concrete discharged from the mixer should be consumed before the setting time starts. The mixer should be cleaned well after every use.

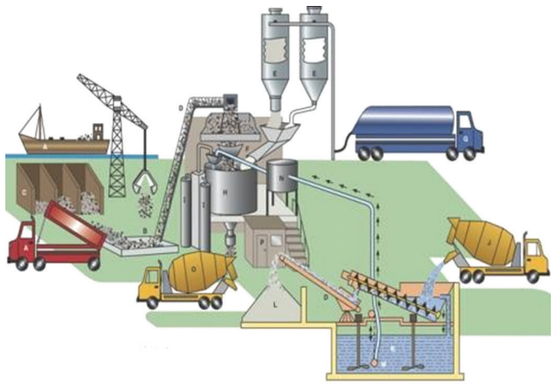


Typical (one bag) tilting drum concrete mixer

ACTIVITY 4

Visit a construction site in your town during the process of concreting by machine mixing and prepare a report with picture.

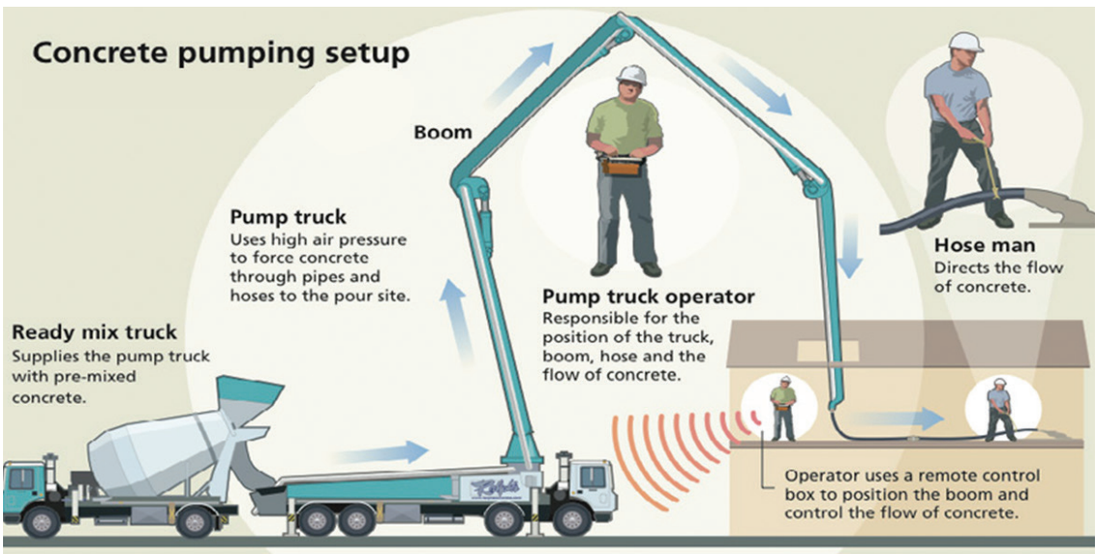
4.3.5.3 Ready Mix Concrete





Batching Plant

When construction is to be carried out in congested places, it is difficult to find space for storing aggregates and mixing concrete at the site. Hence, ready mix concrete are used at such sites. The ready mix plants are located away from the centre of city where concrete can be mixed by using batching plants.



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ACTIVITY 5

Visit ready mix plant nearby and prepare a report.

In case of where it is difficult to lift the concrete to large heights by employing manual labour, concrete is pumped up through specially designed pumps. These `pump concrete mix should be designed in such a way that they do not allow segregation.



The ready mix concrete while being transported in rotating drums which keep the concrete in agitated condition as well a dose of retarding agents (additives) are added to the concrete.

4.3.6 Compaction of Concrete



The thoroughly mixed concrete should be placed continuously and compacted rapidly. The main aim of compaction is to remove air bubbles and thus give a maximum density to concrete. Compaction can be done in 2 ways.

1. Hand Compaction
2. Mechanical Compaction

4.3.6.1 Hand Compaction



This is done with the help of steel tamping rods or timber screeds. Narrow and deep members are compacted with tamping rods. The slabs and floors are tamped with screeds. Compaction should be done in layers of 300mm for mass concrete and 150 mm for reinforced concrete.

4.3.6.2 Mechanical Compaction





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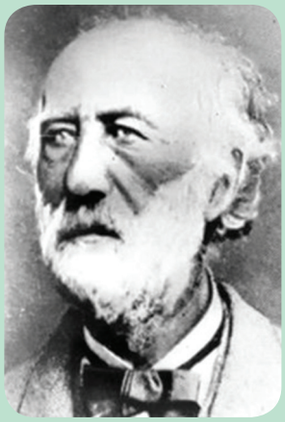
Reinforced concrete:

In 1848, Jean-Louis-Lambot was the first person to use reinforced concrete by using iron bars and wire mesh.





Vibrators are used for this way of compaction. The vibrators permits the use of a lower water- cement ratio as the compaction is very thorough even for drier mixes. The advantages of this type of compaction are,

i. A good surface finish can easily be obtained.
ii. Formworks can be removed early.
iii. A leaner mix with high strength can be obtained.
iv. Concrete can be deposited also in small openings and in the places where it will be difficult to deposit by hand methods.

4.3.7 Curing of Concrete

After concrete is set, it should be continuously cured for a specific period. For the chemical reaction (Hydration) to take place between the constituent of cement, there should be a humidity of 95% in the mix. Hence, it is necessary to keep the concrete wet for a specific period. If the concrete is not cured properly then cracks appear on the top and the full strength also not attained.

4.3.7.1 Methods of Curing

I. Ponding with water.
ii. Covering the concrete with wet sand, jute bags, etc.
iii. Intermittent spraying and covering concrete with polythene bags.
iv. Completely immersing in water tanks as in the case of precast elements.
v. By steam curing.
vi. Vertical surfaces like columns are cured by covering with wet sack or by spraying.



Ponding with water



Intermittent spraying

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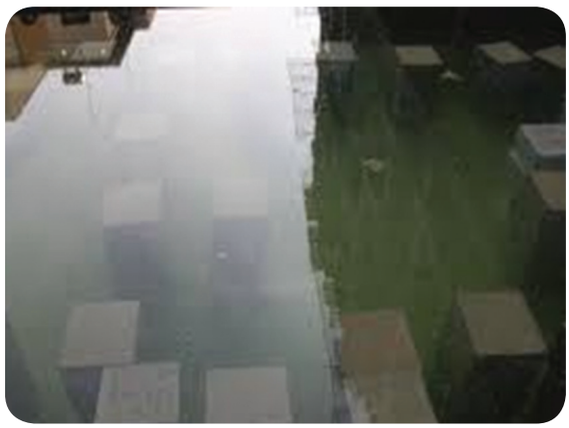
Covering concrete with polythene bags



Steam curing



Immersing in water tank



Cured by covering with wet sack



Covering the concrete with wet sand



Covering the concrete with, jute bags

4.3.8 Properties of Concrete

Cement concrete possesses the following important desirable properties:

i. It has high compressive strength.
ii. It is free from corrosion and there is no appreciable effect of atmospheric agents on it.
iii. It can be moulded into any form.
iv. It hardens with age.
v. It is proved to be more economical than steel.
vi. It binds rapidly with steel.
vii. It forms a hard surface, capable of resisting abrasion.

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The main undesirable properties of cement concrete are as follows:

i. It undergoes shrinkage while setting and hardening.
ii. It requires careful attention in preparation, placing and curing.
iii. Concrete structure will be bigger and heavier than steel structures.
iv. If it is not compacted thoroughly, porous holes may formed on the surface.

4.3.9 Uses of Concrete

Concrete is used for variety of purposes such as:

i. Foundations of masonry works, especially in damp soil or under water.
ii. Terrace roofs and floors.
iii. Walls, retaining walls.
iv. Arches, dams and bridges, etc.



- The use of concrete can be traced back to ancient Egypt, where it was used as an infill material for the pyramids.
- First concrete highway was built in 1909 in Greenfield Township, which is now northwest Detroit, Michigan, USA.

4.3.10 Types of Concrete

There are many types of concrete that can be made as per requirement. In the ordinary concrete, the following distinctions are usually made.

(1) No fines concrete.
(2) High slump or self-compacting concrete.
(3) High strength concrete.
(4) High performance concrete.

4.1.10.1 No Fines Concrete



It is designed with cement, coarse aggregate and water without fine aggregates. This is generally used in mass concrete work in foundation where we want to prevent capillary rise of water.

4.1.10.2 High Slump or Self Compacting Concrete



In situations like concreting of piles, we cannot compact the concrete by external means. Similarly, in places where there is congestion of steel, we need this type of concrete. These are produced by

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increasing the workability of concrete by the aid of plasticizers and super plasticizers.

4.1.10.3 High Strength Concrete

Concrete which is designed to have strength 40 N/mm^2 (Grade 40) and above is called high strength concrete.



4.1.10.4 High Performance Concrete

Concrete which is designed to have strength more than 60N/mm^2 is called high performance concrete. Also these concrete have special characters like high workability, high resistance to corrosion, etc.



DO YOU KNOW?

Precasted concrete construction is the modern type of construction now-a-days.

Search link: Http://en.m.wikipedi.org>wiki>precastedconcretecon-struction.



4.3.11 Other Types of Concrete

In addition to the above concretes, a large number of special types of concretes are made for special purposes. They are:

i. Fibre reinforced concrete.
ii. Light weight concrete.
iii. Fly ash concrete.
iv. Silica fumes concrete.
v. Polymer concrete.
vi. Ferro cement concrete.
vii. Pre packed concrete.

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DO YOU KNOW?

A 10- storey precasted structure was erected in 48 hours in Mohali, Chandigarh by involving 200 workers including technicians.



4.3.12 Precautions to Be taken During Transportation and Placing of Concrete

During Transportation

- There should be no segregation or spilling of concrete.
- Water should not be added in any circumstances.
- Concrete should be placed and compacted before its setting starts.

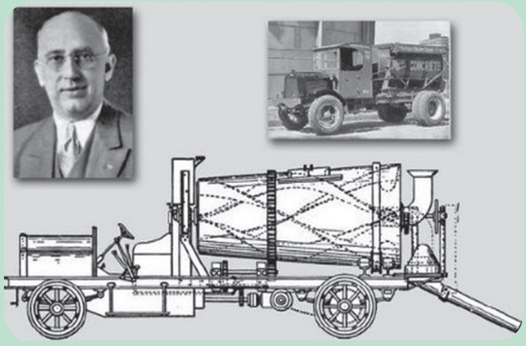
During Placing

- The form work should be properly cleaned and prepared well to receive fresh concrete.
- It should be deposited as nearly as possible to its final position.
- The position of form work and reinforcement should not be disturbed.
- It should not be dropped from height more than a metre to avoid segregation.
- It should be laid continuously.
- The thickness should not be more than 30-45cm in case of mass concrete and 15 - 30 cm in case of RCC Works.
- It should be consolidated or compacted well.
- Walking on freshly laid concrete should be avoided.
- Concrete should not be laid during rain.

DO YOU KNOW?

Stephen Stepanian:

An American inventor and owner of numerous patents including the elevator and conveyor, compound tool and the wrench. He is also the inventor of self-discharging motorized transit mixer that was the predecessor of the concrete mixer truck. Stepanian is often called the 'father of the ready-mix concrete' industry



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4.3.13 Grades of Concrete

Concrete grades are denoted by M_{10}, M_{20}, M_{30} according to their compressive strength. The 'M' denotes mix design of concrete followed by the compressive strength number in N/mm^2.

'Mix' is the respective ingredient proportions which are cement, fine aggregate and coarse aggregate.

If we mention M_{10} concrete, it means that, the concrete has 10 N/mm^2 characteristic compressive strength after 28 days.



ACTIVITY 6

Collect pictures of coloured concrete buildings and various concrete construction and prepare an album.

Note: The minimum grade of concrete for plain cement concrete (PCC) is M_{15} and for reinforced cement concrete (RCC) is $M_{20.}$

Grade	Proportion of concrete	Characteristic Compressive Strength (N/mm^2)
M_5	1:5:10	5 N/mm^2
$M_{7.5}$	1:4:8	7.5 N/mm^2
M_{10}	1:3:6	10 N/mm^2
M_{15}	1:2:4	15 N/mm^2
M_{20}	1:1 ½ : 3	20 N/mm^2
M_{25}	1: 1: 2	25 N/mm^2
M_{30}	1: 1: 3	30 N/mm^2

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. ……. concrete is adopted for concreting in congested areas.
   a. Ready mix
   b. Reinforced cement
   c. Plain cement
   d. Lime

2. The materials used to improve the quality of concrete is …..
   a. Fine aggregate
   b. Binding material
   c. Admixture
   d. Cement

3. ……. water should not be used in concrete.
   a. Pond
   b. Lake
   c. River
   d. Sea

4. The strength of high strength concrete is ……..
   a. 20 N/mm^2
   b. 40 N/mm^2
   c. 30 N/mm^2
   d. 10 N/mm^2

QOWJP

PART II (3 Marks)

Answer in one or two sentences

5. Define RCC and PCC.
6. List the ingredients of concrete.
7. List any four admixtures used in concrete.
8. What is water-cement ratio?
9. Write shortly about grade of concrete.

PART III (5 Marks)

Answer shortly

10. Write about any two ingredients of concrete.
11. Explain hand mixing of concrete.
12. Write about ready mix concrete.
13. What is compaction of concrete?
14. Write the uses of concrete.
15. What are the advantages of mechanical compaction of concrete?

PART IV (10 Marks)

Answer in detail

16. Explain machine mixing of concrete with sketch.
17. Explain about compaction of concrete.
18. Define curing and list the methods of curing.

Part – I Answers

1. (a) 2. (c) 3. (d) 4. (b)

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BUILDING MATERIALS

Unit - 5
Basic Civil Engineering

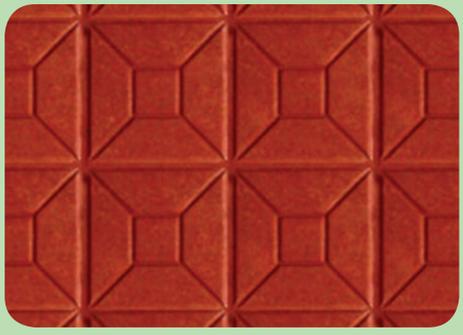
5.1 TIMBER



5.2 LIME

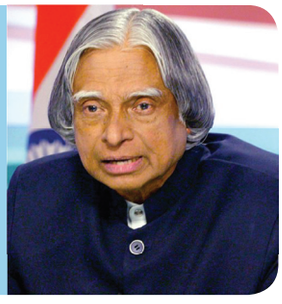


5.3 TILES



Learning gives creativity, creativity leads to thinking, thinking provides knowledge, knowledge makes you great

-A.P.J.Abdul Kalam



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5.1 Timber

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5.1.2 Types of Timber
5.1.3. Defects in Timber
5.1.4. Seasoning of Timber
- Objective of Seasoning
- Methods of Seasoning

5.1.5 Timber Products and their Uses
5.1.6 Uses of Timber in Construction

5.2 Lime

5.2.1 Introduction
5.2.2 Types of Lime
5.2.3 I.S. Classification of Lime
5.2.4 Uses of Lime
5.2.5 Difference Between Fat Lime and Hydraulic Lime

5.3 Tiles

5.3.1 Introduction
5.3.2 Types of Tiles and its uses
5.3.3. Ceramic Tiles

5.1 TIMBER

Learning Objectives

At the end of this lesson you shall be able to

- State the types of timber
- Describe the defects in timber
- Explain the seasoning of timber
- State the methods of seasoning of timber
- Explain the timber and its products with uses

5.1.1 Introduction

Wood is one of the oldest materials used by mankind to increase the comfort and well beings. Since it is so light in weight, large structures could be built on slender foundations with help of beams of great strength.

5.1.2 Types of Timber

1. Teak Wood
2. Sal Wood
3. RoseWood
4. Mango Wood
5. Jack Wood

5.1.2.1 Teak Wood

Teak wood is one of the most available hard wood. It is more durable due to the presence of aromatic oil, which largely preserves it from the attack of white ants. It grows in south India and central India.



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DO YOU KNOW?

The biggest tree in the world:

General Sherman (Giant Sequoia Tree) in California's Sequoia National Park in Tulare country in the United States of California. By volume it is the largest known living single stem tree on earth.

Volume: 52000 cubic feet (1487 m^3)

Height: 84 m

Weight: 1.9 million kilogram.



Characteristics of Teak Wood

i. It shrinks very little and its fibres are straight.
ii. It can be worked easily and finally polished.
iii. It weighs 7700 N/m^3.
iv. Its colour is yellow to dark brown.
v. It is one of the most valuable timber in the world.



Uses: It is used for ship building, railway sleepers, for making furniture and railway carriages and also for structural and decorative purposes.

5.1.2.2 Sal Wood

It is available mostly in hilly areas of UP, Bihar, Assam and Visakhapatnam.



Characteristics of Sal Wood

i. Wood is hard, close grained, heavy and durable.
ii. Not easily attacked by white ants and seasons.
iii. Average weight is 8600 $N/m.^3$

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Uses: Used in bridge construction, ship building, piles, etc.

5.1.2.3 Rosewood

Rosewood is dark pink in colour and it takes a high polish. It is found in Kerala, Maharashtra, Madhya Pradesh, Tamilnadu and Orissa.



Characteristics of Rosewood

i. It is strong, tough and close grained.
ii. It maintains its shape well and available in large sizes.
iii. Its weight after seasoning is about 7900 N/m^3.

Uses: Used for furniture of superior quality, ornamental works, etc.

ACTIVITY 1

a. Find out the oldest tree in your town and try to determine its age.
b. Take out the cross section of timber and see the grains in it.

5.1.2.4 Mango Wood

This tree is very much esteemed for fruits and is found all over in India. This wood is easily attacked by white ants and decays on exposure to wet atmosphere.



Characteristics of Mango Wood

i. It can be easily designed.
ii. It is coarse and open grained.
iii. It is deep grey in colour.
iv. Its average weight is 6900 N/m^3.



Uses: Used to make cheap furniture and temporary constructions.

5.1.2.5 Jack Wood

Its colour is yellow when freshly cut and it darkens with age. It maintains its shape well. It is found in Maharashtra and Tamilnadu.



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Characteristics of Jack Wood

i. It is easy to work.

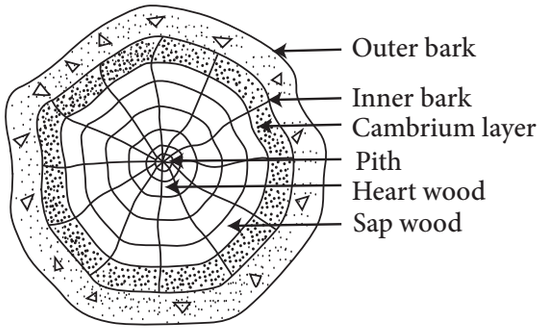
ii. It gives a good finish.

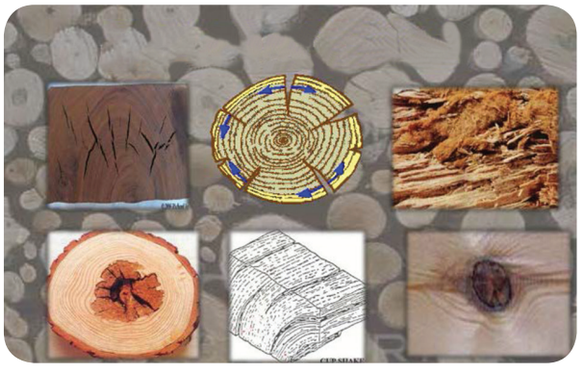
iii. Its weight after seasoning is 5950 N/m^3.



Uses: Used for plain furniture, boat construction, door and window panels, etc.

Inner parts of Timber







DO YOU KNOW?

The largest tree in India:

- The banyan tree (250 year-old) located in Acharya Jagadeesh Chandra Bose Indian botanic garden, Howrah near Kolkata.
- A 330 m long road was constructed around the tree to drive the visitors around the circumference of the tree. It covers 14500m^2 (3.5acres) area.





5.1.3 Defects in Timber

1. **Star Shakes**: These are the cracks which extend from bark towards the sapwood. These are wider at outside end and narrower at inside end. These are usually formed due to extreme heat or severe frost during the growth of the tree.

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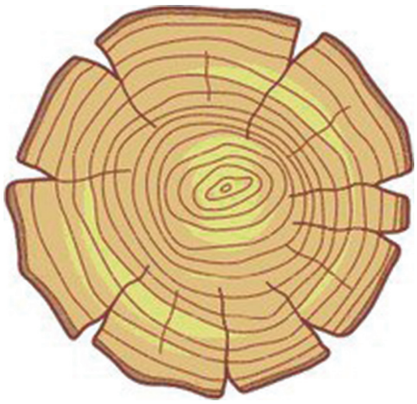
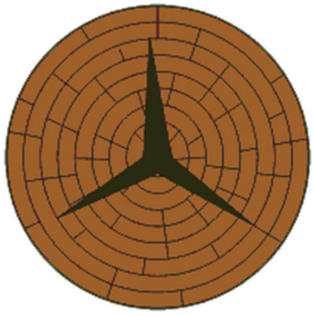
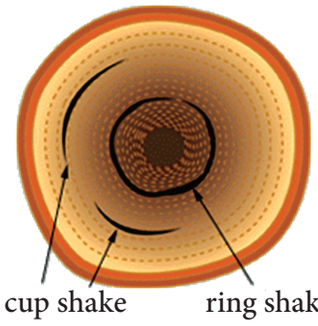


2. **Heart Shakes:** These cracks occur at the centre of the cross section of the tree and it extends from pith to sapwood in the direction of medullary rays. These cracks occur due to shrinkage of interior part of tree which is approaching maturity. It divides the cross-section of the tree into two or four parts.



3. **Cup Shakes**: Cup shakes separate the whole or part of one annual ring from another and are caused by wind and frost in the growing tree.



4. **Radial Shake:** These are similar to star shakes and occur in felled timber when exposed to the sun during seasoning. Radial shakes are generally irregular, fine and numerous.

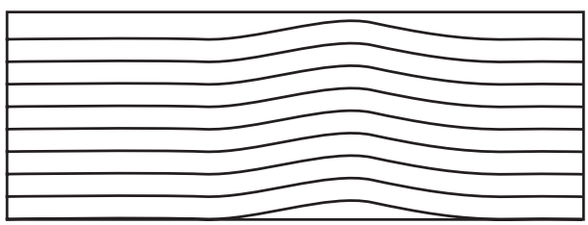


5. **Rind Galls:**



A peculiar curved swelling found on the body of the tree is known as rind galls. They develop at points from where branches are improperly cut-off or removed.

6. **Upsets:** Upsets are portions of the timber in which the fibres have been injured by crushing, bending or shocks during growth of the tree.



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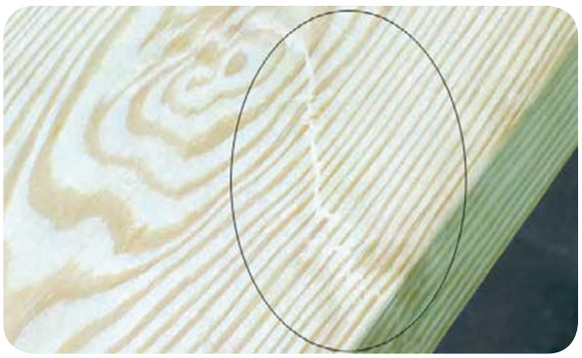
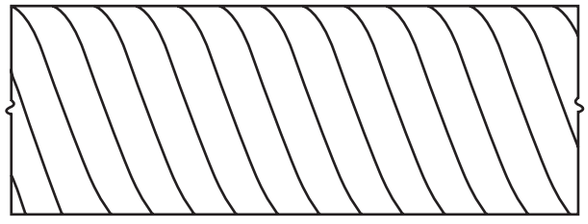


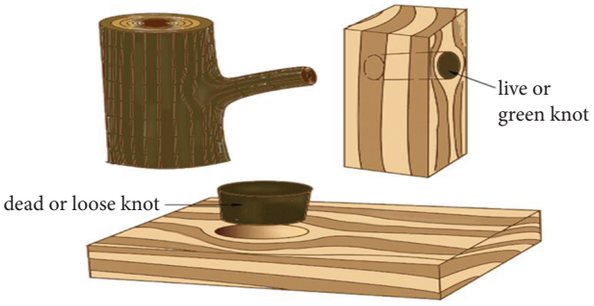
7. **Twisted Fibres:**



Twisted fibres are caused by the action of a prevalent wind turning the tree constantly in one direction. Timber thus injured is not fit for convertion, as so many fibres would be cut through.

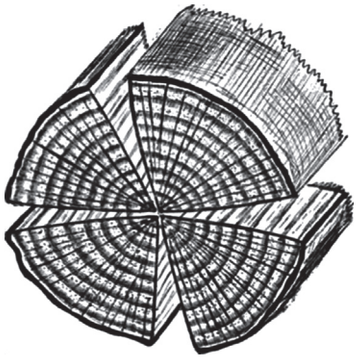


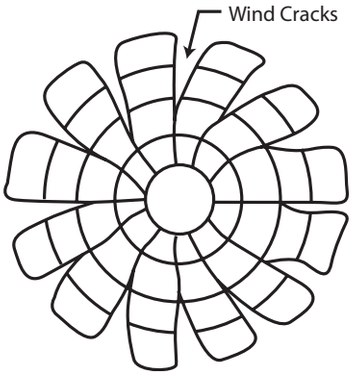
8. **Knots:** Sometimes branches or limbs are cut off from the tree. The portion from which the branch is cut off continues to receive nourishment from the stem for a long time and it ultimately results in the formation of knots.





9. **Wind Crack:** Wind cracks are shakes or splits on the sides of a bark of timber due to the shrinkage of exterior surface exposed to atmospheric influences.





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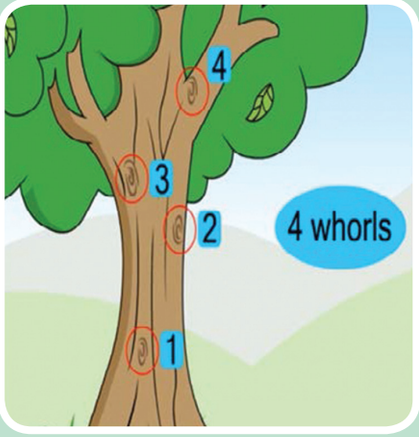
How to calculate the age of a live tree?

Way 1 - Try to find out when it's planted.

Way 2 - Count the numbers of branch whorls above chest height. Add 1 to your total. (Example: 4 whorls + 1 = 5 years)

Way 3 - Multiply the diameter by the growth factor.

Way 4 - Example: For White Oak tree, if the growth factor is 5 and its diameter is 22 inches, then its age is 22 × 5 = 110 years.



10. **Druxiness:** Druxiness is the name given to decayed spots or steaks of whitish colour in timber.



5.1.4 Seasoning of Timber

Seasoning is the process of drying timber in a controlled condition to remove all the sap and to reduce moisture content without introducing any splits and distortion in the wood.

5.1.4.1 Objectives of Seasoning

I. To reduce the weight of timber.

ii. To make timber fit for receiving coating of paints.

iii. To impart hardness, strength and stiffness to timber.

iv. To make timber safe from the attack of fungi, insects, etc.

v. To reduce the tendency of timber to warp, crack and shrink.

5.1.4.2 Methods of Seasoning of Timbers

1. Natural Seasoning
2. Artificial Seasoning

1. Natural Seasoning :



In this method, timber logs are sawn into planks or other marketable sizes after felling. The sawn timber is stacked under a covered shed. Sawn timber is stacked in such a way that sufficient space is left around each sawn piece, so that free circulation of air may take place without any difficulty. Timber pieces may be stacked horizontal or vertically. But horizontally stacking arrangement is

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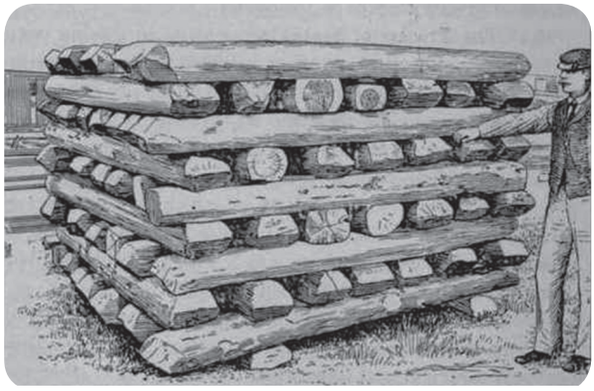
the most common method. The platform where stack is to be erected should be raised from the adjoining ground by at least 300 mm.

The stack is prepared by laying layers of sawn pieces in cross wise directions in alternate layers, length of the stack is equal to length of timber pieces. Width and height of the stack are restricted to about 1.5m and 3m respectively. A number of such stacks may be constructed under the same shed. Minimum distance between adjacent stacks should be kept about 600mm. This method of seasonings is also called "**Air seasoning**" as natural air remains circulating around each piece of the stacks and in due course of time seasoning is brought about.



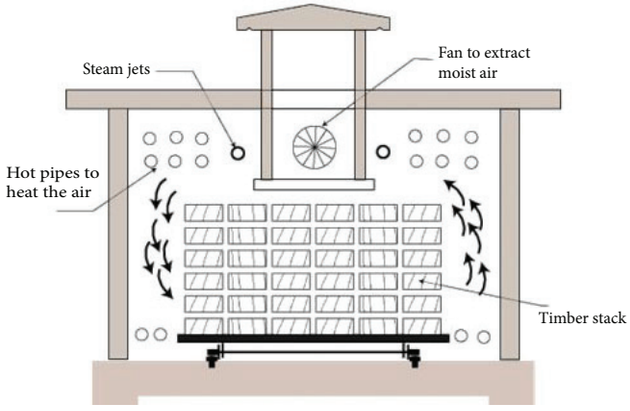
2. Artificial Seasoning

i) Boiling

ii) Electrical Seasoning

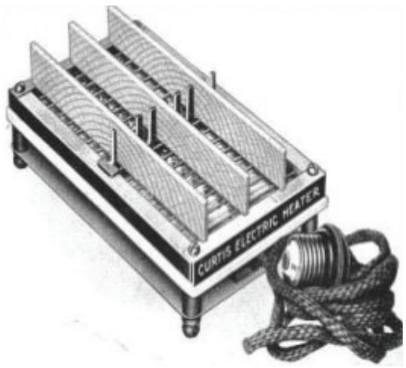
iii) Kiln Seasoning

(i) Boiling: In this method, timber is immersed in water and the water is boiled for about three to four hours. It is then dried very slowly. Instead of boiling in water, timber may be exposed to the action of hot steam. This method of seasoning proves to be costly.



(ii) Electrical Seasoning: In this method high frequency alternating current is passed on timber. When timber is wet it offers less resistance to the flow of electric current. The resistance increases as the wood dries internally, which also results





Electrical Seasoning

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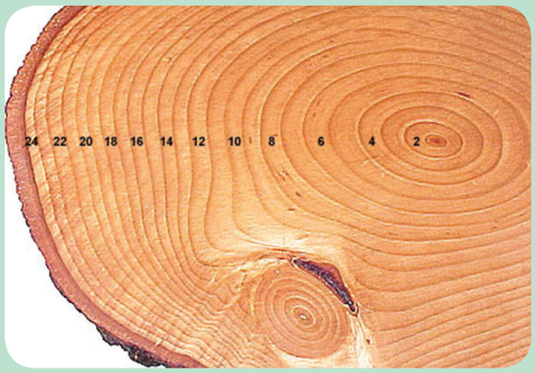
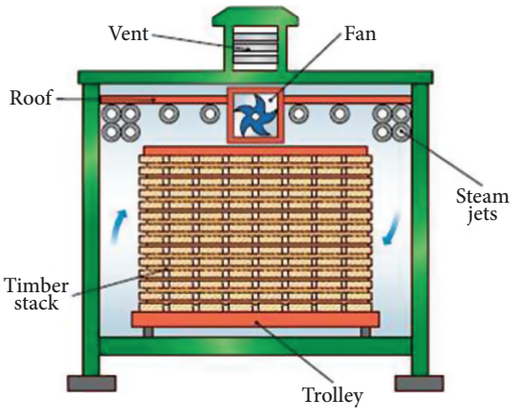
in the production of heat. This method is not adopted as it is not economical.

How to determine the age of a dead tree?

By counting the number of rings in the log.



(iii) Kiln Seasoning: This method of seasoning is carried out in air tight chambers or ovens. Converted timber pieces are stacked inside the chamber such that spaces are left for free circulation of air. Now, air fully saturated with moisture and heated about 40° c is forced inside of the chamber. The heated air gradually enters inside of the timber pieces and the moisture content in the timber is gradually reduced.



5.1.5 Timber Products and their Uses

1. Veneers
2. Plywood
3. Fibre board
4. Particle or Light board
5. Hard Board
6. Block board
7. Laminated Boards

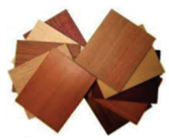
5.1.5.1 Veneer

Veneers are thin sheets of wood with 0.4mm to 6mm thickness obtained by different knife cutting processes. These are produced by rotary cutters where a knife blade is firmly held against a leg which is rotated. The sheets that are turned out are cut into standard sizes. Teak, sissoo, rosewood are some of the Indian timbers capable of producing high-grade veneers.


Saw Blade


Knife Blade







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5.1.5.2 Plywood

Plywood is made by pasting three or more veneers having the direction of grain running at right angles to each other in alternate layers. The adhesive coated sheets are assembled and pressed together by hot press. It is then cut into different pieces of marketable sizes. It is also available in various thickness ranging from 3mm to 25mm in Moisture Resistant (MR) and Boiling Water Resistant (BWR) grades.



5.1.5.3 Fibre Boards

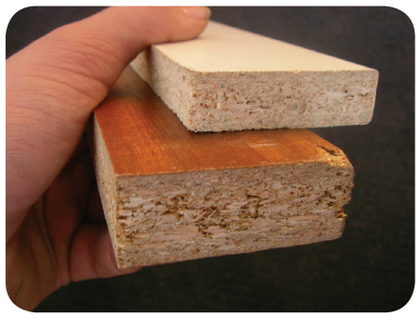
For making fibre boards, wood chips are steamed to separate fibres from each other. These fibres are blended with resin and wax and turned into sheets by passing through a pressing machine under controlled heat and pressure. It is then cut into pieces of marketable sizes. These boards are available in thickness ranging from 2.3mm to 35mm in plain MDF boards and prelaminated MDF boards. (MDF = Medium Density Fibre board)



5.1.5.4 Particle Boards

Low Density Fibre (LDF) boards are called particle boards. These are manufactured from waste wooden chips, saw mill shavings or even saw dust blended with syntheic resin or other suitable binders by pressing.





5.1.5.5 Hard Board

Hard boards are made from wood fibres extracted form wood chips and pulped wood waste. It is also called as High-density fibre (HDF) board. These boards are stronger, denser and harder than other types of boards because, it is made by the materials which are highly compressed. Usually hard boards are 3mm in thickness.



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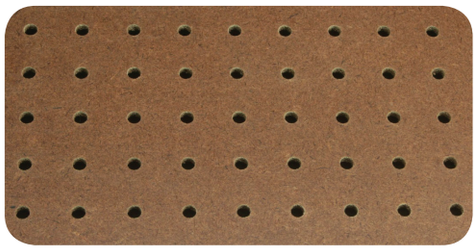


5.1.5.6 Block Board

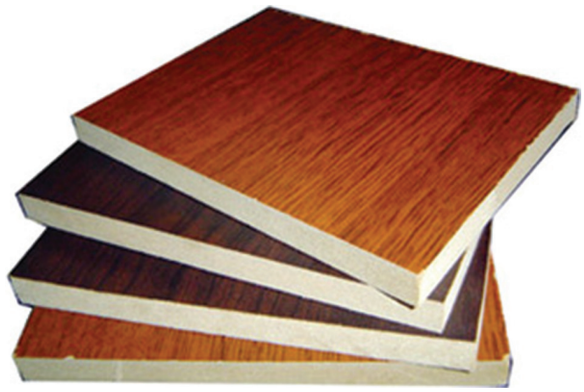
Block boards are made up of a core of softwood strips. These strips may be 25mm wide. The strips are placed edge to edge and sandwiched between veneers of hardwood. The sandwich is then glued under high pressure. These boards are not suitable for outdoor use. It is available as sheets of 2440 × 1220mm in size with 30mm thickness.



5.1.5.7 Laminated Board

Laminated boards looks very similar to blockboards but it is made up of softwood strips, 5-7mm in width. It is also sandwiched between two outer Veneers with the grains running at right angles to the core strips.





5.1.6 Uses of Timber in Constructions

1. It can be used in the form of vertical posts, beams, lintels, etc.
2. It can also be used as members of roofing trusses and rafters.
3. It is used as form work for cement concrete structures.
4. It is very much used in timbering in the deep trenches.
5. It is an important material for furniture making.
6. It is very much used in making sports goods, musical instruments, agricultural implements, etc.
7. It is used in making woods floors, partitions, doors and windows, etc.

ACTIVITY 2

a. Collect some small samples of different types of timber. Smell and weight it.

b. Prepare a comparison statement for its colour, smell, weight, grains, etc.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. Teak wood weight is ……..
   a. 1100 N/m^3 b. 2200 N/m^3
   c. 5500 N/m^3 d. 7700 N/m^3
2. The dark pink colour tree is ……
   a. Teak wood b. Rose wood
   c. Sal wood d. Jack wood
3. Natural seasoning is also called ……
   a. Air seasoning
   b. Chemical seasoning
   c. Electrical seasoning
   d. Kiln seasoning
4. Temperature for seasoning of timber in kiln seasoning is ……
   a. 140°C b. 240°C
   c. 40°C d. 110°C



PART II (3 Marks)

Answer in one or two sentences

5. Write short notes on teak wood.
6. List three methods of artificial seasoning of timber.
7. What are the methods in seasoning of timber?

PART III (5 Marks)

Answer shortly

8. What are the types of trees? Explain about any one.
9. What are the uses of timber in construction?
10. What are the objects of seasoning?

PART IV (10 Marks)

Answer in detail

11. Write about any two timber products and their uses.

Answers

1. (d) 2. (b) 3. (a) 4. (c)

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5.2 LIME

Learning Objectives

At the end of this lesson you shall be able to

- State the types of lime.
- Compare fat lime and hydraulic lime.
- Know the I.S.Classification of lime.

5.2.1 Introduction

Lime is an important binding material in building construction. Several buildings in India were constructed using lime.



5.2.2 Types of Lime

Generally, lime is classified into two types. They are:

1. Fat lime
2. Hydraulic lime

5.2.2.1 Fat Lime

Due to high calcium content, it is called high calcium lime and it is also called as white lime and pure lime. If we get pure lime in nature it is called as quick lime. When fat lime is boiled in water the cubic content increases upto 2.5 times. This lime contains 95% calcium oxide.

DO YOU KNOW?

Lime was used as a construction material in Egypt for plastering the pyramids approximately in 4000 BC.

Properties of Fat Lime

i. It hardens slowly.
ii. Its plasticity is high.
iii. It is soluble in water easily and quickly.
iv. It is in pure white in colour.

Uses of Fat Lime

i. Useful for white washing on the plastered walls.
ii. When added with sand, that lime mortar is used for brick work and stone masonry work.
iii. When mixed with surkhi, that mortar is used in the constructions of big compound walls, basements, etc.

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5.2.2.2 Hydraulic Lime



It sets under water. There is small quantity of clay content and iron oxide. According to the quantity of clay content, it is classified in to three types. They are:

1. Feebly hydraulic lime
2. Moderately hydraulic lime
3. High quality hydraulic lime

Feebly hydraulic lime is having 5% to 10% clay. This content is easily soluble in water. It takes 21 days to set..

Moderately Hydraulic Lime is having 11% to 21% clay. This content takes two hours for dissolving. It takes one or two weeks to set.

High quality hydraulic lime is having 21% to 30% clay. This soil will not easily soluble. But set in one (or) two days.

5.2.3 I.S Classification of Lime

Indian Standard Institution classified lime into 5 classes. Class A, Class B, Class C, Class D and Class E.

Class A

It is an eminently hydraulic lime normally used for structural purposes. It is normally supplied as hydrated lime. This contains about 25% of clay. It is especially suitable for under water works.

Class B

Semi hydraulic lime is the name contains both hydraulic lime and fat lime. It contains about 15% of clay. It is supplied both as hydrated or quick lime. It is used for mortar and concrete.

Class C

It is predominantly fat lime used for finishing coat in plastering, white washing, etc., and with suitable admixtures such as surkhi (or) any other pozzolanic material to produce artificial hydraulic lime. It is supplied both quick lime and hydrated lime. This can set under water.

Class D

It is the lime containing substantial proportions of magnesium oxide and is similar to fat time. It is used for finishing coat in plastering, white washing, etc.

Class E

It is kankar lime generally used for masonry mortars and is supplied as hydrated lime.

ACTIVITY 3

Collect the lime sample and its rates in your town.

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5.2.4 Uses of Lime

The following are uses of lime in construction.

i. For white washing.

ii. To prepare Mortar for Masonry and plastering work.

iii. To prepare lime-sand brick.

iv To stabilize earth.

v As inner lining in open hearth furnace.

vi In manufacturing of cement.

5.2.5 Difference Between Fat Lime and Hydraulic Lime

S.no	Property	Fat Lime	Hydraulic Lime
1	Main ingredient	95% calcium oxide. 5% clay soil.	5% to 30% clay soil and small quantity of ferrous oxide.
2	Slacking action	Quickly slacks. At that time volume is increased upto two times. Heat and sound occurs.	Slow slaking property. No sound and heat releases when slakes.
3	Setting action	Slow setting property. Absorbs carbon-di-oxide from the atmosphere and converts as calcium carbonate.	Sets under water. It changes as tricalcium aluminate and di calcium silicate when combines with water.
4	Hydraulic property	No hydraulic property.	Possess hydraulic property.
5	Colour	White.	Moderate white
6	Strength	Not so hard.	Highly hard.
7	Uses	Useful for white washing.	To prepare mortar used for the masonry work in water logged areas.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The lime contains …… calcium oxide.
   a. 50%
   b. 70%
   c. 85%
   d. 95%

2. Several buildings in India were used ……. for construction.
   a. Sand
   b. Lime
   c. Line
   d. Clay

3. Increasing in volume when fat lime is boiled in water is …….
   a. 2.5 times
   b. 3.5 times
   c. 4.5 times
   d. 5.5 times



PART II (3 Marks)

Answer in one or two sentences

4. What are the types of lime?
5. Write the uses of fat lime.

PART III (5 Marks)

Answer shortly

6. Explain the IS Classification of lime.

PART IV (10 Marks)

Answer in detail

7. Write the difference between fat lime and hydraulic lime.

Part – I Answers

1. (a) 2. (b) 3. (a)

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5.3 TILES

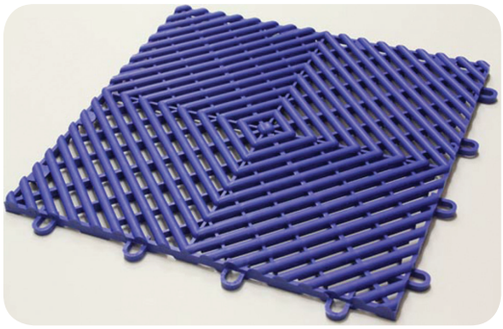
Learning Objectives

At the end of this lesson you shall be able to

- State the types of tiles.
- Understand the uses of tiles.

5.3.1 Introduction

Tiles are used for various purposes in building industry. They are thinner than bricks and hence should be carefully handled to avoid any damage.



5.3.2 Types of Tiles and Their Uses

1. Drain tiles
2. Floor tiles
3. Roof tiles

5.3.2.1 Drain Tiles

These tiles are prepared in such a way that they retain porous texture after burning. If the tiles are used in water logged areas, they allow sub soil water to pass through their holes. They are also used to convey irrigation water. Such drain tiles are rarely adopted in modern times.



DO YOU KNOW?

When was the first tile made?

In 14000 BC the first tile was made at Mesopotamia in Iraq. The maximum size of a tile was 300 cm × 150 cm – giant tiles

Search link: www.granitifiandre.com> porcelaintile

5.3.2.2 Floor Tiles

Floor tiles may be square or rectangle in shape. These are flat tiles and their thickness varies from 6.5 mm to 14 mm. As the floor tiles are hard and tough, there is minimum wear and tear. To prepare coloured floor tiles, colouring substance is added in the clay at the time of its preparation. Floor tiles

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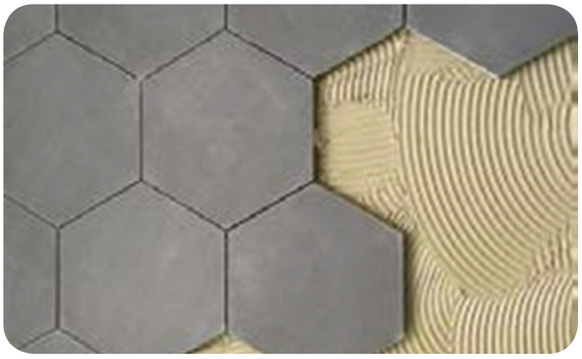
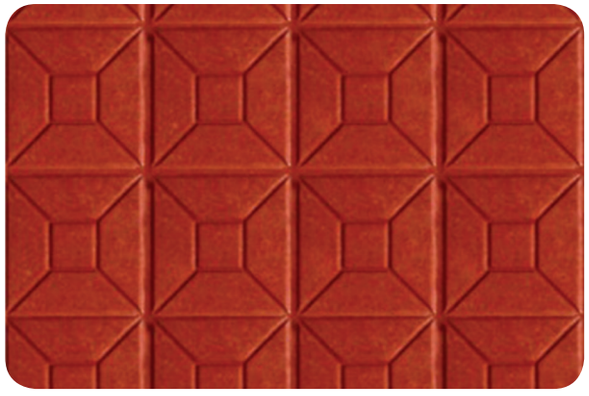
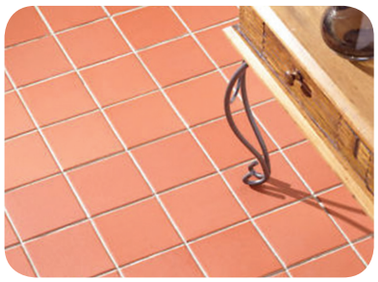
of comparatively less thickness can be adopted for fixing on walls.











5.3.2.3 Roof Tiles

These tiles are used for covering of pitched roof. Several kinds of roof tiles are available. They are:

- Allahabad Tiles
- Corrugated tiles
- Flat tiles
- Flemish tiles
- Mangalore tiles
- Pan tiles
- Pot tiles

5.3.2.3.1 Allahabad Tiles

These tiles are made as two portions. The edges of the base portion is with projecting upward ribs. Its size reduced from 27 cms to 23 cms. The length is 38 cms. The top portion is in the shape of semi-circle. Its diameter reduces from 15.5 cms to 12 cms. It is made up of high quality clay by hydraulic pressing and burning..





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5.3.2.3.2 Corrugated Tiles

These tiles have corrugations. Hence it is called corrugated tiles. When these tiles are placed on the roof, it is enough to overlap two corrugations to join each other. These are made by galvanized iron sheets and cement mixed with asbestos fibres.



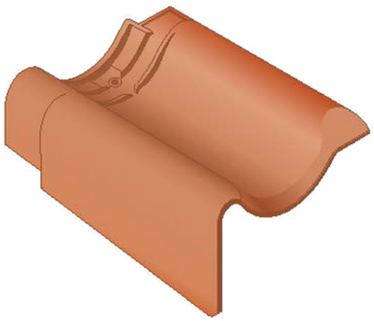
5.3.2.3.3 Flat Tiles

These are like ordinary floor tiles. These are used to lay on the terrace above the weathering course. It is some time used as under tile in pitched roof.



5.3.2.3.4 Flemish Tiles

These tiles are moulded in the shape of 'S'. It is also used to lay in pitched roofs.



5.3.2.3.5 Mangalore Tiles



To drain water, the red colour Mangalore tiles are moulded with two channel like structure. To join the tiles with each other, there will be a upward projection in the side of tiles.



By using Mangalore moulds, ridge, hip, chimney portion tiles are designed.





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As this tiles are coming from Mangalore of Karnataka state to Tamilnadu, these are called Mangalore tiles. This tiles are also manufactured in Cochin, Calicut of Kerala state. Maximum 24% of water can be absorbed by "A" class Mangalore tile.

ACTIVITY 4

Prepare an album by pasting different types of floor, roof, and drain tiles.

5.3.2.3.6 Pan Tiles

These are small and hard. When compared to pot tiles, they have minimum undulations. Good quality tiles are manufactured by moulding, drying and burning. The length is 33 cm to 38 cm. The breadth is 23cm to 28cm.







5.3.2.3.7 Pot Tiles



These are ordinary semi-circular country tiles. As this tiles are made by Pot makers, they are called pot tiles. These tiles are small and comfortable to handle. So, it is called hand tiles in Tamil Nadu. These tiles are easily breakable.



5.3.3 Ceramic Tile

Ceramic tile is made up of sand, natural clay, and water. Once it has been moulded into shape they are then fired in kiln. Ceramic tiles can either be glazed or unglazed. In buildings, ceramic tiles are used as floor andn wall tiles. Common types of ceramic tiles used in construction are :

1. Ceramic floor tiles
2. Ceramic terracing tiles
3. Ceramic ceiling tiles
4. Glazed ceramic tiles
5. Fully vitrified tiles
6. Porcelain tiles

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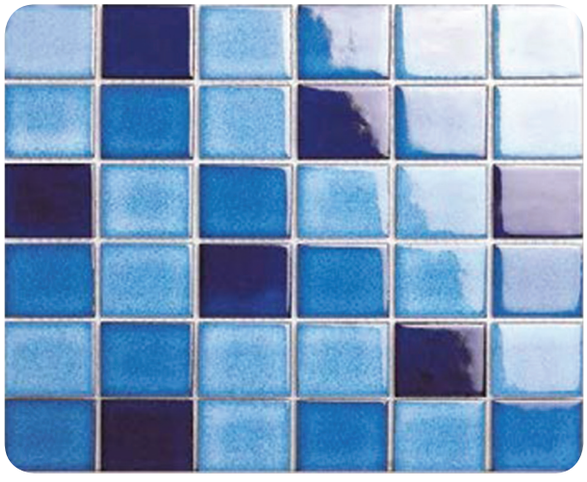
Ceramic Terracing Tiles: These tiles are flat tiles made up of well prepared and weathered clay and burnt in a kiln. They should be burnt uniformly. They can be hand-made or machine pressed. Usual sizes are 200 × 200 × 15mm and 150 × 150 × 15 mm. The thickness may vary from 15 - 20 mm.



Glazed Ceramic Tiles: These are of earthenware, having top surface glazed and underside unglazed, so that tile may adhere properly with the surface. A glaze is applied in order to improve the appearance, making it non-absorbent and increasing its durability. These tiles are made in different sizes.



Fully Vitrified Tiles: Vitrified tile is the ceramic tile with low porosity. It is an alternative to marble and granite flooring. These tiles are often used in outdoors due to their water and frost resistance. They are extremely durable and are made to endure heavy traffic.

Since the edges of these tiles are uniform, they can be laid with very close joint.



ACTIVITY 5

Collect different types of tiles with your class friends and display it in the class room.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The thickness of ceramic terracing tiles varies from ……
   a. 15mm to 20mm
   b. 2mm to 300mm
   c. 5mm to 400mm
   d. 6mm to 100mm
2. Mangalore tiles are also manufactured in the states of …..
   a. Tamil Nadu & Andhra
   b. Kerala & Tamil Nadu
   c. Andhra & Kerala
   d. Karnataka & Kerala

L4TQH

PART III (5 Marks)

Answer shortly

3. What are the types of tiles?
4. What are the types of roof tiles?

PART IV (10 Marks)

Answer in detail

5. Elaborate about ceramic tiles?

Part – I Answers

1. (a) 2. (d)

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BUILDING CONSTRUCTION

Unit - 6
Basic Civil Engineering

6.1 FOUNDATION

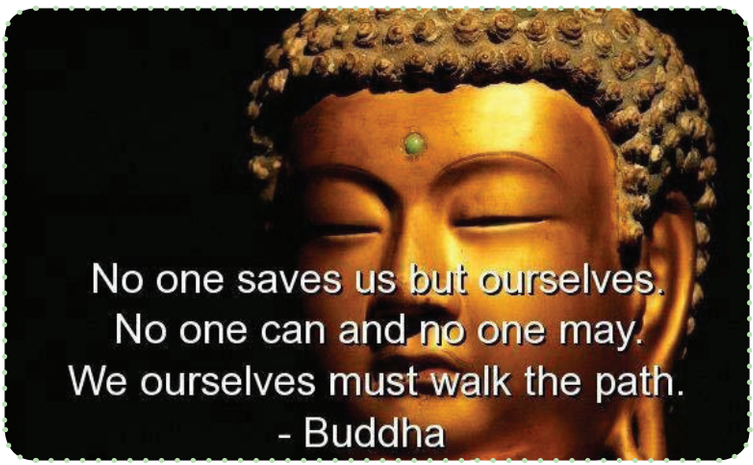


6.2 STONE MASONRY



6.3 BRICK MASONRY





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6.2 Stone Masonry
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- 6.2.3 Dressing of Stones
- 6.2.4 Classification of Stone Masonry
- 6.2.5 Points to be Considered in the Construction of Stone Masonry

6.3 Brick Masonry
- 6.3.1 Introduction
- 6.3.2 Terms used in Brick Masonry
- 6.3.3 Types of Bonds in Brick Work
- 6.3.4 Tools used in Brick Masonry and Stone Masonry
- 6.3.5 Points to be Considered in the Construction of Brick Masonry
- 6.3.6 Thickness of Brick Wall
- 6.3.7 Difference Between Stone Masonry and Brick Masonry

6.1 FOUNDATION

Learning Objectives

At the end of this lesson you shall be able to

- State the types of foundation.
- Explain various types of foundation.
- Understand the setting out work for foundation.
- List out the causes of failure of foundation and their remedies.

6.1.1 Introduction

Foundation is the most important and strongest part of a building. Every building has two important parts, one part below the ground level (Sub-structure) and another part above the ground level (Superstructure). The structure constructed below the ground level to transmit the total load of the structure above it safely to the earth is called foundation.

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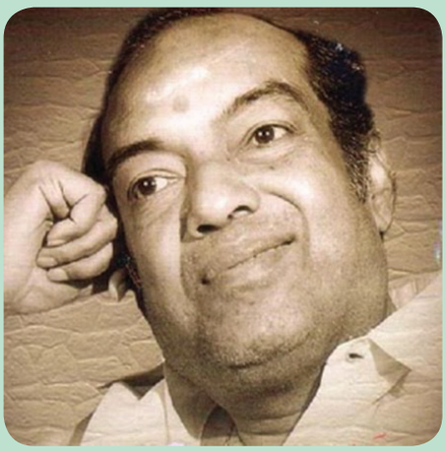
DO YOU KNOW?

In the film "Padithal mattum pothuma" – Kannadhasan wrote a song.

அடிப்படை இன்றி கட்டிய மாளிகை காற்றுக்கு நிற்காது!

அழகாய் இருக்கும் காஞ்சிரைப் பழங்கள் சந்தையில் விற்காது!



6.1.2 Objectives to provide foundation

I. Foundations are constructed to distribute the total load of the structure uniformly to the soil below and to prevent unequal settlement.

ii. The foundations gives stability, strength and protection to the structure from wind, storm and rain.

iii. The foundation gives levelled and hard surface for the construction above the ground level.

6.1.3 Types of Foundation

1. Shallow foundation.
2. Deep foundation.

6.1.4 Shallow Foundation

These foundations are constructed in ordinary buildings with low depths.

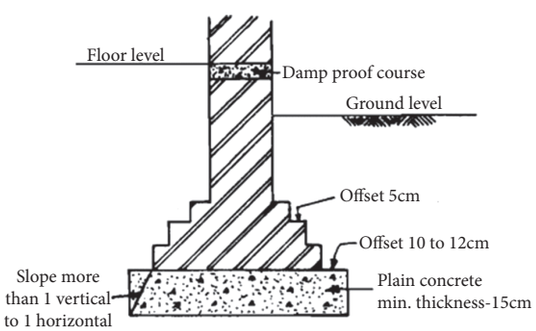
Types of Shallow Foundation

1. Wall footing (or) spread footing.
2. Isolated footing.
3. Combined footing.
4. Continuous footing.
5. Inverted arch footing.
6. Strap footing.
7. Grillage foundation.
8. Raft foundation.

6.1.4.1 Wall Foundation (or) Spread Footing

The foundation of the wall is a continuous strip of concrete or stepped footing. The stepped footing is also called as spread footing. It is provided to distribute the load of the structure on large area of the soil.

This is the cheapest type of foundation and is largely used for ordinary building. The concrete ratio used for foundation may be 1:3:6 or 1:4:8.



Method of designing the breadth and depth of wall foundation:

1. Breadth of foundation = Total load per metre /allowable bearing capacity of soil.

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2. Depth of foundation. It is designed by Rankine's formula

$$h = \frac{p}{\gamma}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$$

Where,

h = minimum depth of foundation

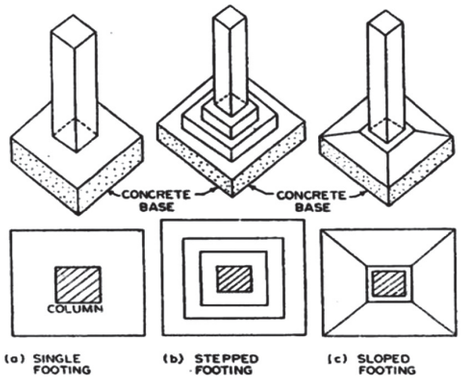
p = gross bearing capacity

γ = density of soil

ϕ = angle of repose or internal friction of soil.

6.1.4.2 Isolated Footing

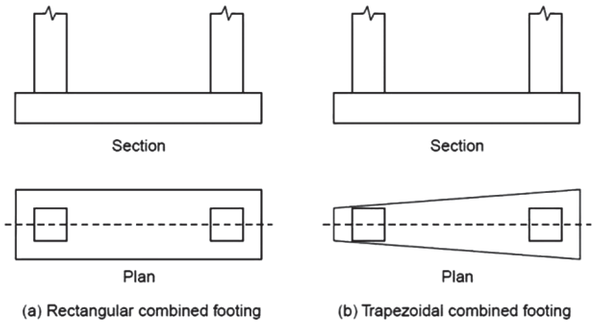
These foundations are formed for individual concrete (or) brick pillar. The base structure is formed as stepped or slopped footing. Reinforced concrete foundations are used to provide foundation for heavy weight pillars.





6.1.4.3 Combined Footing

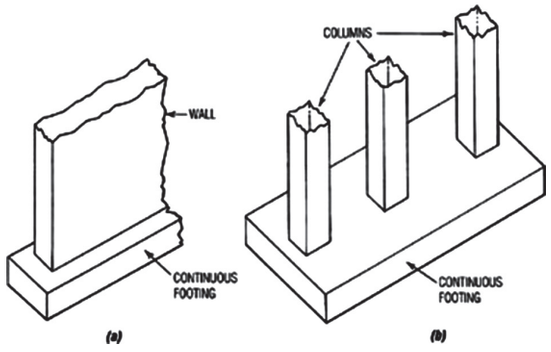
A combined footing supports two or more columns in a row. The combined footing may be rectangular (or) trapezodal in shape. The centre of gravity of combined loads and the center of gravity of the footing should coincide.





6.1.4.4. Continuous Footing

In this type of footing a single continuous RC slab is provided as foundation of two or more columns in a row. This type of footing is best where earthquake is liable to act. This footing prevents unequal settlement. Sometimes deeper beam is provided between the columns.



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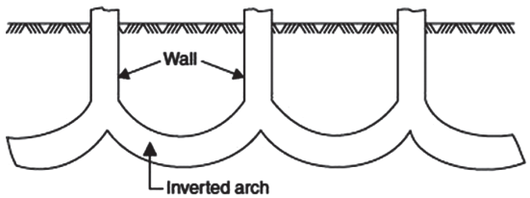
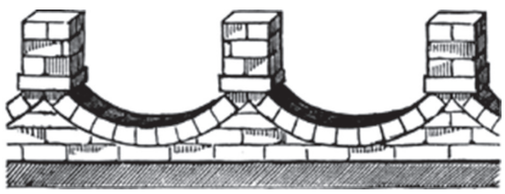
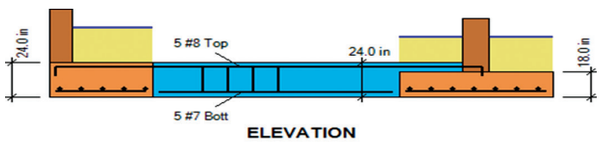
6.1.4.5. Inverted Arch Footing

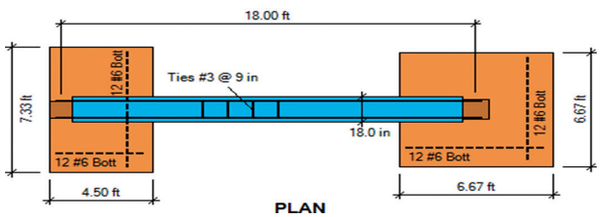
While forming the foundation on soft and fine soil these footings are used to reduce the depth of foundation. Through the inverted arch the whole load acting are transferred by spreading to wider area. Mostly these are used for bridges and multi-storeyed building in olden days. As it is curve in shape it bears heavy load due to its arch action. This type is rarely adopted now-a-days.





6.1.4.6 Strap Footing







BURJ KHALIFA.

The 'Burj Khalifa' is a mega tall skyscraper in Dubai, United Arab Emirates.

Total height is 829.8m (2,722 ft). It has been the tallest structure in the world since its topping out in late 2008.





ACTIVITY 1

Prepare a report about 'Burj Khalifa' with pictures.

Strap footing consists of two or more individual footings connected by a RC beam. These beams are called strap beams. This type of footing may be used where the distance between the columns is more.

6.1.4.7. Grillage Foundation

These foundations are used to transmit heavy loads from steel column to the soils

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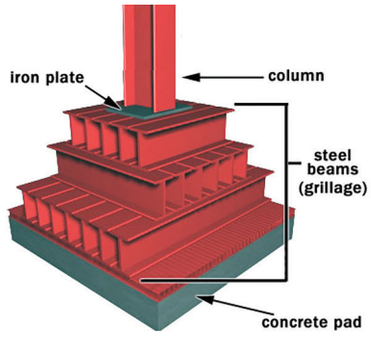
having low bearing capacity. Deep excavation of soil can be avoided by using this foundation. This type of foundation is lighter and more economical.

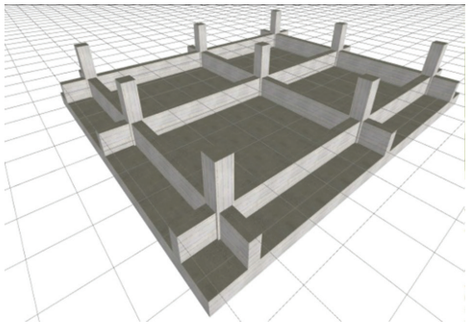
This type of foundation is often used at the base of the steel column. It consists of one, two or more tiers of steel beams superimposed on a layer of concrete. Adjacent tires being placed that right angle to each other.



6.1.4.8. Raft Foundation

A raft or mat is a combined footing that covers the entire area beneath the structure and supports all the columns. The raft foundation is economical than isolated footing, if the sum of the base areas of the isolated footing exceeds about half the total building area.





6.1.5 Deep Foundation

These foundations are suitable when buildings are to be constructed in poor soil (low bearing capacity of soil) or hard rock is only available in high depth. It is classified into two types.

1) Pile foundation
2) Well foundation

6.1.6. Setting Out Of Foundation

It is a process of marking the centre line of a building in the proposed site of construction for earth work excavation.

The following steps are to be followed for setting out of foundation:

i. The land where the building is to be constructed should be cleaned and levelled by removing all the vegetation and undulations.
ii. Dimension of the room to be constructed is studied carefully. Say 4.80 m x 3.30 m.
iii. Now the centreline sketch should be prepared.
iv. If the wall thickness is 0.20 m, the centre-line dimension will be 5.00 m x 3.50m.
v. As per the centre line drawing the centreline of front wall should be marked (points 1 and 2) by driving steel pegs and strings are to be tied to it.
vi. The length of front wall is marked as A and B in that line according to the drawing.
vii. By using right angle, the line is extended from the point B and C is marked as per measurement.
viii. The same procedure is continued until it reaches the point A.
ix. Now, we can get a rectangle bounded by strings.
x. Then the diagonals AC and BD are checked. It should be equal.

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The deepest foundation.

'Petronas tower' also known as Petronas Twin Towers became the structure having the deepest seated foundation in the world. It is situated in Kuala Lumpur, Malaysia.

- The whole foundation rested on 104 piles.
- To reach the safe bed rock, the piles were extended to the depth ranging from 200 to 374 feet.
- The piles were embedded by thick raft of 15 feet in depth.
- The concrete raft foundation, comprising 4,70,000 cubic feet of concrete was continuously powered through a period of 54 hours for each tower.

It takes 12 months to complete the foundation.

Search link: http://en.m.wikipedia.org>wiki>petronas tower

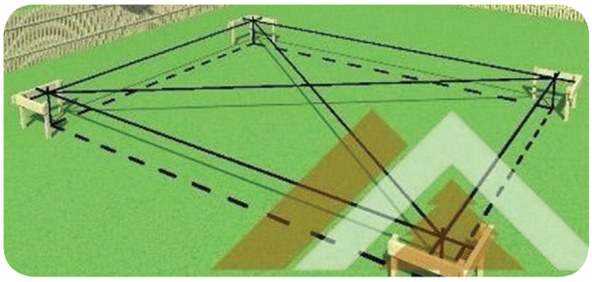


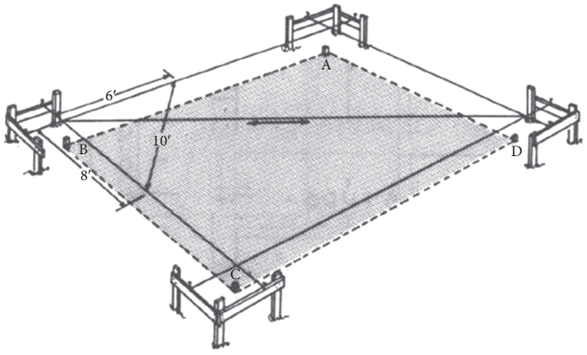
ACTIVITY 2

Prepare a report about deepest foundation structure with pictures.

xi. Now, the half of the width of the foundation should be marked on either sides of the centreline using white powder.

xii. Thus a building is set out at site for excavation.





6.1.7 Causes of Failure of Foundation and Its Remedies

Causes:

1. Unequal settlement of the sub soil.
2. Unequal settlement of the masonry.
3. Withdrawal of moisture from the sub soil.
4. Lateral pressure of the super structure.
5. Horizontal movement of the earth.
6. Transpiration of trees and shrubs.
7. Atmospheric action.

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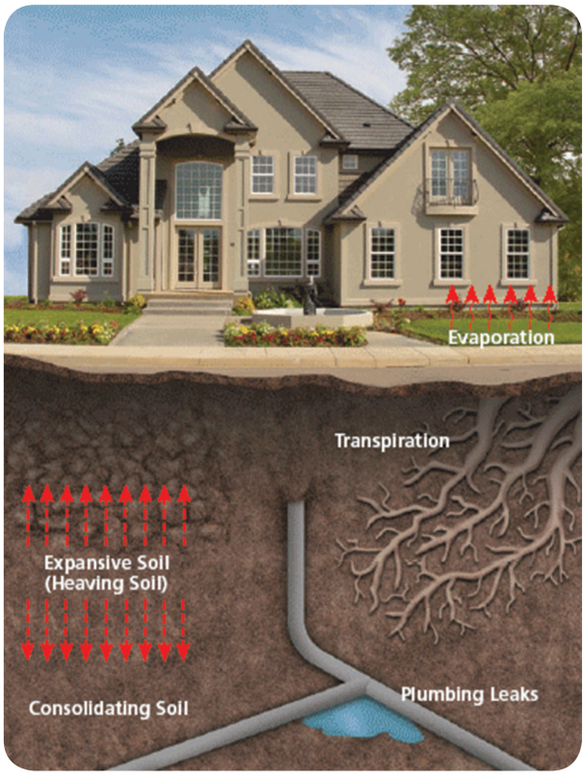
ACTIVITY 3

Collect pictures of various types of foundation, various foundation failures and prepare an album.



6.1.7.1 Unequal Settlement of the Sub Soil

When the load of all the parts of building is not even, the unequal settlement occurs. Based on the intensity of the load it may be low or high. This is because the bearing capacity of soil which is not uniform in all places. Cracks are formed in the building due to the variations in the settlement of soil.

Method of Prevention

i. Foundations should rest on hard rock or hard moorum.

ii. Type and design of foundation should be selected according to the nature of soil by considering the safe bearing capacity of the soil.

DO YOU KNOW?

The tallest building in the world.

'Jeddah Tower' is a skyscraper under construction in Jeddah, Saudi Arabia. If completed in 2020 as planned, the Jeddah Tower will reach an unprecedented height, becoming the tallest building in the world as well as the first structure to reach the one-kilometer-high mark.



6.1.7.2 Unequal Settlement of the Masonry

The mortar joints in the wall and other building portion may shrink and this may lead to unequal settlement of the building portion.

Method of Prevention

i. The water used to mix the cement mortar should be in correct proportion.

ii. Height of raising the super structure should be uniform. It should not exceed 1.5m / day.

iii. Curing of the masonry should be adequate.

6.1.7.3 Withdrawal of Moisture from the Sub Soil

Failure of foundation occurs where there is variation in the height of water table. The cracks are formed when the soil shrink due to the sudden reduction of water table from top to bottom.

Method of Prevention

The foundations are provided with piles to the extreme or should rest on hard rock in those places.

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6.1.7.4 Lateral Pressure on the Superstructure

The lateral pressure due to lateral movement of the earth tends to turn the super structure.

Method of Prevention

The base of the foundation wall should be much wider.

6.1.7.5 Horizontal Movement of the Earth

When buildings are constructed in the low level area and on the river bed where the soil is loose, the foundation may fail due to the horizontal movement of earth.

Method of Prevention

To avoid sliding of soil, bearing walls or pillar with plates may be constructed.

6.1.7.6 Transpiration of Trees and Shrubs

The moisture content of soil is absorbed by the penetration of roots from the trees and plants around the foundation of the building. So cracks are formed due to the shrinkage of soil.

Method of Prevention

i. The foundations should be beyond the roots of tree. Minimum depth should be one meter.

ii. The fast growing trees and trees requiring more water should be 8 meter away from the building.

6.1.7.7 Atmospheric Action

The important factors affecting the foundation are sun, wind and rain. Chemical reactions takes place when the chemical substances in the rain water come in contact with earth, resulting in adverse effects.

Method of Prevention

i. Foundation should be deep upto where the rain water cannot reach.

ii. After the masonry works are finished, sides of wall should be filled with earth and consolidated well. Rain water should be drained properly and it should not stagnate near the walls.



Leaning tower of Pisa, Italy

The tower's tilt began during construction in the 12th century, caused by an inadequate foundation on ground too soft on one side to properly support the structure's weight. The tilt increased in the decades before the structure was completed in the 14th century. It gradually increased until the structure was stabilized by efforts in the late 20th and early 21st centuries



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Model Questions

PART I (1 Mark)

Choose the correct answer

1. Cement concrete ratio used for foundation is ……..
   a. 1:3:6
   b. 1:4:6
   c. 1:5:6
   d. 1:2:6
2. Foundation provided to protect from Earthquake is …….
   a. Wall footing
   b. Continuous footing
   c. Combined footing
   d. Pile foundation
3. Foundation provided for construction of bridges is …….
   a. Pile foundation
   b. Spread foundation
   c. Inverted arch foundation
   d. Wall foundation.

PART II (3 Marks)

Answer in one or two sentences

4. Define foundation.
5. What are the types of deep foundations?
6. Write the Rankine's formula to calculate the depth of foundation and write the notation.



PART III (5 Marks)

Answer shortly

7. Explain the types of wall foundation with sketches.

PART IV (10 Marks)

Answer in detail

8. What are the causes of failure of foundation and explain any five methods of prevention?

Part – I Answers

1. (a) 2. (b) 3. (c)

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6.2 STONE MASONRY

Learning Objectives

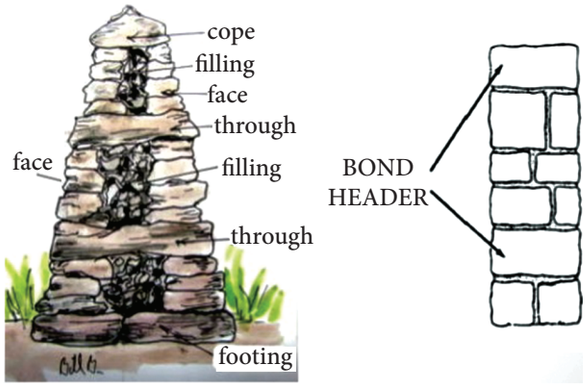
At the end of this lesson you shall be able to

- Understand the technical terms used in stone masonry.
- List the classification of stone masonry.
- Know about dressing of stones and its types.

6.2.1 Introduction

If construction is carried out using stones with cement or lime mortar, it is known as **stone masonry**.

6.2.2 Terms Used In Stone Masonry



i) Natural Bed

The surface on which the materials was originally deposited in the formation of rock is known as natural bed.

ii) Quoins



The external corner or angles of a wall are known as quoins and the stones or bricks forming the quoin are known as quoin stones or quoin bricks.

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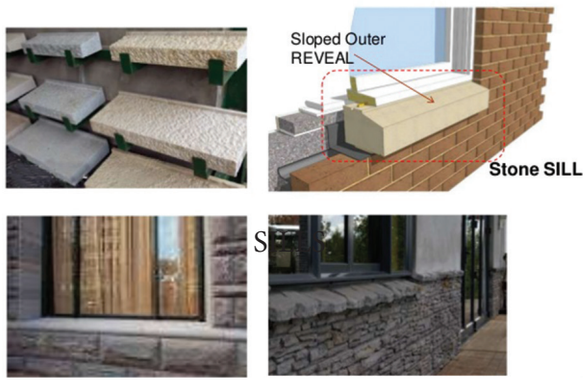
iii) Sill Level

The bottom surface of a door or window opening is known as sill level.



iv) Corbel

It is projection provided on the face of the wall by projecting stones. The projection is used to serve as a support for wall plates (wooden beam) for roof trusses, beams, etc.

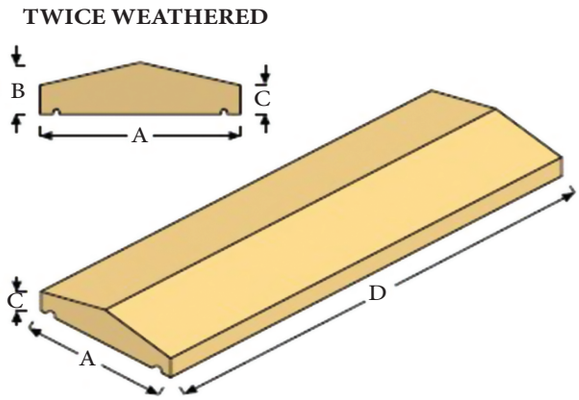


v) Spalls

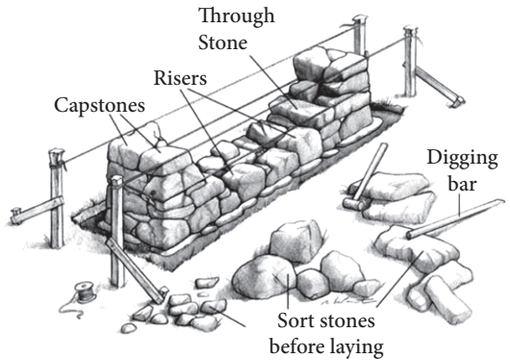
Stone chips broken off from large size stone during dressing and shaping are known as spalls. These are used as filling stones.

vi) Weathering

It is a term to indicate the bevelled top surface of the stone. It is sloped so as to allow easy drain of rain water.



vii) Through Stones



In stone masonry, some stones at regular intervals are placed through the full thickness of wall to develop bond. Such stones are known as through stones.

viii) Cornice



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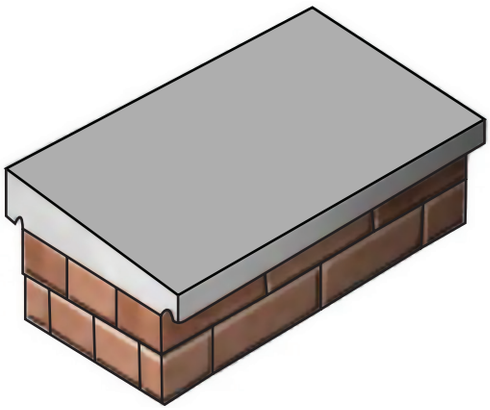
This is a moulded course of masonry having large projections. It may be provided at the junction of the wall and ceiling near the top of the building.

ix) Coping



It is course of stone, concrete or bricks provided at the top of the wall so as to protect the wall from seepage of rain water through joints. This course is generally provided at the top of a parapet wall or compound wall.

x) Throat

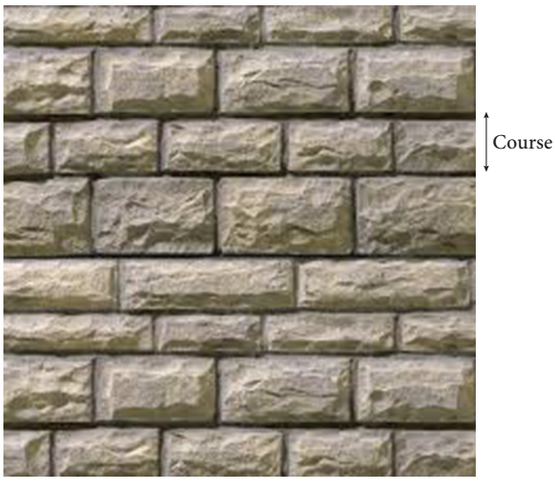


It is a small groove cut on the underside of sill, coping, cornice and projected chajja to discharge the rain water without trickling down to the walls.

xi) Course

A layer of stones or bricks is known as a course.

Thickness of a course = Thickness of a stone or brick + Thickness of one mortar joint.



xii) Plinth



The projecting course at ground floor level is known as the plinth. It is also used to indicate the height of floor level from ground level. It is sometimes moulded and given ornamental treatment.

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The offset at plinth level is sometimes omitted for the architectural purpose.

xiii) String Course

It is continuous horizontal course of masonry, generally provided at every floor level. This course remains projecting from the face of the wall and is intended to improve the elevation of the structure.



xiv) Lacing Course



The horizontal course provided to strengthen a wall of regular small stones is known as a lacing course.

6.2.3 Dressing of Stones

The process of cutting stones into suitable sizes and shapes is known as dressing of stones.

Objectives of Dressing

i. To convert the stone pieces into desired shape and size.
ii. To make thin mortar joints there by reducing the mortar consumption and to improve the quality of work.
iii. To give the desired surface finish.
iv. To make transport easy and economical.

Types of Dressing

1. Hammer Dressing.
2. Chisel Dressing.
3. Punched Dressing.
4. Furrowed Dressing.
5. Combed Dressing

6.2.3.1 Hammer Dressing

A hammer dressed stone shall have no sharp and irregular corners and shall have comparatively even surface. All the sharp and irregular corners of the stone obtained by quarrying shall be knocked off by using the flat face of a scrabbling hammer. The surface shall be dressed with the pointed end of the hammer.



6.2.3.2 Chisel Dressing

Stones available from the quarry is first dressed with hammer and then

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smoothly dressed by means of a pointed chisel. So that, all the projections are removed and a fairly smooth surface is obtained. This type of dressing is commonly adopted for ashlar work.



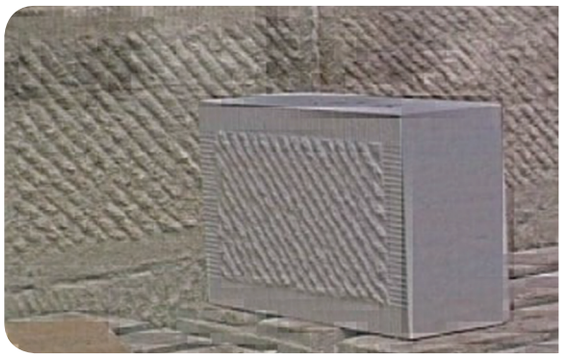
6.2.3.3 Punched Dressing

This is another form of rough dressing usually used for lower portions of the buildings. The exposed face of the stone is dressed with the help of a punch, thus making depressions or punch hole on it at some regular distance.



6.2.3.4 Furrowed Dressing

This type of finish is applied to the fillets or flat bands of cornices, string courses, doors and windows, etc. A margin of about 20mm width is sunk on all the edges of the stones and the central portion is made to project about 15mm.



6.2.3.5 Combed Dressing

Combed finish is suitable for soft stones. Steel combs of sharp teeth is dragged on the surface of soft stones. This is done in all directions of the stone surface. This also called as dragged finish.



6.2.4 Classification Of Stone Masonry

The stone masonry classified as

1. Rubble masonry
2. Ashlar masonry

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6.2.4.1 Rubble Masonry



In this masonry, stones are not dressed. They are used in the masonry as obtained from the quarry. It may be shaped with the help of hammers just by removing excess projection before using in the masonry.

Types of Rubble Masonry

I. Coursed rubble masonry.
ii. Un-coursed rubble masonry.
iii. Random rubble masonry.
iv. Dry rubble masonry.

Coursed Rubble Masonry

In this type of rubble masonry, the height of stones vary from 5cm to 20cm. The stones are sorted out before the work starts. The masonry work is then carried out in courses such that stones in a particular course are of equal heights. This type of masonry is used for the construction of public buildings, residential buildings, etc.



Un-coursed Rubble Masonry



In this type of rubble masonry, the stones are not dressed. But they are used as they are available from the quarry, except breaking some corners. The courses are not maintained regularly. The larger stones are laid first and the spaces between them are then filled up by means of spalls. The wall is brought to a level at every 30 cm to 50 cm. This type of rubble masonry being cheaper and is used for the construction of compound walls, godown, garages, labour quarters, etc.

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Random Rubble Masonry



The stones of irregular sizes and shapes are used for the construction of this masonry. The stones are arranged so as to have a good appearance. More skill is required to make this masonry structurally stable. The face stones are chisel dressed and the mortar joints does not exceed 6mm to 12mm. This type of masonry is used for the construction of residential buildings, compound walls, etc.

ACTIVITY 4

Collect informations and pictures about the structures and temples using stone masonry.

Dry Rubble Masonry



This is similar in construction of the coursed rubble masonry, except that no mortar is used in the joints. This requires skill in construction. This type of masonry is used in compound walls, pitching bridge approaches, retaining wall, etc.

DO YOU KNOW?

Brihadisvara Temple, Thanjavur.

It was built by emperor Raja Raja Chola and completed in 1010 AD. The temple turned 1000 years old in 2010. King Raja Raja Chola had the main temple built completely with granite. It is hard to imagine how, in that age, more than 1,30,000 tones of granite was brought to the temple site, especially given that there is no granite quarry within a hundred kilometres of the temple site.

Search link: htpps://en.m.wikipedia.org>wiki>Brihadisvara temple.



6.2.4.2 Ashlar Masonry

In this masonry the entire construction is done using square or rectangular dressed stones. The stones

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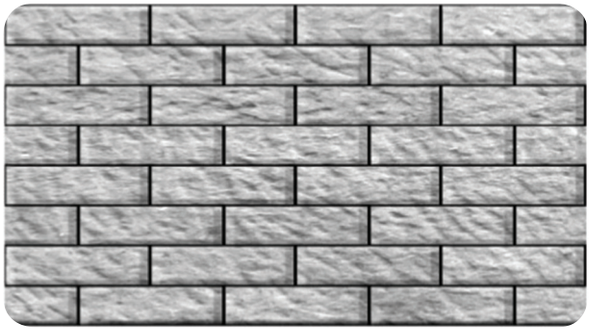
used in this masonry are dressed with chisel. The height of stones varies from 25cm to 30cm.

Types of Ashlar Masonry

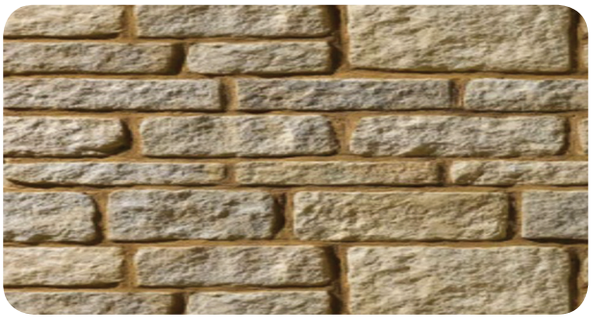
I. Ashlar fine masonry.
ii. Ashlar rough tooled masonry.
iii. Ashlar rock masonry.
iv. Ashlar chamfered masonry.
v. Ashlar block in course masonry.

Ashlar Fine Masonry



In this type of masonry, the beds, sides and faces are finely chisel dressed. The stones are arranged in proper bond and the thickness of the mortar joints does not exceed 3mm. This type of construction gives perfectly smooth appearance. It is costly in construction.

Ashlar Rough Tooled Masonry



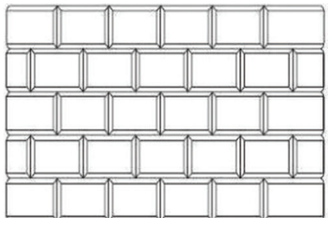
In this type of ashlar masonry, the beds and sides are chisel dressed. But the face is made rough by means of tools. The thickness of mortar joints does not exceed 6mm. This type of work is also known as bastard ashlar.

Ashlar Rock Masonry

In this type of ashlar masonry, a strip about 25mm wide is made by means of a chisel, is provided around the perimeter of the exposed face of every stone. But the remaining portion of the face is left in the same form as received from quarry. The projections on the exposed face known as the bushings exceeding 80mm in height are removed by a hammer. This type of construction gives massive appearance.



Ashlar Chamfered





In this type, 2.5cm chisel drafting around the face is made at an angle of 45˚ with the help of chisel. Another chisel drafting about 10mm to 12 mm wide is again made around the perimeter inside the chamfered drafting. The remaining

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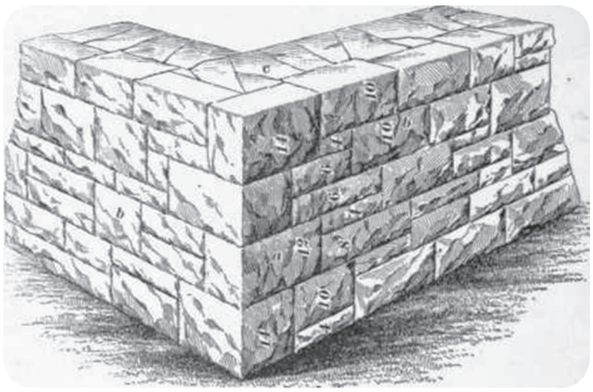
DO YOU KNOW?

The Most Beautiful and Famous Stone Buildings.

1. The Taj Mahal, India.
2. The Colosseum, Rome, Italy.
3. Great Pyramid, Giza, Egypt.
4. Washington Monument.

space is left as such. However projections of more than 8cm are removed with the help of hammer.

Ashlar Facing or Ashlar Block in Course



This masonry may be called as combination of rubble masonry and ashlar masonry. The faces of the stones are generally hammer dressed and the thickness of mortar joints does not exceed 6mm. The depth of courses varies from 20cm to 30 cm. This type of construction may be used for heavy engineering works such as retaining walls, sea walls, etc.

6.2.5 Points to be considered in the construction of Stone Masonry

I. Thestonesusedshouldconfirmtherequired specifications.

ii. The stone should be well watered before use.

iii. All the stones should be laid on the natural bed. The load should act at right angle to the natural bed.

iv. The dressing of stones should be properly done.

v. Proper bond with sufficient number of through stones should be provided in construction.

vi. No tensile stress should develop in the masonry.

vii. Good quality of mortar should be used in construction.

viii. Stone work should be raised uniformly.

ix. In the stone work, small pieces and chips should not be used.

x. The stone work should be carried out as per line and level.

xi. It should be cured for the required period.

ACTIVITY 5

Prepare an album about the most beautiful stone buildings.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The load from the stone masonry should act at …… to the natural bed.
   a. Slope
   b. Straight
   c. Right angle
   d. Horizontal
2. The name of stone used in external corners is ……..
   a. Corbel stone
   b. Sill stone
   c. quoin stone
   d. Weathering stone.
3. The size of stone used in coursed rubble masonry is ……
   a. 2cm to 50cm
   b. 5cm to 20cm
   c. 7cm to 9cm
   d. 1cm to 20cm
4. The bottom surface of a …… is called as sill.
   a. Door or Window
   b. Ventilator
   c. Beam
   d. Roof



PART II (3 Marks)

Answer in one or two sentences

5. What are the types of masonry?
6. Mention the types of dressing of stones.

PART III (5 Marks)

Answer shortly

7. Explain the terms used in stone masonry.

PART IV (10 Marks)

Answer in detail

8. List the types of rubble masonry and brief any two of them.
9. What are the types of ashlar masonry? Explain any two.

Part – I Answers

1. (c) 2. (c) 3. (b) 4. (a)

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6.3 BRICK MASONRY

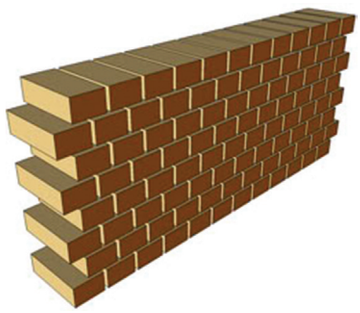
Learning Objectives

At the end of this lesson you shall be able to

- State the terms and tools used in masonry.
- Understand the types of bonds in brick work.
- Compare stone masonry and brick masonry.

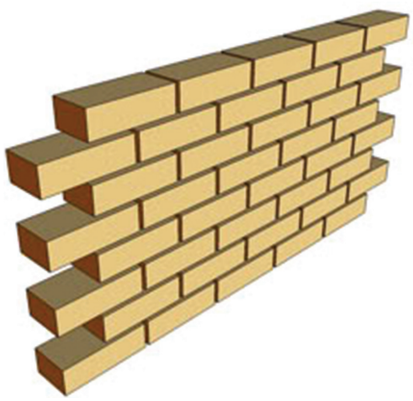
6.3.1 Introduction

Construction of brick units binded together with cement or lime mortar is termed as **Brick Masonry**.



6.3.2 Terms Used in Brick Masonry

i. **Stretcher :** It is a full brick which is laid with its length parallel to the face of the wall. If all the bricks are laid as stretchers, the course is named as stretcher course.



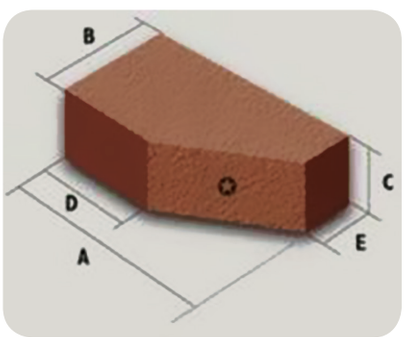
ii. **Header:** It is full brick which is laid with its length perpendicular to the face of the wall. A course of brick work entirely composed of headers is named as header course.

iii. **Bed:** It is the term used to indicate the lower surface of brick in each course.

iv. **Bond:** The interlocking arrangement of bricks, so as to avoid the occurrence of continuous vertical joints is known as bond.

v. **Closer:** It is a piece of brick used to create bond in brick work.

vi. **King Closer:** It is a brick which is cut in such away that, the width of one of its corner is half of that of a full brick.



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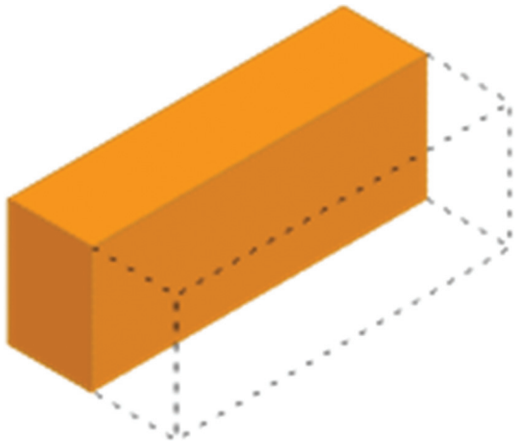
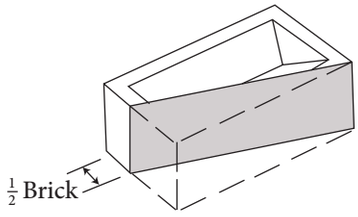
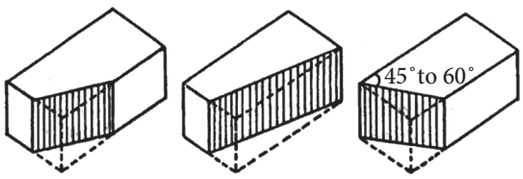
vii. **Queen Closer:** It is a term applied to a brick which is half as a full brick. Queen closer is made by cutting a brick length wise into two portions.



viii. **Beveled Closer:** It is similar to king closer, the only difference is that the whole length of brick is bevelled for maintaining half width at one end and full width at the other end.

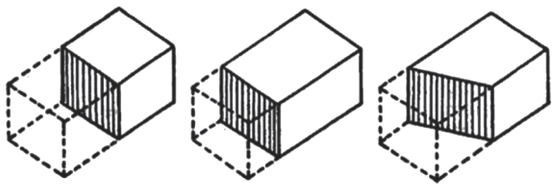


ix. **Mitred Closer:** It is a brick whose one end is cut splayed or mitred for the full width.



King Closer Bevelled Closer Mitred Closer

x. **Brick Bat:** It is the portion of a brick cut across the width or a brick cut by some fraction of its length. If a brick is cut by half size it is called as **half bat** and if cut by three quarter size it is called **three quarter bat**.



Half Bat Three Quarter Bat Bevelled Bat

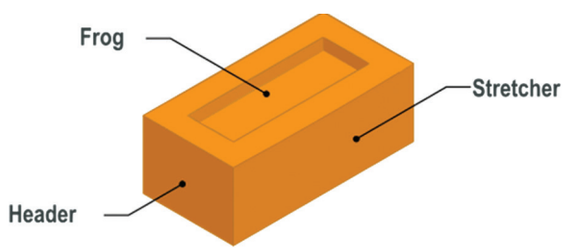
xi. **Lap:** The horizontal distance between two vertical joints of successive brick course is termed as lap. This should atleast 1/4th of length of brick.

xii. **Arris:** The edges of the bricks are called as arises. Arrises should be sharp and unbroken.

xiii. **Bed Joint:** Joints parallel to the bed of bricks or stone in a course are termed as bed joints.

xiv. **Perpends:** It is the vertical joint on the face of a wall in between two alternate bricks.

xv. **Frog:** Depressions provided in the face of the brick is called as frog. It forms a key for holding the mortar.



ACTIVITY 6

Visit a construction site during the process of brick masonry and prepare a report about that.

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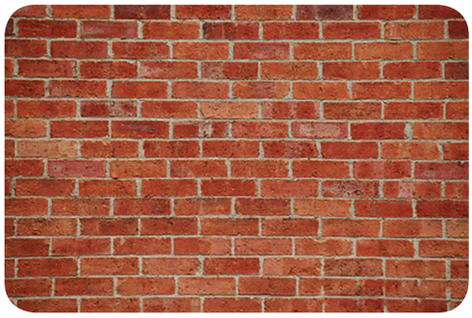
6.3.3 Bonds in Brick Works

The different types of bonds commonly adopted in brick work:

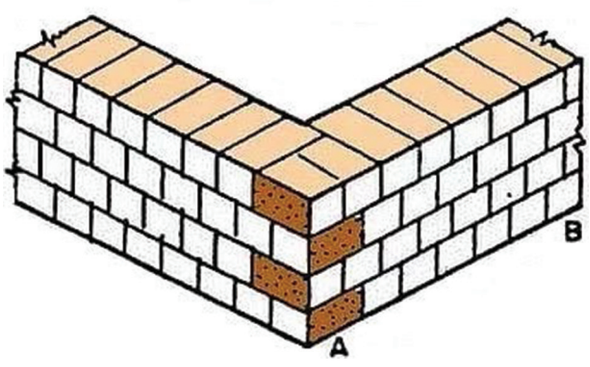
1. Stretcher bond.
2. Header bond.
3. English bond.
4. Flemish bond.
5. Garden wall bond.
6. Raking bond.
7. Dutch bond.
8. Brick on edge bond.

6.3.3.1 Stretcher Bond



In this arrangement of bonding in brick work, all the bricks are laid as stretchers. The thickness of the wall is half brick. It is commonly adopted in the cavity walls and partition walls.

6.3.3.2 Header Bond



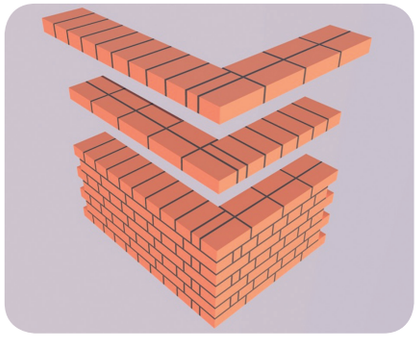
In this type of bonding, all the bricks are laid as headers on the face. It is used for walls curved on plan. The thickness of the wall is equal to one brick.

6.3.3.3 English Bond

This is the most commonly used bond because it is stronger than the other bonds.

The important features of English bond

i. The bond consists of alternate course of headers and stretchers.
ii. A queen closer will be placed next to the first header in each header course.
iii. A course consisting of headers on front face will show headers on the back face also in one brick, two brick, and three brick thick walls.
iv. In walls having their thicknesses equal to an odd number of half bricks (i.e. 1½ brick thick walls or 2½" brick thick walls and so on). The same course will show stretchers on one face and headers on the back.
v. Continuous vertical joints are eliminated.
vi. More quantity of cement mortar consumes in header course than stretcher course. As for as possible less quantity of cement mortar should be used for header course. Otherwise vertical joint will be formed in next course.



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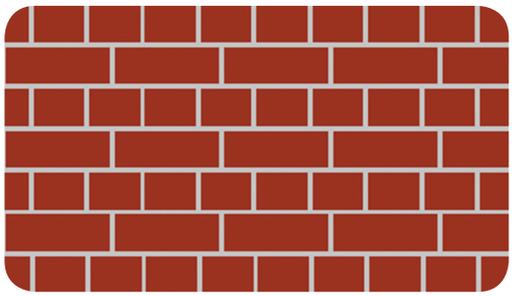


6.3.3.4 Flemish Bond

The important features of Flemish bond:

i. Each course consists of alternate header and stretchers.

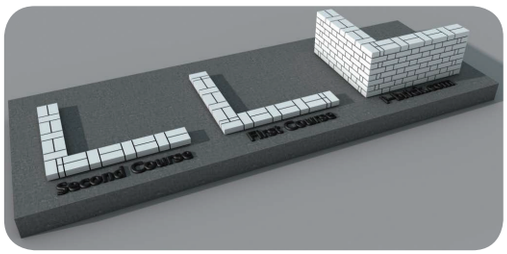
ii. Queen closers are placed in alternate courses next to the quoin header.

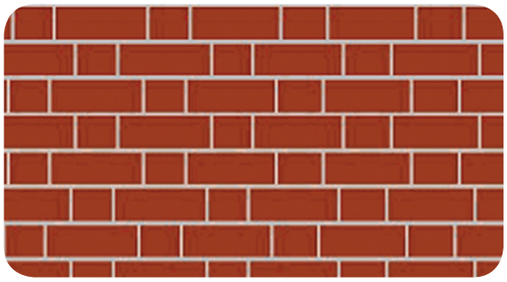
iii. When 1½, 2½ brick walls are constructed, bat bricks are also used with full brick. For 1, 2, 3 brick wall construction, only full bricks should be used.

iv. Flemish bond is weaker than English bond.

v. Continuous vertical joints may occur in Flemish bond.

vi. Flemish bond renders the appearance of the face work more attractive and pleasing.





6.3.3.5 Brick on Edge Bond

This type of bond uses stretcher bricks on edges instead of bed. The bond is weak in strength but it is economical. Hence it is used for garden walls, compound walls, etc.



Oldest Brick Temple in India

Rasmancha in Bishnupur, West Bengal is the oldest brick temple in India. It is the only temple of its kind in the whole country.



6.3.4 Tools Used in Brick Masonry and Stone Masonry

I. **Trowel**: It is used to lift and spread the mortar and also for cutting bricks.

ii. **Plumb Rule and Bob**: It is used to check the verticality of the wall.

iii. **Spirit Level**: It is used to check the horizontality of the surface.

iv. **Line and Pin**: It is used to construct the walls straight and uniform.

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v. **Straight Edge**: It is used to check the vertical and straight alignment of walls.

vi. **Mason Square**: It is used to set right angles.

vii. **Hammer**: It is used for breaking and rough dressing of stones.

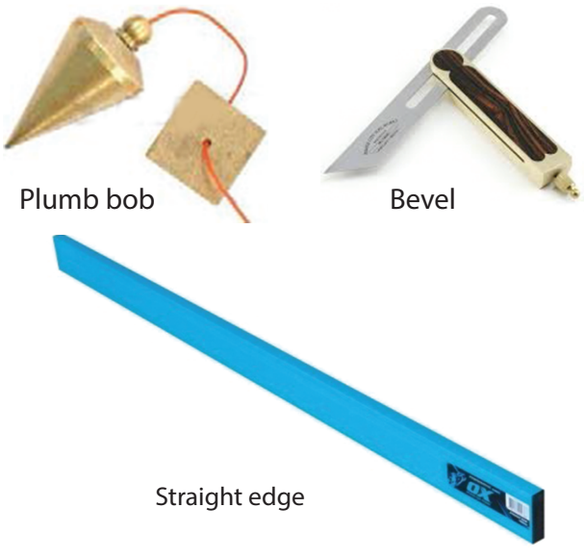
viii. **Crowbar**: To break the stones in quarry.

ix. **Chisels**: To dress stones.

x. **Pick Axe**: To split stones and for rough dressing.

xi. **Bevel**: To set out angles.















Line & Pins



Chisel

6.3.5 Points to be considered in the construction of Brick Masonry

I. The bricks used in a good work should be sound, hard and well burnt with uniform size, shape and colour.

ii. The bricks should be thoroughly soaked in water before its use. It reduces their tendency of suction of water from wet mortar.

iii. Only specified mortar of a good quality should be used.

iv. No brick bats should be used in the work except as closers.

v. The progress of work in raising masonry should be in uniform layers at one level.

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vi. Brick work should be ensured that a proper bond is maintained throughout the work.

vii. The bricks should be laid on a full bed of mortar. The frog in the brick should be at the top and filled with mortar to ensure proper bonding.

viii. Scaffolding should be adopted for construction at higher level.

ix. All the course should be laid truly horizontal and all the vertical joints should be truly vertical. The verticality should be checked with plumb bob.

x. All the finished masonry work should be kept wet for at least seven days.



ACTIVITY 7

Prepare an album of rich heritage monuments and temples situated in India.

6.3.6. Thickness of Brick Wall

Thickness of brick wall is decided by considering the following:

1. The total load acting on the walls.
2. The total height of the wall.
3. The quality of materials used for the construction of wall.
4. The length of the wall.
5. The height between one floor to the other.

Formula to find the thickness of wall is:

$$A = \frac{P}{O}$$

$$T \times L = \frac{P}{O}$$

$$\text{Thicknes of wall 'T'} = \frac{P}{L \times O}$$

Where,

P = Total load on the wall

A = Area of the wall

L = Length of the wall

T = Thickness of the wall

O = Permissible bearing capacity

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6.3.7 Difference Between Stone Masonry and Brick Masonry

S.No	Stone Masonry	Brick Masonry
1	The stones obtained naturally are dressed to a particular shape and used for masonry work.	The bricks are burnt in kiln and used for masonry work.
2	Stone masonry is very strong.	Strength of brick masonry is lesser than stone masonry.
3	Water tight stone masonry may be constructed.	Water tight masonry work is not possible.
4	Stone masonry does not have the property of water absorption. So this masonry is suitable for bathroom and toilets than brick masonry.	Brick walls are having the property of water absorption. To protect the walls from the dampness cement plastering is necessary.
5	Stone masonry is hard and construction is tough.	Construction of brick masonry work is easy.
6	Bonding property is not much high in stone masonry and consumption of cement mortar is also high.	Good bonding can be made in brick work. Less quantity of cement or lime mortar is used.
7	Lifting and handling of stones are not easy. So speed of masonry work is slow.	As the size of brick is small, handling and lifting is easy. So masonry work is faster.
8	In hilly areas stones are highly available. So construction cost is low.	Other than hilly area cost of brick work is economical.
9	We cannot directly use the stone which are taken from stone quarry. It should be dressed to some extent. So cost becomes high.	We can use the bricks directly from the kiln. So cost becomes low.
10	Minimum width of stone masonry should be 30 cm. Construction of stone masonry below this width is not possible.	We can construct brick walls from 10 cm thickness.
11	Heat absorption property is high for stone masonry.	Heat absorption property is not much high.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The bottom surface of brick in each course is ……
   a. Bond
   b. Bed
   c. Arris
   d. Perpend
2. The portion of brick cut across the width is …….
   a. Queen closer
   b. King closer
   c. Brick bat
   d. Mitred closer
3. Flemish bond is ….. than English bond.
   a. Thicker
   b. Thinner
   c. Stronger
   d. Weaker
4. ……. is used to set right angles in walls.
   a. Trowel
   b. Spirit level
   c. Plumb bob
   d. Mason square

LSCWJ

PART II (3 Marks)

Answer in one or two sentences

5. Define queen closer.
6. What is the use of plumb bob?
7. List the types of bonds in brick work.
8. Write short notes on frog.

PART III (5 Marks)

Answer shortly

9. List the tools used for brick masonry.
10. Explain any five terms used in brick masonry.

PART IV (10 Marks)

Answer in detail

11. Explain English bond brick work with neat sketch.
12. Explain Flemish bond brick work with neat sketch.

Part – I Answers

1. (b) 2. (c) 3. (d) 4. (d)

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BUILDING CONSTRUCTION

Unit - 7
Basic Civil Engineering

7.1 LINTELS AND ARCHES



7.2 DOORS AND WINDOWS



" Intelligence plus character - that is the goal of true education"

Martin Luther King Jr.

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7.1 Lintels and Arches

7.1.1 Introduction
7.1.2 Types of Lintels used in Building Construction
7.1.3 Arches – Introduction
7.1.4 Technical Terms used in Arches
7.1.5 Classification of Arches
7.1.6 Difference Between Arches and Lintels

7.2 Doors and Windows

7.2.1 Introduction
7.2.2 Terms Used in Doors and Windows
7.2.3 Size and Location of Doors and Windows
7.2.4 Types of Doors
7.2.5 Types of Windows
7.2.6 Fixture for Doors and Windows

7.1 LINTELS AND ARCHES

Learning Objectives

At the end of this lesson you shall be able to

- Understand the types of lintels and arches.
- Differentiate lintels and arches.

7.1.1 Lintel - Introduction

A lintel is a horizontal member which is placed across the openings like doors, windows, etc., in buildings. Lintels takes the load from the structure above it and provides support to it. Lintel is also a type of beam. The width of lintel is equal to the width of wall and the ends are built into the wall. These are very easy to construct when compared to arches.

Bearing of Lintel

The bearing of lintels should be provided as follows.

1. 10 cm to 20cm
2. Height of lintel beam
3. $1/10^{th}$ to $1/12^{th}$ of span of the lintel

7.1.2 Types of Lintels used in Building Construction

Lintels are classified based on the material used for the construction as:

1. Timber Lintel
2. Stone Lintel
3. Brick Lintel
4. Steel Lintel
5. Reinforced Concrete Lintel
6. Reinforced Brick Lintel

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7.1.2.1 Timber Lintel

In olden days of construction, timber lintels were mostly used. But, now-a-days they are replaced by concrete lintels based on modern techniques. However in hilly areas still timber lintels are in use. The main disadvantage of timber lintels are (i) more expensive (ii) less durable (iii) non-fire resistant.



7.1.2.2 Stone Lintel

These are the most common type of lintel especially where stone is available in large quantities. The thickness of lintels are most important factor of its design. These are also provided over the openings in brick walls. Stone lintels are provided either single piece or multiple pieces.



7.1.2.3 Brick Lintel

When the opening is less than 1m and for lesser loads, brick lintels are used. The depth of brick lintel varies from 10cm to 20 cm depending upon the span. Bricks with frogs are most suitable than normal bricks because, frogs when filled with mortar gives more sheer resistance of end joints. Such lintel is known as joggled brick lintel.



7.1.2.4 Steel Lintel

If the super imposed loads are heavy and openings are large, we can go for steel lintels. These lintels consist of channel sections or rolled steel joists. Single steel section or combinations of two or more are used depending upon the requirement.



7.1.2.5 Reinforced Brick Lintel

If loads are heavy and span is greater than 1m, then reinforced brick lintels are useful. The depth of reinforced brick lintel should be equal to 10cm to 15 cm or multiple of 10 cm. The bricks are so arranged that 2 to 3 cm wide space is left in lengthwise between adjacent bricks for the insertion of mild steel bars for reinforcement. Then cement mortar(1:3) is used to fill up the gaps.

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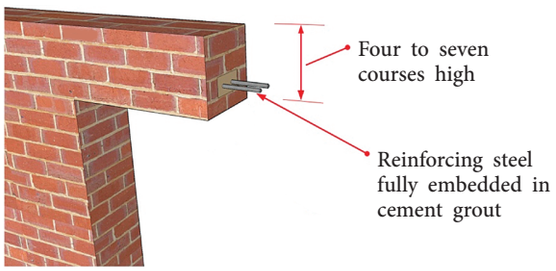


7.1.2.6 Reinforced Cement Concrete Lintels

At present, the lintels of RCC are widely used for the openings of doors, windows, etc., in the buildings because of its strength, rigidity, fire resistance, economy and ease in construction. RCC lintels are suitable for all the loads and to any span. The width of lintel is equal to width of wall. Depth of lintel is depend upon the length of span and magnitude of loading.

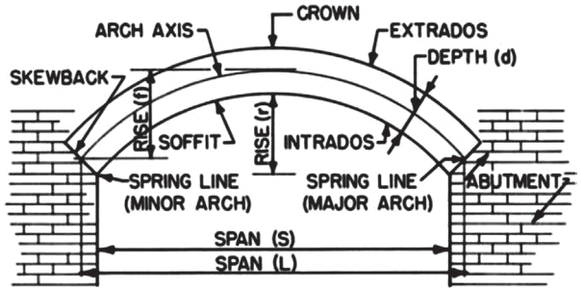


7.1.3 Arches - Introduction

An arch is a structure that is curved at the top and is supported on either side by a pillar, post or wall. It is constructed of wedge shaped block of stones or bricks joined together with mortar and provided across the opening to carry the weight of the structure above the opening.



7.1.4. Technical Terms



The various technical terms used in arches are as follows:

a) **Abutment**: This is the end support of an arch.
b) **Pier**: These are the intermediate supports of an arcade.
c) **Intrados**: This is the inner curved surface of an arch.
d) **Extrados**: This is the outer curved surface of an arch.
e) **Voussoirs**: The voussoirs or arch stones are the wedge shaped units forming the arch.
f) **Springing stone**: The springing stone or springer is the first voussoir at springing level on either side of the arch.
g) **Springing line**: This is an imaginary line joining the two springing points.
h) **Crown**: This is the highest point of extrados or it is the highest part of an arch.
i) **Key stone**: This is the highest central wedge shaped block of an arch.
j) **Skew back**: This is the inclined surface of the abutment on which the arch rests.

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k) **Span:** This is the clear horizontal distance between the two supports.

l) **Rise:** This is the vertical distance between the highest point of intrados and springing line.

m) **Depth of arch**: This is the perpendicular distance between the extrados and intrados.

n) **Haunch of an arch**: Haunch is the lower part of the arch between crown and skewback.

7.1.5 Classification of Arches

A) Classification according to shape.

According to this classification, arches may be of the following types.

1) Flat arch
2) Segmental arch
3) Semi-circular arch
4) Horse shoe arch
5) Pointed arch or gothic arch
6) Relieving arch
7) Circular arch
8) Inverted arch

B) Classification based on materials of construction.

1) Stone arches
2) Brick arches
3) Concrete arches

Flat Arch

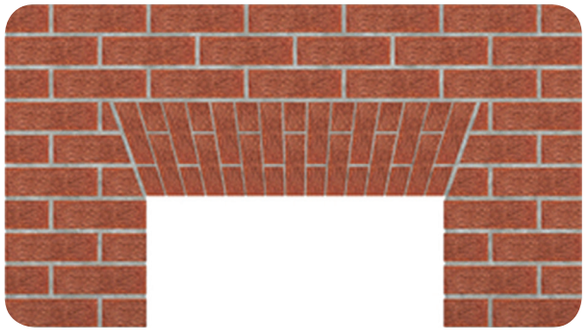
A flat arch usually the angle formed by skew backs is 60° with horizontal, thus forming an equilateral triangle with intrados at the base. The intrados is apparently flat, but it is given a slight rise of camber of about 10mm to 15mm per meter width of opening to allow for small settlements.

DO YOU KNOW?

India gate, New Delhi, India is one of the most popular arch in the world. This monuments dedicated to Indian soldiers who died in World War 1 and the Afghan wars.



However, the extrados is kept horizontal and flat. Flat arches are used only for light loads and for spans up to 1.5m.



Segmental Arch

This is common type of arch used for buildings. The centre point of these arches lies below the springing line. It is one of the strongest arch because, it is able to resist thrust. Segmental arches are most commonly used for residential

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constructions over doorways, windows and fire places.



Semi Circular Arch

It is also known as Roman arch. This is the modification of segmental arch in which the centre point lies on the springing line. The shape of these arches are semi-circle. The thrust transferred to the abutments is perfectly in vertical direction since the skewback is horizontal.





Horse Shoe Arch

DO YOU KNOW?

Gate way arch, St. Louis, United States is the tallest arch monument in U.S (height 630 feet)



ACTIVITY 1

Collect the pictures of a popular arches around the world and make an album.



Pointed Arch



Releiving Arch

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Circular Arch



Inverted Arch

7.1.6 Difference Between Arches and Lintels

S.No	Arches	Lintels
1	Generally curved in shape.	Horizontal in shape.
2	Gives excess rises over door and window openings.	There is no excess rises in lintels.
3	Good for uniformly distributed loads and weak in point loads.	Strong in uniformly distributed loads as well as point loads.
4	Joints should be in radial shape.	Joints should be vertical.
5	Supported at the abutments and piers.	There is no supports like piers and abutments.
6	Arches gives beautiful appearance to the buildings.	Gives ordinary appearance to the buildings.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. ..... takes the load from structure above the doors and windows opening.
   a. Sunshades
   b. Pillars
   c. Lintels
   d. Columns
2. Brick lintels are used when the opening is less than .....
   a. 1m
   b. 2m
   c. 3m
   d. 0.5m
3. The end support of an arch is .....
   a. Pier
   b. Abutment
   c. Springer
   d. Crown
4. ..... is the highest central wedge shaped block of an arch.
   a. Sill stone
   b. Springing stone
   c. Key stone
   d. Bond stone



PART II (3 Marks)

Answer in one or two sentences

5. Write short notes on lintel.
6. List the type of lintels.
7. What is springing line?
8. State the types of arches based on materials of construction.

PART III (5 Marks)

Answer shortly

9. List the types of arches.
10. Explain stone lintel with sketch.
11. What are the difference between arches and lintels?

PART IV (10 Marks)

Answer in detail

12. Explain the terms involved in the arches with a neat sketch.
13. What are the types of lintels? Explain any two with neat sketch.

Part – I Answers

1. (c) 2. (a) 3. (b) 4. (c)

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7.2 DOORS AND WINDOWS

Learning Objectives

At the end of this lesson you shall be able to

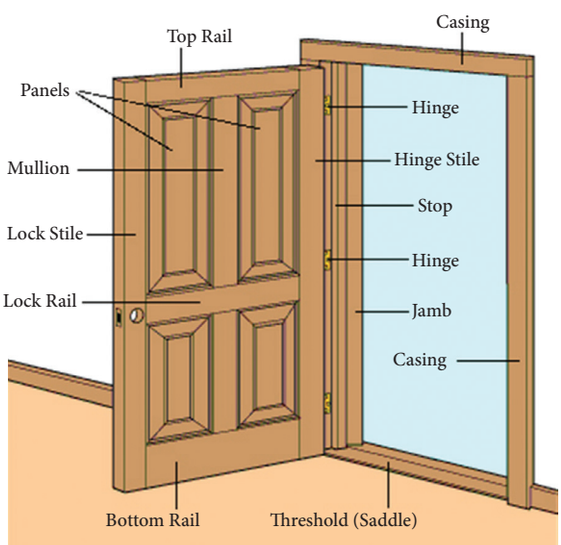
- Understand the terms used in doors and windows.
- Classify the doors and windows.
- Explain the fixtures for doors and windows.

MSWLH

7.2.1 Introduction

A door may be designed as a frame work secured in an opening left in a wall for the purpose of providing access to the uses of the structure. A window may be defined as an opening made in a wall for the purpose of providing day light, vision and ventilation.

7.2.2 Terms used in Doors and Windows



1. **Frame:** It is a group of members which form a support for a door or window.
2. **Shutter:** These are openable parts of a door or window. It is an assembly of styles, panels and rails.
3. **Style:** The vertical outside member of the shutter of a door or window is termed as style.
4. **Top rail:** The topmost horizontal member of the shutter is termed as top rail.
5. **Bottom rail:** The lowermost horizontal member of the shutter is termed as bottom rail.
6. **Lock rail:** The middle horizontal member of a door shutter, to which locking arrangements are fixed is termed as lock rail.
7. **Panel:** The area of shutter enclosed between adjacent rails is termed as panel.
8. **Sash:** The frame made for glass like panels is termed as sash.
9. **Mullion:** The vertical member of a frame which separates the shutter in the middle is mullion.
10. **Transom:** The horizontal member of a frame which divides the shutter into two parts is termed as transom.

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11. **Louver:** The small strips of wood fixed inclined in the shutter is termed as louver.
12. **Putty:** The mixture of lime and linseed oil used for fixing the glass with shutters is termed as putty.

7.2.3 Size and Location of Doors And Windows

The following guidelines should be kept in view while deciding the location of doors and windows in a building.

1. As far as possible door should be located near the corner of a room, but 20 cm away from the corner.
2. The number of doors in a room should be kept minimum to achieve optimum utilisation of space.
3. The window sill should be placed at 75 to 100 cm above the floor level.
4. Windows should be located opposite to each other wherever possible.
5. The size and number of windows should be sufficient to provide adequate light, ventilation and privacy in the room.
6. The shutters of windows in external walls should be opened at outside.

The Size Of Doors:

For Residential buildings

Internal doors -

0.90 × 2.10 m (or) 0.90 × 1.95 m

External doors -

1.20 × 2.10 m (or) 1.00 × 1.95 m

Bathroom doors -

0.75 × 2.10 m (or) 0.75 × 1.95m

For Public buildings

Schools and Hospitals - 1.20 × 2.25 m

Car Shed - 2.25 × 2.75 m

The minimum height of the doors should be 1.80 m.

In general,

Width of the door = 0.40 to 0.60 × height.

Height of the door =Width of the door + 1.20 m

7.2.4 Types of Doors

1. Ledged doors.
2. Ledged and braced doors.
3. Ledged and framed doors.
4. Ledged, braced and framed doors.
5. Framed and panelled doors.
6. Glazed doors.
7. Flush doors.
8. Louvered doors.
9. Collapsible doors.
10. Revolving doors.
11. Rolling shutters.
12. Sliding doors.

7.2.4.1 Ledged Doors

This door consists of a series of vertical battens fixed together with horizontal members known as ledges. There are three ledges named top ledge, bottom ledge and middle ledge. The door is hung on the frame by means of T – Hinge. These types of doors are mostly used for rooms where economy rather than the appearance is the main consideration.



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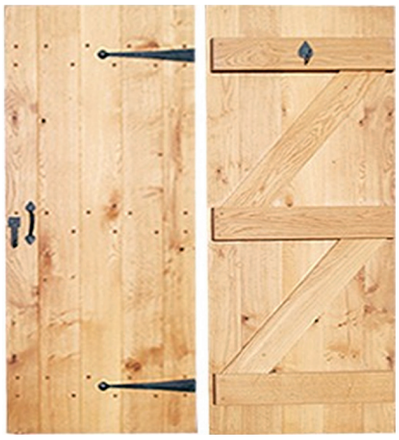
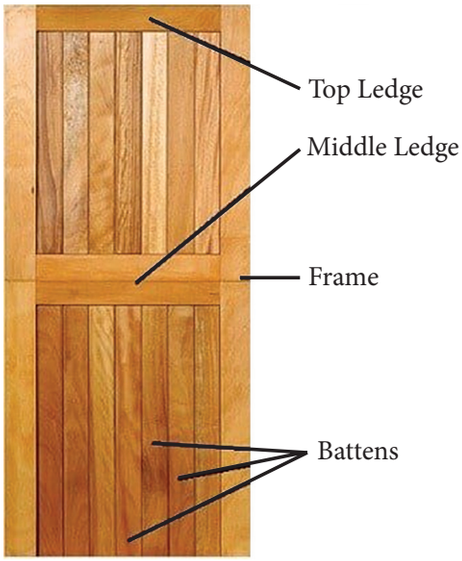
7.2.4.2 Ledged and Braced Doors

It is also like ledge doors. But, there are two additional members called braces, fixed in an inclined manner towards the side on which the door is hung. As the braces gives more strength to these doors, it is used in the places where the width of the door way is more. It is hung on the frame by means of T-hinges.



7.2.4.3 Ledged and Framed Doors

These doors are formed by fixing two styles at either end of ledged door setup. These are stronger and beautiful in appearance than ledged doors.



7.2.4.4 Ledged, Braced and Framed Doors

This door consists of battens, ledges, braces and frames. It has more strength, durability and good in appearance. The braces are housed and inclined towards the side on which the door is hung.



7.2.4.5 Framed and Panelled Doors

This type of door is commonly provided in all types of buildings. This door consists of frame work of styles and rails which are grooved inside to receive one or more panels. The number of panels and type should be selected according to the places used. The thickness of shutter should be 30mm to 40mm and thickness of panels should be 20mm. The door may be single, double, three, four or six panelled and so on. This door is good in appearance.

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7.2.4.6 Glazed Door

This type of door is used in residential as well as public buildings like hospitals, schools or colleges, etc., to get extra natural lighting in addition to the lighting provided by windows. They may be partially or fully glazed. The glass should be fitted in frames by using putty.



Fully Glazed Door

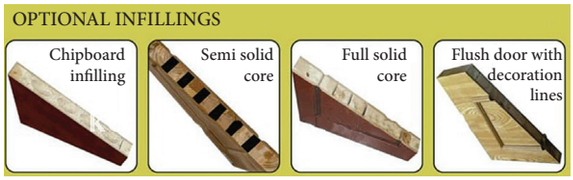


Partly Glazed Door

7.2.4.7 Flush Doors

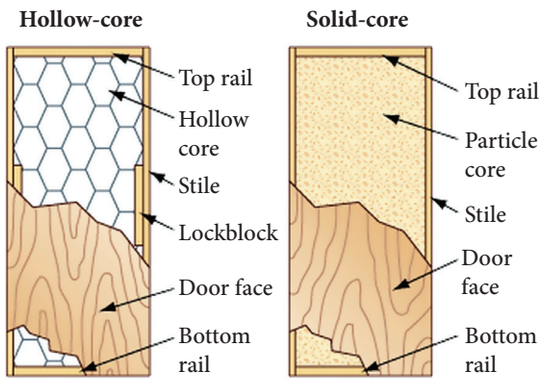
Flush doors have pleasing appearance, simple construction, high strength, durability and economic. Flush doors can be classified in following types.

i. Solid core type flush door
ii. Hollow core type flush door



i) **Solid core type flush door:** This type of door is made out of selected pieces of timber placed in series and pasted together in between the frame work. As it is sandwiched between plywoods, it acts as a solid material. The thickness of the shutter should be 30mm.

ii) **Hollow core type flush door:** In this type, the frame consists of styles, top rail, bottom rail and minimum intermediate rails. The space between styles and the rails is divided by fixing wooden battens not less than 25mm in width. Thus the voids are equally distributed. The voids should be filled with light weight material like cork. Plywood sheets and face veneers are then glued under pressure on both faces of the core.



7.2.4.8 Louvered Doors

In this type, the styles of shutter are grooved to receive a series of louvers which may be of glass or wood. The Louvers are set within the grooves in inclined position, so

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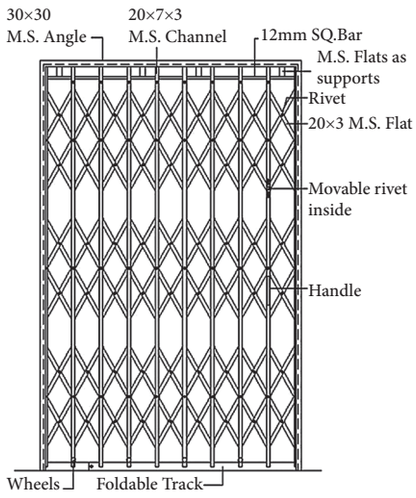
that they sloped downward to the outside in order to run off the rain water and obstruct the horizontal vision. It may be fixed or pivoted. These are commonly used in residential buildings.



7.2.4.9 Collapsible Doors

These doors are used for shops, garages, public buildings, godowns, etc., and in situations where width of opening is large. The door essentially consists of vertical double channels each 20 x 10 x 2mm in size and spaced at 10 to 12 cm apart. These are braced with flat iron diagonals 20mm wide and 5 mm thick. The door shutter slides over rollers mounted in position by the rails. This door is also used for residences to increase safety and protection.





7.2.4.10 Revolving Door

This door essentially consists of four leaves radially attached to a centrally placed mullion in a circular opening. The leaves may be glazed, panelled or partly glazed. Such doors are commonly provided in hotels, banks, offices, ATM Centres and other such important public buildings.



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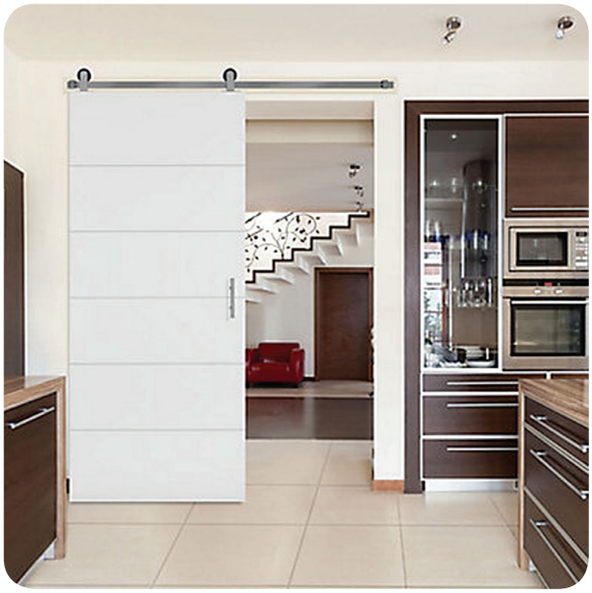
7.2.4.11 Rolling Shutters

The door consists of thin steel slabs interlocked to each other and wind upon in a specially designed pipe shaft mounted at the top of the opening. The door shutter travels into two vertical steel guide channels installed at either end of the opening. The shutter is counter balanced by means of helical spring enclosed in the drum. These are used for shops, factories, garages, etc.



7.2.4.12 Sliding Doors

This door is provided with top and bottom guide rails or runners within which the shutters slide. The guide rails run past the opening for a distance equal to the width of shutter. So that, when the door is required to be opened, the door shutter occupies a new position parallel to the wall face and clear off the opening. This type of door is suitable for shops, sheds, godowns, offices and garages.



ACTIVITY 2

1. Collect photos of world's 5 tallest doors and make an album.
2. List out the doors available in your school campus.

7.2.5 Types of Windows

1. Dormer window.
2. Louvered window.
3. Bay window.

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Largest door in the world:

It is located in NASA. There are four entries to the bays located inside the VAB buildings which are fours of the largest doors in the world. Each door is 456 feet high, has 7 vertical panels and 4 horizontal panels, and takes 45 minutes to completely open or close.



4. Lantern window.
5. Skylight window.
6. Gable window.
7. Corner window.
8. Sliding window.
9. Glazed or sash window.

7.2.5.1 Dormer Window

It is a vertical window built in the sloping side of a pitched roof. This window is provided to achieve proper ventilation and lighting to the room constructed below the roof.



7.2.5.2 Louvered Window

In this type, the styles of shutter are grooved to receive a series of louvers. The louvers are set within the grooves in inclined position. So that, they slope downward to outside in order to obstruct the horizontal vision. Louvers should be fixed or pivoted. Mostly it is used in the residential buildings.



7.2.5.3 Bay Window

A window projecting outward from the walls of a room is termed as a bay window. Bay window may be square, rectangular or polygonal in plan. It is introduced with a view to provide an

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increased area of opening to admit light and ventilation.



7.2.5.4 Lantern Window

If the light from the windows in the walls is not enough, windows are provided on the roof also. These are called as lantern window. It should be square or rectangular in shape.





7.2.5.5 Skylight Window



In this type, a fixed window provided on the sloping surface of the pitched roof. The frame work of skylight window supports the glass panels. This type of windows are provided to get more light.

7.2.5.6 Gable Window

The triangular wall constructed to provide sloped roof in a building is known as gable wall. The window provided in the gable wall of a building is termed as gable window.



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7.2.5.7 Corner Window

This type of window is essentially located in the corner of a room. It serves an architectural features for improving the elevation of the building.



7.2.5.8 Sliding Window

In this type of window, the shutters move on the rollers and can slided either horizontally or vertically depending upon the provision made.



7.2.5.9 Glazed Window

The shutter of this window should be glass. The glass panels are secured in either by putty or by small fillets known as glazing beads. These windows provides light even it is closed.



7.2.6 Fixtures For Doors and Windows

(i) HINGES

1. **Back flap hinge:** It should be used when the thickness of door shutter is less.
2. **Butt hinge:** It is commonly used type of hinge.
3. **Counter flap hinge:** While closing the door the two parts of the door should join together.
4. **Garnet hinge:** It is used in ledged and braced doors.



Do you know about UPVC doors and windows? What is UPVC?

UPVC is the general abbreviation for **Unplasticized Polyvinyl Chloride**. The recent material mostly used in all commercial and other buildings for making doors and windows is UPVC.

UPVC is extensively used because it is not easily affected by climatic changes unlike other substances like wood. The best part about it is it lasts longer without any such prior repairs.

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5. **Rising butt hinge:** It increases height by 10mm while opening.
6. **Strip hinge:** It is used for heavy doors.



Back flap hinge



Butt hinge



Counter flap hinge



Cornet hinge



Rising butt hinge



Strip hinge

ACTIVITY 3

Prepare a report on various fixtures and fittings used in doors and windows with pictures.

(ii) BOLTS

1. **Aldrop bolts:** These are used in external doors of the building.
2. **Barrel bolt:** These are fixed in the backside of doors.
3. **Latch:** These are used for all types of doors and windows.
4. **Hasp and staple bolt:** These are used for external doors.
5. **Tower bolt:** It is nearly the same as barrel bolt. But three or two rings used instead of the barrel.



Aldrop



Barrel bolt



Latch

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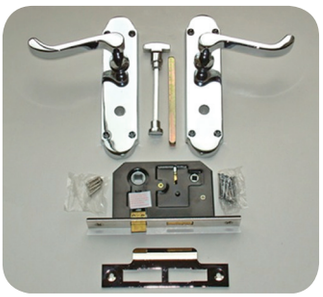
Hasp and staple bolt



Tower bolt



Mortise lock



Pad lock

(iii) LOCKS

1. **Cupboard lock:** This is used for small doors.
2. **Hook and eye:** To keep the windows in open condition and also in the door of almirahs where there is no need of safety, these bolts are used.
3. **Mortise lock:** This type of lock is used to lock the flush doors from outside of the rooms.
4. **Pad lock:** These are used together with aldrop bolt.



Cupboard lock

Hook and eye

ACTIVITY 4

1. Prepare a report about UPVC doors and windows with photos.
2. Prepare report about fixtures and fittings with photos.

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Model Questions

PART I (1 Mark)

Choose the correct answers

1. The vertical members in both the sides of shutter is .....
   a. Rail
   b. Sash
   c. Style
   d. Panel

2. ..... are the horizontal members used in ledged doors.
   a. Style
   b. Transom
   c. Head
   d. Ledges

3. Dormer window is a ..... window built in the sloping side of a pitched roof.
   a. Vertical
   b. Inclined
   c. Horizontal
   d. Sloped

4. A window projecting outward from the walls of a room is .....
   a. Corner window
   b. Pivoted window
   c. Bay window
   d. Lantern window

5YP96

PART II (3 Marks)

Answer in one or two sentences

5. Define window.
6. What are the parts of a door shutter?
7. Write short notes on 'putty'.
8. List the hinges used in doors.

PART III (5 Marks)

Answer shortly

9. What are the types of doors?
10. List the types of windows.
11. List the types of bolts and locks used in doors and windows.

PART IV (10 Marks)

Answer in detail

12. Explain flush doors with sketch.
13. Explain framed and panelled doors with a neat sketch.

Part – I Answers

1. (c) 2. (d) 3. (a) 4. (c)

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BUILDING CONSTRUCTION

Unit - 8
Basic Civil Engineering

8.1 STAIRS AND LIFTS



8.2 ROOFS



8.3 FLOORS AND FLOORING





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- 8.1.1 Introduction
- 8.1.2 Terms Used in Stairs
- 8.1.3 Location of Staircase
- 8.1.4 Types of Stairs
- 8.1.5 Moving Stairs or Escalators
- 8.1.6 Lift or Elevators

8.2 Roofs
- 8.2.1 Introduction
- 8.2.2 Characteristics of a Good Roof
- 8.2.3 Classification of Roofs
- 8.2.4 Advantages and Disadvantages of Flat Roof
- 8.2.5 Roof Covering Materials for Pitched Roof
- 8.2.6 Modern Roofing Sheets

8.3 Floors and Flooring
- 8.3.1 Introduction
- 8.3.2 Types of Floors
- 8.3.3 Definition of Flooring
- 8.3.4 Materials used for the Flooring
- 8.3.5 Selection of Flooring
- 8.3.6 Types of Flooring

8.1 STAIRS AND LIFTS

Learning Objectives

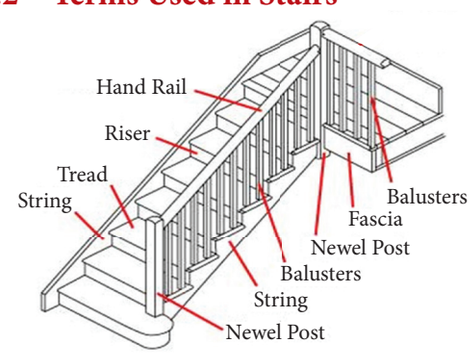
At the end of this lesson you shall be able to

- Understand the terms used in staircase.
- State the types of stairs
- Define lift and its uses.

8.1.1 Introduction

A stair is defined as a series of steps and it is provided to go up or come down between the floors or landings.

8.1.2 Terms Used in Stairs



1. **Tread:** The horizontal upper part of a step which is used to rest the foot while ascending or descending the stairs.
2. **Riser:** The vertical portion of a step providing a support of the tread.
3. **Rise:** It is the vertical distance between the horizontal surfaces of two consecutive steps.
4. **Flight:** A series of steps without any platform or landing is known as flight.
5. **Nosing:** The outer projection of a tread is known as nosing.

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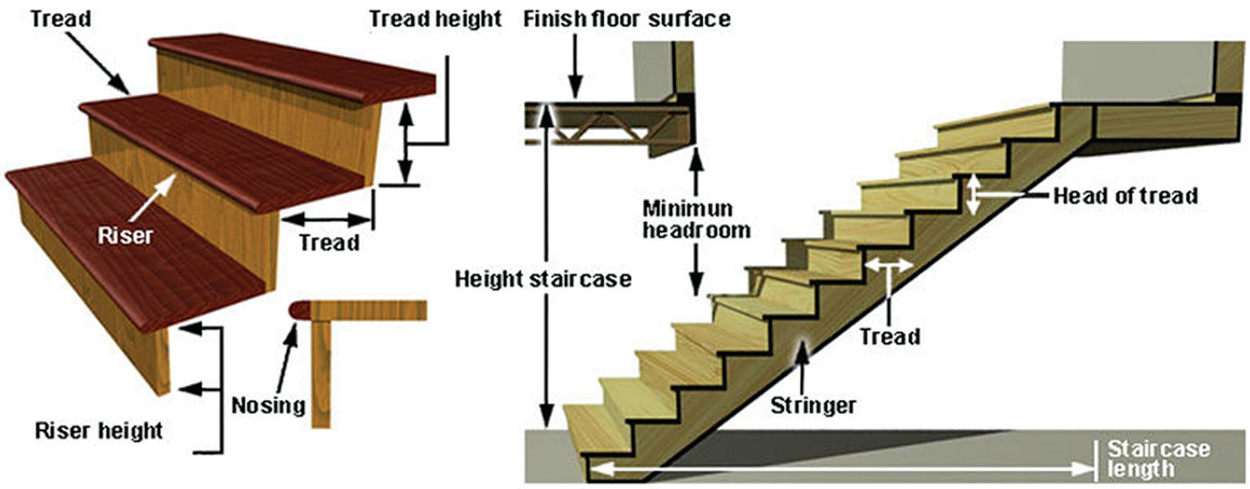


6. **Going:** It is the horizontal distance between the faces of two consecutive steps.
7. **Landing:** A platform provided between two flights of stair is called landing.
8. **Soffit:** It is under surface of a stair.
9. **Pitch:** It is the angle which the line of nosing of the stair makes with horizontal.
10. **Winders:** They are angular or radiating steps and provided to change the direction of a stair.
11. **Baluster:** Vertical members supporting the hand rail.
12. **Hand Rail:** It is the wooden or metallic rail generally provided at convenient height over balustrades.
13. **Newel Post:** Posts set at the begining and end of a stair to support the handrail.

8.1.3 Location of Staircase

It should be centrally located such that, it is easily accessible from the various rooms of the building. In the advent of fire or any such calamity, stairs provide the only means of communication.

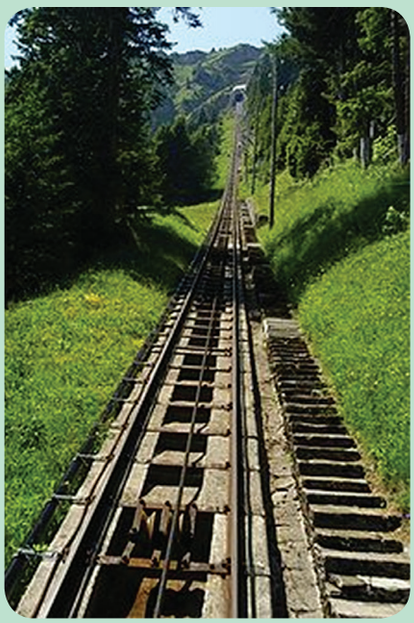
Sufficient light and proper ventilation should be made available in the



The longest stairway in the world:

The steps that run alongside the Niesen mountain railway in Switzerland are officially the longest stairway in the world. There are 11,674 steps in all, and it's only possible to hike them one day a year during the Niesen run. It is only 3.4 km but there is 1669 m of altitude to climb.

Search link: www.dmx.co.uk>worlds-longest-stairs



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staircase for easy and safe communication between the various floors.

In public building the staircase should be located near the main entrance.

8.1.4 Types of Stairs

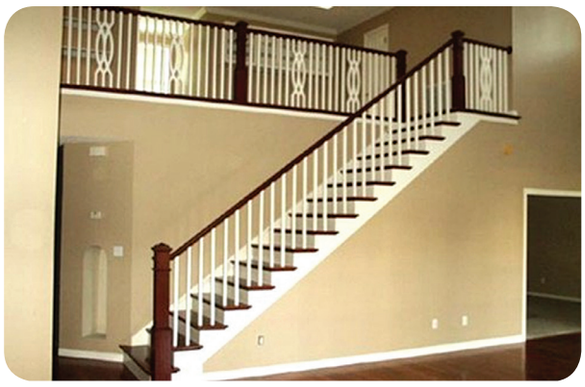
I. According to the materials used

i. Brick stairs
ii. Wooden stairs
iii. Stone stairs
iv. Steel stairs
v. Concrete stairs.
vi. Glazed stairs

II. According to the shapes

1. Straight flight stairs
2. Dog legged stairs
3. Open well stairs
4. Circular stairs or spiral stairs
5. Bifurcated stairs
6. Geometrical stairs

8.1.4.1 Straight Flight Stairs



In these stairs all the steps lead in one direction. Straight stairs may be continuous with landings in between flights. This type is used for small houses, where sufficient width is not available.

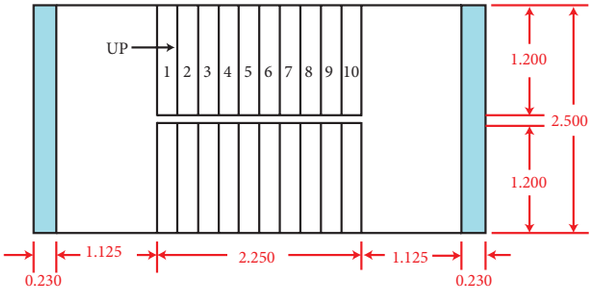
DO YOU KNOW?

The world's longest wooden stairs

The longest wooden stairs in the world, 4444 steps, is in Florli, Norway.



8.1.4.2 Dog Legged Stairs





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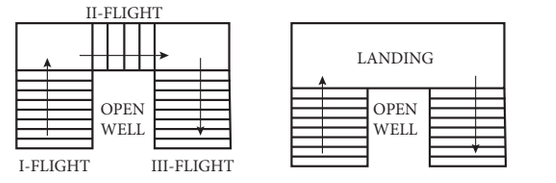
Heaven's gate, China:

The stairway consists of 999 steps. It passes through the hole in the rock to the temple situated at the top of the mountain.



It consists of two straight flights of steps with abrupt turn between them. Usually, a level landing is placed across the two flights at the change of direction. This type of stair is useful where the width of the staircase hall is just sufficient to accommodate two widths of stair.

8.1.4.3 Open Well Stairs



WITH INTERMEDIATE FLIGHT WITHOUT INTERMEDIATE FLIGHT



It is similar to dog legged stair but there is a rectangular well or opening between the backward and forward flights. The total width of stair would be sum of twice the width of one flight and well hole. The well hole allows lighting.

8.1.4.4 Circular Stairs or Spiral Stairs



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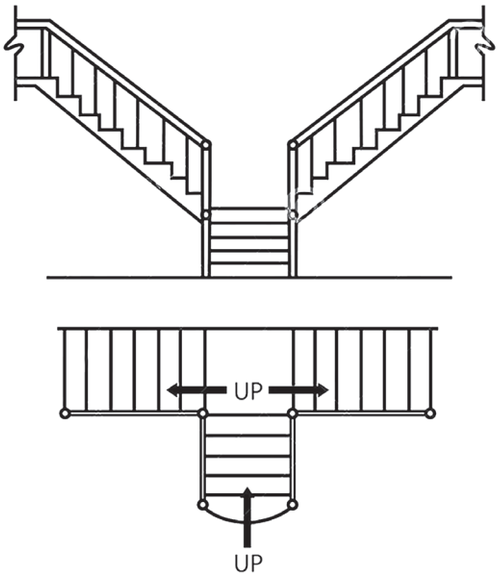
These stairs are circular in shape. In spiral stair the radius of curvature is small and the stairs may be supported by a centre post. Over all diameter of such stairs may range from 2 to 2.5 metre.

8.1.4.5 Bifurcated Stairs





Stairway to heaven:

The 300 feet spiral staircase has been installed on the wall of the Taihang Mountains in Linzhou to offer the thrill of mountaineering without the danger.



Search link:

http://inhabitat.com> architecture
http://www.alux.com>most-luxurious staircase

ACTIVITY 1

Collect the pictures of the most luxurious unique and spectacular staircase in the word and make an album.

These stairs are so arranged that there is a wide flight at the starting which is sub divided into two narrow flights at the mid landing.

Generally, these stairs are more suitable for modern public buildings.

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8.1.5 Moving Stairs or Escalators



Escalators are a sort of moving stairway between two successive floors driven by power.

In place of staircase, escalators may be used in building where there is a continuous heavy traffic flow, such as departmental stores, exhibition halls, railway stations, office buildings, airports, etc.

It is a power driven inclined continuous stairway. Stair users are not required to walk but, stairs themselves keep on moving.

8.1.6 Lift or Elevators



ACTIVITY 2

Visit the buildings with lifts and escalators around your town and prepare a report with photos.



This is an appliance designed to transport persons or goods between two or more floors in a vertical direction by means of a guided car or platform.

For efficient use of lifts, they should be provided near the centre of building also it should be easily accessible from all entrances of the building.

A lift is designed for the transport of passengers is known as passenger lift. Whereas, a lift designed for the transport of goods, is termed as goods lift. It occupies least space.

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The vertical distance between two consecutive steps is …..
   a. Going
   b. Pitch
   c. Tread
   d. Rise

2. …….. are provided to change the direction of geometrical stairs.
   a. Going
   b. Winders
   c. Riser
   d. Baluster

3. Posts set at the top and bottom of a stair supporting the hand rail is ……..
   a. Baluster
   b. Head rail
   c. Newel post
   d. Flight

4. The angle which the line of nosing of the stair makes with the horizontal is …….
   a. Soffit
   b. Pitch
   c. Rise
   d. Tread

5. The outer projection of a tread is known as ……
   a. Landing
   b. Going
   c. Nosing
   d. Winder

PART II (3 Marks)

Answer in one or two sentences

6. Define stair.
7. Distinguish between rise and riser.
8. List any three types of stairs according to the materials used.
9. List any three types of stairs according to the shapes.

PART III (5 Marks)

Answer shortly

10. Explain bifurcated stairs.
11. Write short notes on any five terms used in staircase.
12. Explain the location of staircase.

PART IV (10 Marks)

Answer in detail

13. Explain dog legged staircase with sketch.
14. Explain open well stair case with sketch.

Answers

1. (d) 2. (b) 3. (c) 4. (b) 5. (c)

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8.2 ROOFS

Learning Objectives

At the end of this lesson you shall be able to

- State the classification of roofs and its requirements.
- List the advantages of flat roof.
- Understand the modern roofing sheets.

8.2.1 Introduction

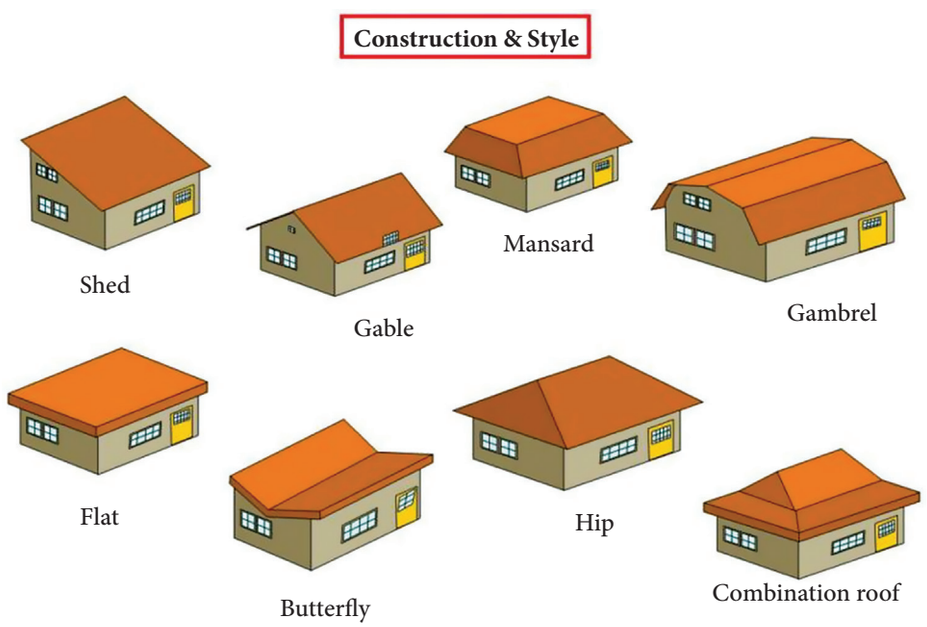
A roof is the uppermost part of a building, provided as a structural covering to protect the building from rain, sun, wind, etc. Roof protects the building from the damages starting from the top.

8.2.2 Requirements of a Good Roof

The following requirements are to be satisfied by a well planned roof.

i. It should be durable against the adverse effects of wind, sun, rain, etc.

ii. It should give good insulation against heat and sound.



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Matrimandir, Auroville.

The Matri mandir is an edifice of spiritual significance for practitioners of Integral yoga, situated at the center of Auroville initiated by the Mother of the Sri Aurobindo Ashram.

It is in the form of a huge sphere surrounded by twelve petals. It took 37 years to built this structure (from Feb. 1971 to Feb. 2008).



iii. It should be structurally sound and stable.

iv. It should permit good drainage.

v. It should have good water proofing arrangement.

vi. It should be fire resistant.

8.2.3 Classification of Roofs

1. Sloping / Pitched Roof
2. Flat Roof
3. Curved or Shell Roof

8.2.3.1 Sloping / Pitched Roof

Roofs with sloping surfaces are known as pitched roofs. These roofs are constructed out of wood, steel or combinations of both and the edges are supported by walls. The slope of the roof depends upon the span (distance between the two supporting walls). Covering materials are selected according to the climatic conditions in that locality.

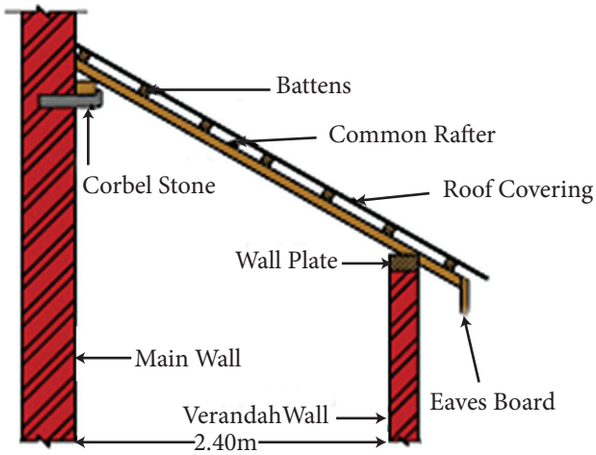


Type of Pitched Roof

1. Single Roof
2. Double (or) Purlin Roof
3. Trussed Roof

Types of Single Roof

1. Lean-to-Roof
2. Couple Roof
3. Couple closed Roof
4. Collar beam Roof



Lean-to-Roof

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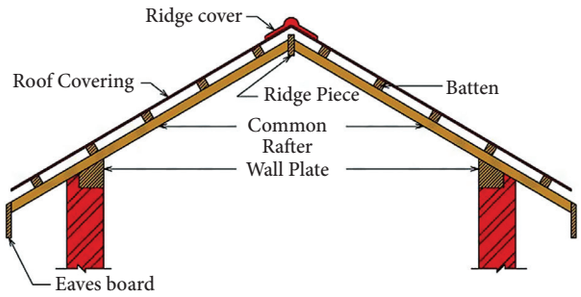
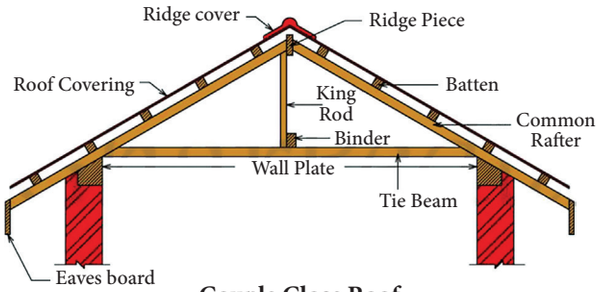
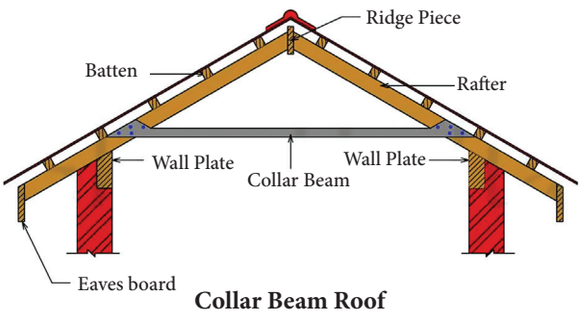


Couple Roof



Couple Close Roof



Collar Beam Roof

Trussed Roof

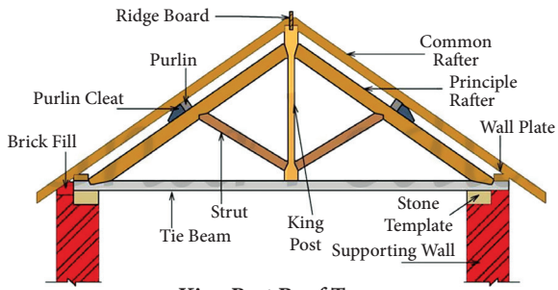
These types of roofs are constructed in triangular shape and made up of steel or timber. These are used when the span exceeds 5.5m. The spacing of trusses depends upon the load on the roof.

The following are some of important types of trussed roof

i. King post truss
ii. Queen post truss
iii. Steel truss

I. King Post Truss

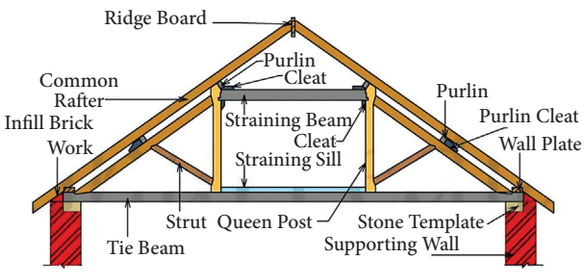
This is used for spans from 5m to 9m. In king post truss, the common rafters are supported by wooden frame work called truss at required intervals. The frame work consists of two principal rafters, a tie beam, two struts and a king post. Purlins are placed longitudinally over the principal rafters to support the common rafters. The spacing of the king post truss is generally adopted as 3m



King Post Roof Truss

ii. Queen Post Truss

This is used for spans from 9m to 14m. In queen post truss the frame work consists of two principal rafters, two queen posts, two struts, one straining beam, one straining sill and a tie beam. Common rafters are placed over the purlins which are placed over the principle rafters.



Queen Post Truss

iii. Steel Roof Truss

For spans greater than 12m, steel trusses are economical. Mild steel rolled sections of standard shapes and sizes are available in the market. It facilitates the construction of steel trusses. For small spans, the steel roof trusses are made using angles connected by rivets or welds.

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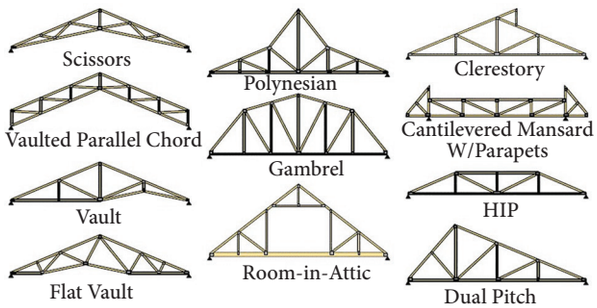
ACTIVITY 3

Collect pictures of different types of roof and prepare an album.

The designs of steel trusses become simple because steel can take both compression and tension. A few types of steel trusses are shown in the figure.



8.2.3.2 Flat Roof

The roof which is nearly flat or at a slope upto 10° is known as flat roof.

Types of Flat Roof

1. RCC roof
2. Madras terrace roof

1. RCC Roof

The following steps are to be adopted in the construction of Reinforced Cement Concrete (RCC) roof slab:



i) **Centering**

As the concrete is in semisolid state during placing, it is necessary to give support until it gains sufficient strength. This temporary supports which are formed by using wooden planks and props or steel plates and steel pipes is called Centering. It should be strong enough to withstand the weight of the roof concrete. Before laying the steel rods on the surface of centering, waste oil should be applied for easy removal of planks. The steel rods are then placed in position and are tied by using binding wires. Usually the concrete mix proportion of 1:1.5:3 is placed over the centering and they are compacted by using vibrator.



ii) Curing and Removal of Form Work

After laying of concrete, the surface of concrete should be cured for about 21 to 28 days. Only then, the concrete will attain its full strength. The form work can be removed after 14 days.



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iii) Weathering Course

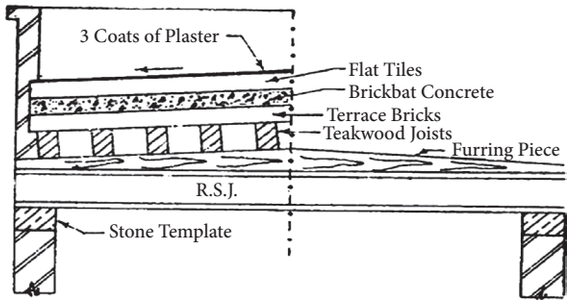
The weathering course will protect the surface of the roof slab from weathering actions. The surkhi mortar 1:1.5 (1 lime and 1.5 brick bats) ratio is laid on the roof surface for about 100mm thick. Above this, flat tiles are laid by using cement mortar 1:3. The joints in between the tiles are pointed by using cement mortar. Proper slope is maintained for easy drainage of rain water.





2. Madras Terrace Roof

1. Madras terrace roof was widely used in Madras Province in olden days.
2. It consists of teak wood beams placed over the steel girders with a furring piece between them. The furring piece gives necessary slope to the flat roof.
3. A course of well burnt bricks is laid in lime mortar by keeping the bricks on their edges diagonally across the beams.
4. A 10cm thick brick bat concrete is laid over it and thoroughly compacted by frequent wetting with water.
5. Flat tiles are laid in 3 layers over this using lime mortar.
6. Finally three coats of plaster are applied for finishing the surface and a slope of about 1 in 30 is given for draining of rain water.







ACTIVITY 4

Visit a construction site near your school and prepare a detailed report about the stages of construction of RCC roof slab with photos.

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8.2.4 Advantages and Disadvantages of Flat Roof

Advantages

I. It is easy for construction and maintenance.

ii. Upper floor can be easily constructed.

iii. Flat roof possesses good insulation properties.

iv. It posses more fire resistance than pitched roof.

v. A flat roof provides better light, ventilation and architectural appearance to the building.

vi. False ceiling is not necessary for flat roof.

Disadvantages

i. Initial cost is higher than the pitched roof.

ii. Flat roof is not suitable for long span, without the introduction of columns and beams.

iii. Flat roof is not suitable for places of snowfall.

iv. Construction speed is slower than the pitched roof.

8.2.5 Roof Covering Materials for Pitched Roof

1. Thatches.
2. Wooden Shringles.
3. Mangalore Tiles.
4. A.C. Sheets.
5. G.I. Sheets.
6. Light Weight Roofing Materials.
7. Poly Vinyl Chloride Sheets.
8. Galvalume Sheets



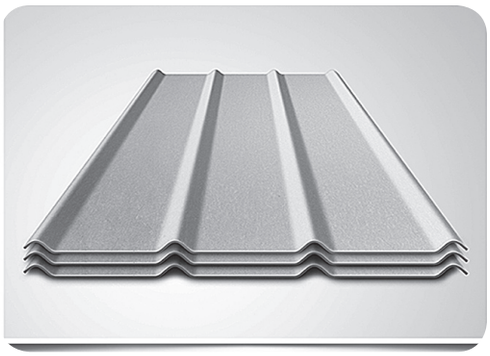
Thatches



Wooden Shringles



Tiles



A.C.Sheets(Trafford)

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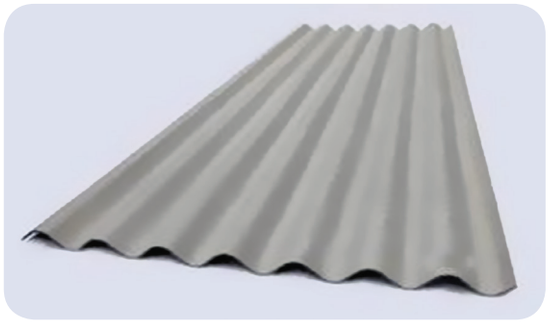
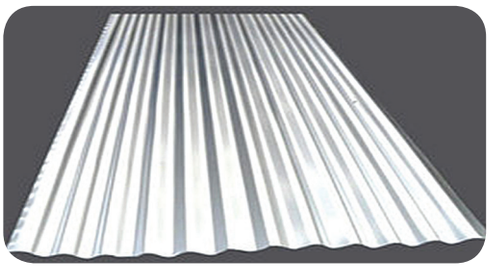
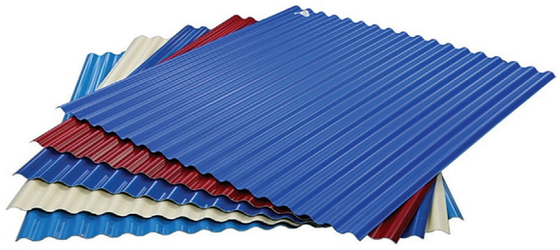


A.C. Sheets (Corrugated)



Light Weight Roofing



Poly Vinyl



Galvalume sheet

8.2.6 Points to Be Considered During the Selections of Roofing Materials

1. Climate of the Locality.
2. Slope of the Roof.
3. Type of the Building.
4. Durability.
5. Construction and Maintenance Cost of the Building.
6. Resistance to Fire and Heat.
7. Weight of the Roofing Material.
8. Appearance and Beauty of Material.

8.2.7 Types of Covering Sheets for Pitched Roof

1. Asbestos Cement Sheets.
2. Light Roofing Sheets.
3. Galvanized Iron Sheets.

8.2.7.1 Asbestos Cement Sheets (A.C. Sheets)

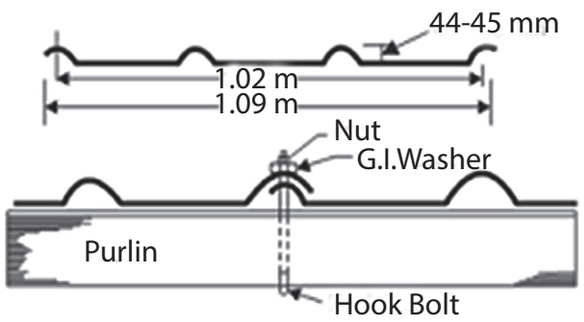
They are manufactured by mixing the cement with about 15% of asbestos fibre. The paste so formed is pressed under rollers. These fibres are so soft like silk. The corrugations helps to increase the strength and rigidity and they permit easy flow of rain water.

Types of AC Sheets

i. Trafford Sheet
ii. Corrugated Sheet

i. Trafford Sheet

Each Trafford sheet consists of four deep corrugations alternating with flat portions. The thickness of these sheets is 6mm. They are available with a breadth of 1.02 m and length of 2.5m, 3m, 3.5m and 4m.



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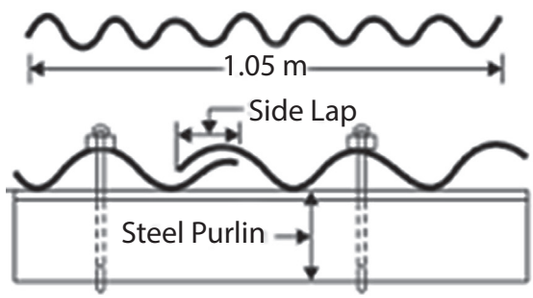
ii. Corrugated Sheet

These sheets are prepared by pressing plates between rollers. These sheets are manufactured with series of parallel depression (Corrugations) from one end to the other. These sheets are more resistant to fire. These sheets produce noise when rain water falls on them.

Crank bolts and 'J' hooks are used to fix these sheets with the purlins. To avoid the leakage of water through holes, bituminous washers are used. There are 7.5 corrugations in this sheet. The upper and lower corrugations are equal. The thickness of these sheets is 6mm. They are available with a breadth of 1.05m and lengths of 2.5m, 3.0, 3.5m and 4m.



Uses of AC Sheets

i. AC sheets are fairly cheap and not easily affected by fire.
ii. They need not be painted.
iii. It is not affected by insects.
iv. It is used in industries, factory buildings and workshops.

Characteristics of AC Sheet

i. Asbestos cement sheet can be sawn, nailed or punched.
ii. They are sound proof.
iii. They are not affected by acids and alkalies.
iv. The Maintenance cost is low.
v. They are used for decorative purpose.

AC Ridge Piece Cover

To avoid water entering into the roof, the cover pieces laid at the top junction of the two sloped AC sheets are known as AC ridge covers.

8.2.7.2 Light Roofing Sheets

These roof coverings are manufactured by inserting wool cloth in between the two asbestos clothes with corrugations. The thickness of these sheets is 3mm. They are available in a breadth of 1m and length of 2m, 2.5m and 3m. They are painted with aluminium paint on both sides. They are easily bendable and easy to cut and nail. These sheets are cheap in cost but has less strength. This type of roof covering is suitable for cattle sheds and temporary sheds.

Types of light roofing sheets

i. Tar sheet
ii. Plastic sheet
iii. Poly vinyl chloride sheet

8.2.7.3 Galvanized Iron Sheets

These sheets are prepared by pressing wrought iron plates between rollers. They are galvanized with a zinc coat to avoid rusting due to climatic change. They are strong due to corrugations. They are also manufactured as plain sheets.

Advantages of Galvanised Iron Sheet

i. They need not be painted, so cost reduces.
ii. It is weightless. So, handling is easy.

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iii. Low conductor of heat.

iv. Not easily corrodable.

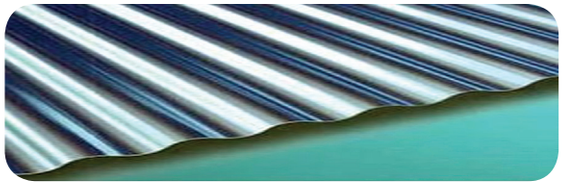
8.2.8 Modern Roofing Sheets

The following are the different modern roofing sheets.

1. Corrugated aluminium sheets
2. PVC roofing sheets
3. Glass fibre reinforced plastic sheets
4. Bituminous sheets
5. Red mud corrugated roofing sheets
6. Galvalume sheets

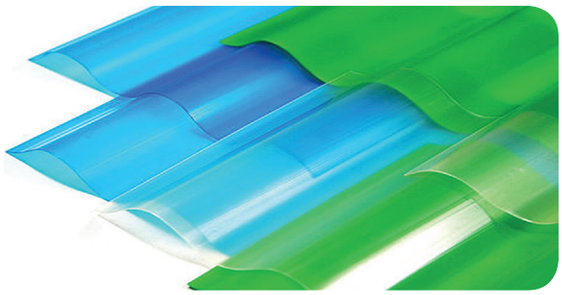
8.2.8.1 Corrugated Aluminium Sheets

Aluminium is a light weight metal and does not corrode like steel. The thickness of corrugated sheets vary from 0.5 to 0.8 mm. They require no maintenance and also has a good resale value. The only disadvantage is that they are more expensive.



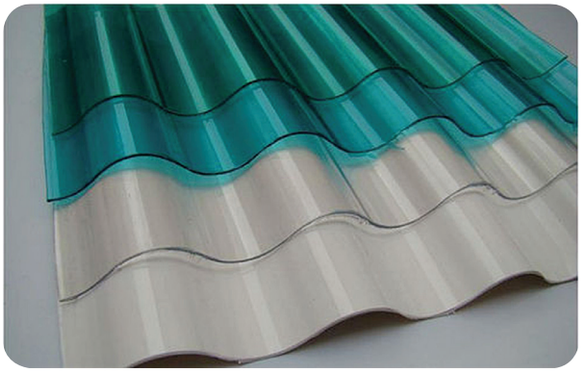
8.2.8.2 PVC Roofing Sheets

Rigid PVC Corrugated sheets are transparent with a light transmission of not less than 70 to 80 percent. So, these sheets do not perform well with direct exposure to sunlight and are also not fire proof. They are mainly used in temporary constructions, car parking, etc., where a very light roofing of pleasing appearance is required.



8.2.8.3 Glass Fibre Reinforced Plastic Sheets

Corrugated glass fibre reinforced plastic sheets with different profiles and light transmissions are used as light roofing materials. Unlike GI and aluminium sheets, these sheets have little resale value.



8.2.8.4 Bituminous Sheets

Light roofing sheets made of bitumen and paper pulp is generally used for covering of temporary sheds. They are cheap but their life is very short (3 to 5 years).They do not have resale value.



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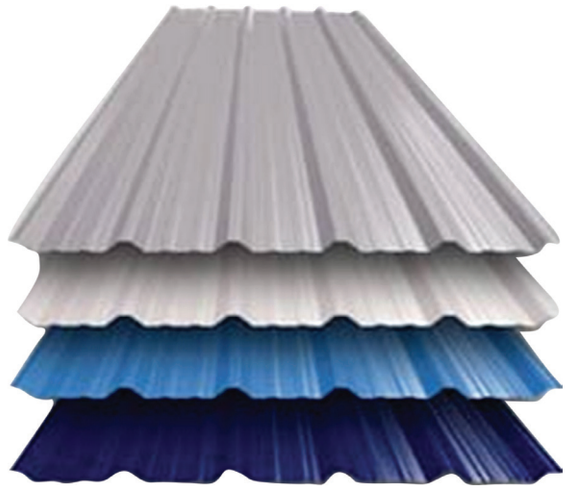
8.2.8.5 Red Mud Corrugated Roofing Sheets

Red mud is obtained from waste materials derived in aluminium industry is combined with polymers to form this corrugated roofing sheets. They are cheap and more durable. Since red mud corrugated roofing sheets are very flexible, they are extensively used as light roofing material for temporary construction.



8.2.8.6 Galvalume Sheet

Galvalume sheets are commercially available light steel roofing sheets made up of low tensile steel or mild steel. These sheets are 4 times more corrosive resistant than GI sheets and are one of the most economical and durable material. The versatility, ease of use, aesthetics and long term performance of the material makes it best preferred material for roofing now-a-days.



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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The upper most part of a building is ……
   a. Wall
   b. Floor
   c. Roof
   d. Door

2. King post truss is used for spans from ……
   a. 3m to 6m
   b. 5m to 9m
   c. 2m to 4m
   d. 4m to 8m

3. For spans greater than ….. steel trusses are economical.
   a. 12m
   b. 6m
   c. 10m
   d. 20m

4. Flat tiles are laid in ……layers in madras terrace roof.
   a. 4
   b. 2
   c. 3
   d. 5

5. The content of asbestos fiber in the manufacture of A.C sheet is …..
   a. 10%
   b. 15%
   c. 20%
   d. 25%

YOQBL

PART II (3 Marks)

Answer in one or two sentences

6. List any three types of flat roofs.
7. What are the important types of roof trusses?
8. What are the types of light roofing sheets?

PART III (5 Marks)

Answer shortly

9. What are the characteristics of A.C sheets?
10. State the requirements of a good roof.
11. List the advantages of flat roof.

PART IV (10 Marks)

Answer in detail

12. Explain king post truss with sketch.

Answers

13. Explain about modern roofing sheets.

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8.3 FLOORS AND FLOORING

Learning Objectives

8.3

At the end of this lesson you shall be able to

- ➢ State the types of floors and flooring.
- ➢ Understand the materials used in flooring and its selections.

8.3.1 Introduction-Floors

Floors are the horizontal elements of a building structure. It divide the building into different levels. It provides more accommodation within a restricted space. They provide support for the occupants, furniture and equipment of a building.

Ground Floor: The floor of a building immediately above ground level is known as ground floor.

Basement Floor: In case part of the building is constructed below ground level or the building has basement, the floor is termed as basement floor.

Upper Floor: If the building is a multi-storeyed one, the floors above ground floors are called upper floors.

8.3.2 Types of Floors

Floors are classified into two categories. They are,

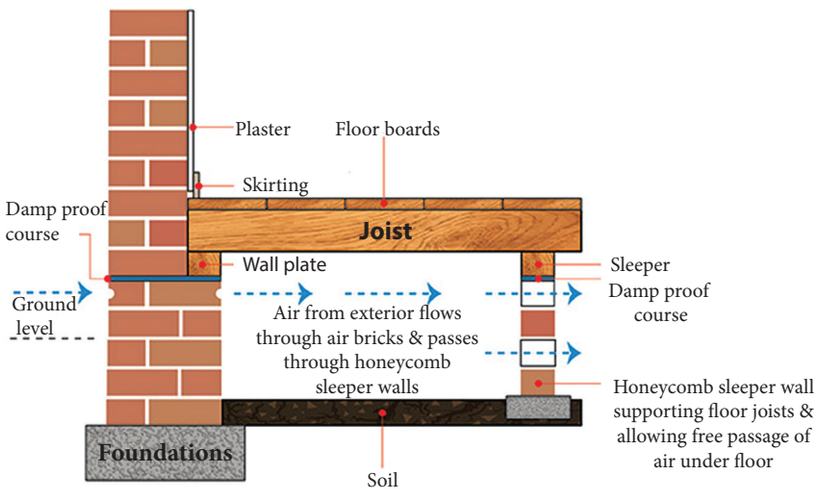
1. Timber floors
2. Composite floors
3. RCC floors



8.3.2.1 Timber Floors

In this type of floors, only timber is used as a flooring material. Following are the types of timber floors.

I. Sleeper Wall Timber Floors



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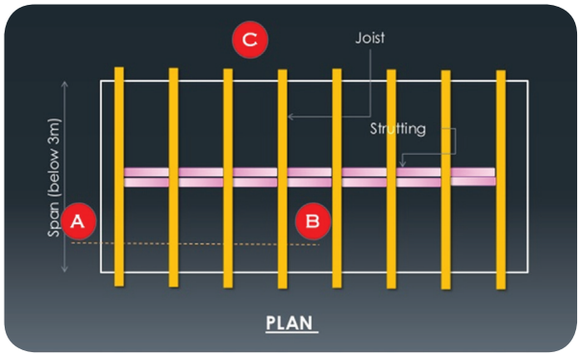
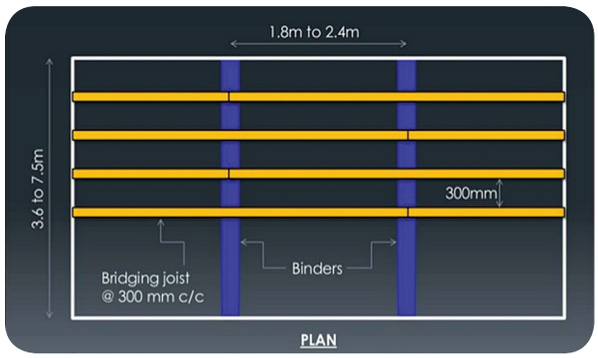
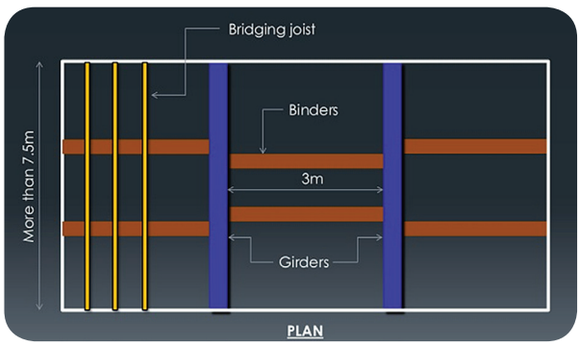
ii. Single joist timber floors



iii. Double joist timber floors



iv. Framed or triple joist timber floors.



8.3.2.2 Composite Floors

Floors composed of more than one material are known as composite floors. Following are the types of composite floors.

i. Filler joist floors
ii. Jack arch floors
iii. Double flagstone floors
iv. Hallow block and rib floors
v. RCC Floor

In the above types of floors, RCC floors are most common now-a-days.

8.3.2.3 RCC Floors

In this type of floor, steel bars and concrete are used to form the floor. This type of floor is widely used in modern construction. The slabs and beams are designed as per loading comes on the floor and proper reinforcement is placed at suitable places. The following are the advantages of RCC floors when compared to other type of floors.

- Maintenance cost is low
- Strong
- Fire proof
- Easy to construct

8.3.3 Definition of Flooring

The permanent covering of the top surface of a floor structure to provide an even and smooth walking surface is known as **"Flooring"**.

8.3.4 Materials Used for Flooring

The following are some of the materials used for flooring.

i. Brick
ii. Concrete
iii. Wood

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iv. Stone
v. Tiles
vi. Terrazzo
vii. Asphalt
viii. Rubber
ix. Glass
x. Linoleum

8.3.5 Selection of Material For Flooring

Following factors are to be carefully considered before selecting the material for flooring:

1. **Appearance:** The flooring material should have desired appearance and it should produce the colour effect in conformity with the use of building.
2. **Comfort:** The flooring material should give comfort when used. Flooring material should have good thermal insulation, imparts comfort to the residents of the building to a great extent.
3. **Cost:** The cost of flooring materials should be reasonable when compared to the utility of the building.
4. **Cleaning :** The flooring materials should be such that it can be easily and effectively cleaned.
5. **Durability:** The flooring material should be durable and it should be strong enough to impart resistance to wear, tear, chemical action. etc.,
6. **Noise:** Flooring should insulate noise (i.e) it should not produce noise when users walk on it. Floor covering of wood, rubber, cork, PVC tiles are suitable for this type.
7. **Slipperiness:** Flooring material should be smooth and should have an even surface. It should not be slippery.
8. **Fire Resistant:** This quality is more important for upper floors. The material should offer sufficient fire resistance. So that fire barriers are obtained between different levels of a building. Concrete tiles, terrazo and marble have this quality

8.3.6 Types of Flooring

Following are the various types of flooring based on the materials used.

1. Tiled flooring
2. Granite flooring
3. Marble flooring
4. Precast concrete flooring
5. Plastic and PVC tile flooring
6. Carpet flooring
7. Rubber flooring

8.3.6.1 Tiled Flooring

Tiles of either clay or cement concrete or terrazzo manufactured in various shapes, size and thickness are used in this type of flooring. This flooring can be laid in shorter time.



8.3.6.2 Granite Flooring

Granite flooring is similar to granolithic flooring. Here, instead of chips, hard granite stones are laid on the sub grade of concrete. The usual thickness is 20mm to 35 mm.

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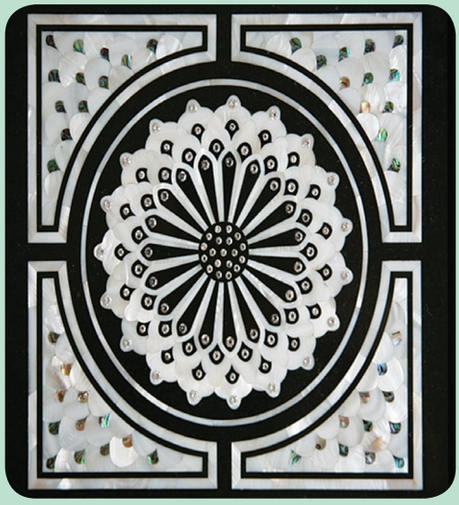
World's Most Expensive Flooring Tiles.

Lux Touch is a ONE MILLION US DOLLER per square meter rated DIAMOND floor, wall and ceiling tile, the most expensive in the world. Each square meter of marble tile is inlaid with over 1000 diamonds, 2400 pieces of mother of pearl, 400 pieces of abalone shell and 500 pieces of black onyx.

Search link: www.blackdiamond-lifestyle.com>diamondfloorings



8.3.6.3 Marble Flooring

This is a superior type of flooring used in important public buildings, residential buildings etc., where extra cleanliness is essential. Marble slabs are rectangular or square in shape.



8.3.6.4 Precast Concrete Flooring

The precast slabs are available in different sizes. They are supported either on walls or rolled steel joints. The sides of each unit contain grooves which enhance good connection with adjacent joints.



8.3.6.5 Plastic and Pvc Tile Flooring

This type of flooring is a recent development in flooring construction. The material poly vinyl chloride is fabricated in the form of tiles of different size, shapes and colour.

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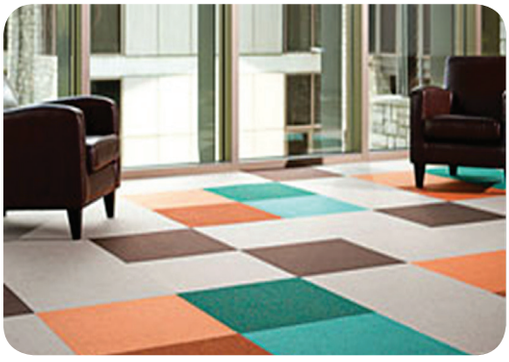
8.3.6.6 Carpet Tile

this flooring is generally used to obtain a noiseless floor in case of libraries. Studios, prayer hall, etc.







GLASS FLOOR

Glass floors are made with transparent glass when it is useful to view something from above or below; whereas translucent glass is used when there is no need to view through. In either case toughened glass is usually chosen for its durability and resistance to breakage

Search link: https://www.homeflooring-pros.com>8 best luxury floorings.





ACTIVITY 5

Prepare a report on Luxury and high quality flooring with pictures.

8.3.6.7 Rubber Flooring

Rubber floorings are in a large extent used in public and industrial buildings.

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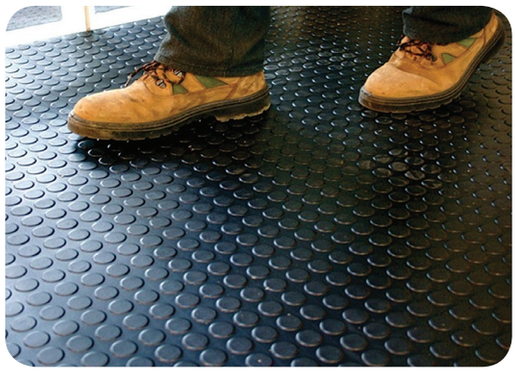
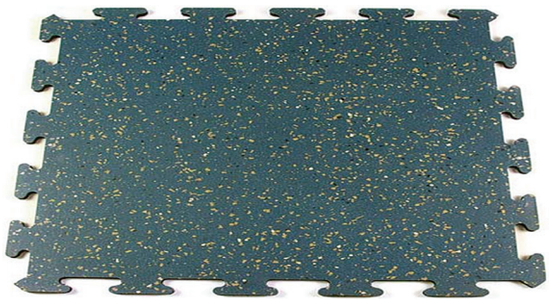
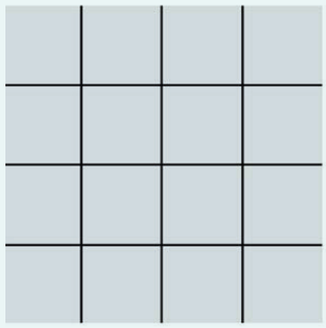
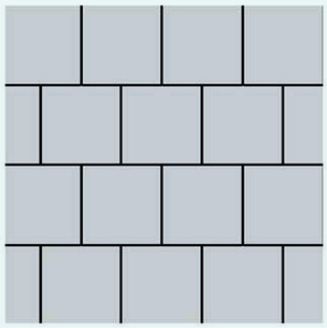




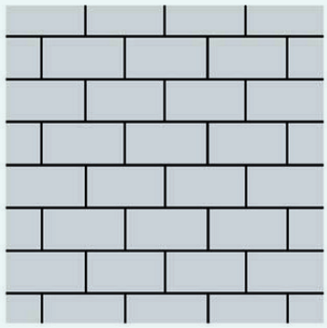
Tiles Laying Patterns



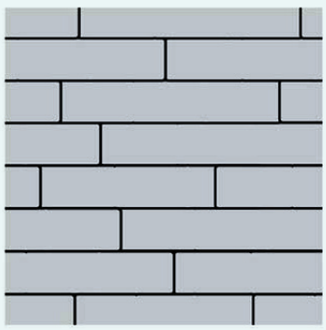
Stack Bond



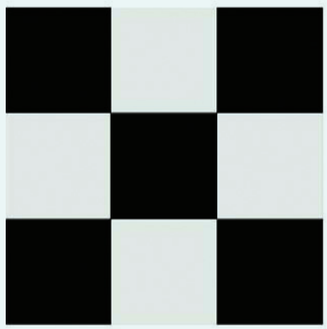
Stretcher (Half-Bond)



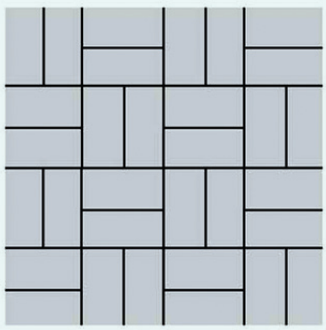
Brick (Half-Bond)



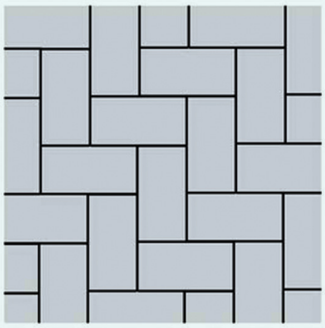
Random (Staggered)



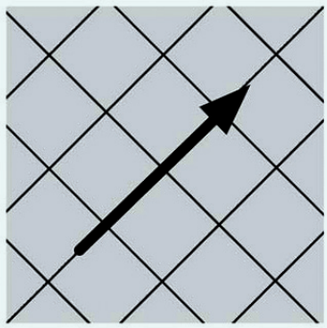
Chequer Board



Basket



Herringbone



Diagonal

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Model Questions

PART I (1 Mark)

Choose the correct answer

1. The floor of a building immediately above ground level is …..
   a. First floor
   b. Basement floor
   c. Ground floor
   d. Second floor
2. The floors above ground floor are called …….
   a. Basement floors
   b. Composite floors
   c. Upper floors
   d. Jack arch floors.
3. The usual thickness of granite flooring is ……..
   a. 5mm to 10mm
   b. 10mm to 20mm
   c. 20mm to 35mm
   d. 30mm to 50mm.



PART II (3 Marks)

Answer in one or two sentences

4. List the types of timber floors.
5. Define flooring.
6. List any three types of floorings.

PART III (5 Marks)

Answer shortly

7. Explain R.C.C floor.

PART IV (10 Marks)

Answer in detail

8. What are the factors to be considered before selection of material for flooring?

Answers

1. (c) 2. (c) 3. (c)

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Case Study - Nateswaran

I am B. Nateswaran.

I feel proud to write about my school, The Government Higher Secondary School, Agasteeswaram which is one among the best school in Kanniyakumari District. It identifies the unique skills of each and every student and help them channelize their energy to excel in that field .

After completing my SSLC in Govt. High school, Elanthayadivilai, I had an opportunity to continue my studies in Govt. Hr. Sec. School, Agasteeswaram during the year 1994-96. My happiness could not be spell bound, on the day, when I was declared state rank(-First) in vocational course "Draftsman Civil". The pillars behind my achievements were my headmaster, teachers and my family members.

A Teacher guides like a scholar

A Teacher cares like a parent

A Teacher scolds like a brother

A Teacher loves like a sister

A Teacher shows concern like God… I saw them there….

I completed my B.E at C.S.I institute of Technology, Thovalai and M.B.A in Madurai Kamaraj University.

Then , I joined as a clerk in Indian Overseas Bank during 2008 and rose to the position of Manager. I render my service here about 10 years with full dedication and sincerity. All this journey through a spectrum of fields with agile and ease was made possible only by my school and teachers.

Through this opportunity, I once again thank everyone, who taught, guided, motivated, inspired and supported me to get this good position.

P. Nateswaran

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Case Study - Deepika

I, Deepika studied in KGKG Girls Hr.Sec.School, Vedharanyam was known for vigorous and witty among my classmates when I was studying VI standard. I got passed in Analytical Skill examination in IX standard with the firm support of my Head Mistress and Teachers. I had chosen Draughtsman Civil group for my further higher secondary studies. I got attained third place in Public examinations by the guidance of my teachers. Draughtsman Civil taught the basic concepts which helped me a lot when I pursued Engineering.

I secured first class in BE Civil Engineering. As I have been inspired by the thoughts and knowledge of my teachers, I have selected the teaching profession. Initially, I was worked as a Lecturer in SRV Polytechnic, Sembodai. After completing my ME in Structural Engineering, I have been placed as Head of Civil Engineering Department in Sir Issac Newton College of Engineering and Technology, Pappakovil. I am guiding my students as my teachers guided me.

“ If you believe, life is a circle,

You will round only inside the circle.

Come out of the circle then only

You can see the fruitfulness of life”

I am always grateful to my parents, teachers and the people who helped me to reach this height in my career.

Deepika. K

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Case Study - Arunkumar Mohanraj

My name is Arunkumar Mohanraj native of Puducherry. I studied in Jeevanandam Govt. Higher secondary school at Mudaliarpet, Puducherry, then continued in Venkatasubba Reddiar Govt.Technical Higher Secondary school at Lawspet, Puducherry. I consider this school as something very unique in Puducherry, where you can learn and study at the same time. I got an opportunity to study Draughtsman Civil which had excellent course works and practical field study with appreciative class teachers.

After completing my schooling, my parents insisted me to perceive study in a different field abroad. I decided to go to France where I perceived my bachelor degree and double master degree program in the prestigious university of Paris Sud (Paris Descartes). I studied Public Health for my first degree which also included clinical research and epidemiology studies. My second degree was master in Physiology and Pathology in ageing. It was a crucial stage in my life, and I struggled really hard to obtain my master degree in France. After my battle, Now I got an opportunity to pursue PhD in Neuroscience in Ben Gurion University at Israel.

Finally, I conclude that "Hard work never fails". I wish you all for your bright future.

Arunkumar Mohanraj.

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Case Study - Joseph Marie Dass

"Life is a festival only to the wise" – Ralph Waldo Emerson

My name is Joseph Marie Dass and I am one amongst few people who considers life as a festival and celebrates it. Here, with immense pleasure I am sharing my wonderful experience with you. I was a student from a middle class family in the union territory of Puducherry.

In my view, giving a book knowledge alone cannot be considered as education, the moral values which shapes us to be good citizen is needed for a complete education. I got that kind of complete education in Venkatasubba Reddiar Govt. Technical Higher Secondary School, Lawspet, Puducherry where I mastered the concept of Draughtsman Civil and secured 70%. This scucess under my subject teacher's guidance induced me to choose Civil Engineering in CIT, Puducherry. I secured 75 % and got placed in MST Rebar Pvt. Ltd.

Then I shifted to Ashirwad analytical laboratory as a Civil supervisor (Structural division), now I have attained the post of JE-I for my hard and dedicated work.

Now, I have received an invite from ISRO, where i have been qualified and waiting for results.

Education is not a destination, it is a life long journey. It is the passport to the future, tomorrow belongs to those who prepare for it today. The function of education is to teach one to think intensively and critically.

I am sure you all know about the importance of getting a complete education. I wish you all an enjoyable schooling and a successful future.

Joseph Marie Dass

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Marks Allocation

Draughtsman Civil - Theory - 1st Year

Part A	Choose the correct answer	15 × 1 = 15 marks
Part B	Answer any ten questions	10 × 3 = 30 marks
Part C	Answer any five questions in brief	5 × 5 = 25 marks
Part D	Answer all the questions in details	2 × 10 = 20 marks

Total	**90 marks**
Internal Assessment	**10 marks**
Total	**100 marks**

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Model Question Paper I

Basic Civil Engineering – Theory

Total Marks: 90

Part A

Choose the correct answer ***15 × 1 = 15***

1. Engineering drawing is a _____language which consists of different types of lines and letters.
   a) Tamil b) western c) World wide d) Indian
2. The only line which intersects object line is_____.
   a) Hidden line b) Leader line c) Extension line d) Dimension line.
3. _____ software is mostly used to draw drawing.
   a) Auto Desk b) NISA c) Auto Cad d) ARCHICAD
4. _____is mentioning the real dimension near the object.
   a) Dimension style b) Dimension text c) Dimension line d) None of the above
5. _____ rocks cannot split in to thin layers.
   a) Stratified b) Un-Stratified c) Foliated d) None of the above
6. The percentage of Iron oxide content in good brick earth is _____.
   a) 5-6% b)3-4% c)2-3% d)4-5%
7. In a Layman's view cement means _____.
   a) Natural cement b) Artificial cement c) Quick setting cement
   d) Portland cement
8. The proportion of cement mortar used for brick work is _____.
   a) CM 1:4 b) CM 1:6 c) CM 1:3 d) CM 1:2
9. The ratio of Reinforced cement concrete is _____.
   a) 1:4:8 b) 1:3:6 c) 1:5:10 d) 1:2:4

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10. _____ timber is used for ship building .
    a) Teak b) Sal c) Mango d)Jack

11. The title used to carry irrigation water is _____.
    a) Corrugated tile b) Drain tile c) Floor tile d)Roof tile

12. The foundation used to transmit heavy loads from steel column to the soil having low bearing capacity is _____.
    a) Isolated footing b) Continuous footing c) Grillage foundation
    d) Combined footing

13. The Layer of brick which is projecting at roof level of every floor is known as_____.
    a) coping b) Plinth c) String course d) Cornice

14. The inner surface of an arch is termed as _____.
    a) abutment b) intrados c) extrados d) Springing stone

15. The vertical wooden member which splits the doors or windows into two parts is _____.
    a) Style b)Bottom rail c) Panel d) Mullion

Part B

Answer any ten questions in one or two sentences ***10 × 3 = 30***

Note : Question No 25 is Compulsory

16. List the general classification of rocks.
17. Write any three uses of stones.
18. List the ingredients and its proportions of brick earth.
19. Write any three Properties of good mortar.
20. Write short note on : Fiber board
21. List any three types of ceramic tiles.
22. What are the objects of providing foundation?
23. Write the types of dressing of stones.
24. List the types of arches based on the materials for construction.
25. List and three types of hinges used in doors and windows.
26. List any three types of stairs based on the shapes.
27. List the types of pitched roof .
27. What are the materials used to constructed roofs ?

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Part C

Answer any five questions in brief ***5 × 5 = 25***

Note : Question No 30 is Compulsory

29. Write briefly about set square with neat sketch.
30. Write any five advantages of using software to draw drawing .
31. List the steps involved in preparation of brick earth and explain any two of them.
32. List the field tests conducted on cement and explain any two of them.
33. What is seasoning of timber ? List the objects of seasoning of timber.
34. Write name and uses of any five tools used in masonry work.
35. Draw a straight stair and indicate its parts.

Part D

Answer all questions in detail ***2 × 10 = 20***

36. Explain any ten principles adopted in dimensioning with sketch.

(or)

Differentiate between River sand and Manufactured sand (M-sand).

37. Draw neatly a panel door and indicate its parts.

(or)

Explain about any four modern roofing sheets.

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Model Question Paper II

Basic Civil Engineering– Theory

Total Marks: 90

Part A

Choose the correct answer. ***15 × 1 = 15***

1. The ebony edge of drawing board should be projected _____ from the edge of drawing board.
   a) 6 to 10 mm b) 5 to 6 mm c) 2 to 3 mm d) 7 to 8 mm
2. The software used for design of highways is _____.
   a) M.S. ROADS b) KANAL ++ c) AQUA ++ d) GEO
3. The specific gravity of good stones should be more than _____.
   a) 1.8 b) 2.1 c) 2.5 d) 2.7
4. The clay content in brick earth should be _____.
   a) 20 to 30 % b) 20 to 35 % c) 35 to 50 % d) 40 to 45 %
5. In block test, the cement block is immersed in water for _____.
   a) 5 days b) 3 days c) 7 days d) 10 days
6. _____ is the small groove cut on the underside of cornice, coping and sill to drain the rain water.
   a) Layer b) Throating c) Plinth d) Through Stone
7. The wedge shaped stones to form arch are called as _____.
   a) Voussoirs b) Extrados c) Springing stone d) Springing line
8. The horizontal member which splits window frame into two parts is _____.
   a) Transome b) Sash c) Louver d) Mullion
9. The minimum height of door is _____.
   a) 2.0 m b) 1.5 m c) 1.8 m d) 2.2 m
10. The horizontal portion of the step where we rest the foot is _____.
    a) Rise b) Tread c) Riser d) Going
11. The roof having sloped surface is known as _____.
    a) Shell roof b) Pitched roof c) Flat roof
    d) Madras terrace roof
12. The weight of rose wood after seasoning is _____.
    a) 7900 N/m^3 b) 6900 N/m^3 c) 8600 N/m^3 d) 7700 N/m^3
13. The thickness of hard board is _____.
    a) 2 mm b) 3 mm c) 30 mm d) 5 mm

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14. The percentage of calcium oxide in fat lime is _____.
    a) 80 % b) 85 % c) 95 % d) 90 %

15. The other name of pot tiles is _____.
    a) Ceramic tiles b) Mangalore tiles c) Flat tiles d) Hand tiles

Part B

Answer any ten questions in one or two sentences ***10 × 3 = 30***

Note : Question No 25 is Compulsory

16. Define centre line.
17. What are the uses of STAAD PRO – Software ?
18. What do you mean by 'Dimension text' ?
19. What are the physical classification of rocks ?
20. State the importance of 'Alumina' in brick earth.
21. Write short notes on hollow block.
22. What is meant by natural cement ?
23. Define lime mortar.
24. What are the methods of seasoning of timber ?
25. List any three types of locks.
26. State the types of staircases according to the materials used.
27. List the types of trussed roofs.
28. Mention the types of stone masonry.

Part C

Answer any five questions in brief ***5 × 5 = 25***

Note : Question No 30 is Compulsory

29. Name any five commands used in Auto CAD.
30. What are the types of bricks ?
31. List any five types of artificial cement.
32. What are the uses of timber in construction ?
33. What are the types of shallow foundations ?
34. What are the differences between lintels and arches ?
35. Write any five uses of mortar.

Part D

Answer all the questions in detail ***2 × 10 = 20***

36. Explain about Setsquare and Drawing pencils with sketch.

(or)

Tabulate the differences between stone masonry and brick masonry.

37. Explain revolving door with sketch.

(or)

List the timber products and explain any two of them in brief.

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2. "Engineering drawing and Graphics", by K.Venugopal.
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6. "Building Materials", by P.C.Varghese.
7. "Building Materials", by S.K.Duggal.
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9. "Building Materials and Construction ", by S.Bhavikatti.
10. "Building Construction", by S.C. Rangwala.
11. "Building Construction", by P.C.Varghese.
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Glossary

1.1 DRAWING INSTRUMENTS AND THEIR USES	
Crafts man	கைவினைஞர், ஒரு தொழிலில் ஈடுபட்டுள்ளவர்
Laminated	மென் தகடுகளாலான
Drafting machine	வரைவுப்பொறி
Rubbing	அழித்தல் அல்லது தேய்த்தல்
Trimmed size	ஒழுங்கு செய்யப்பட்ட அளவு
Slotted joint	துளையிடப்பட்ட இணைப்பு
Mechanism	இயந்திர நுட்பம்
1.2 LINES, LETTERING AND DIMENSIONING	
Hidden	மறைவான, மறைத்து வைக்கப்பட்ட
Projection	வீழல், ஒளி நிழல்எறிவுறு
Hatching	நேர்த்தியான கோடுகள் மூலம் நிழல் வண்ணங்காட்டுதல்
Interrupted	குறுக்கிடப்பட்ட, இடைமறிக்கப்பட்ட
Intermediate	இடைப்பட்ட
2.1 AUTO CAD SOFTWARES	
Software	மென்பொருள்
Environmental	சுற்றுப்புறச் சூழ்நிலை
Management	மேலாண்மை
Modelling	வடிவமைப்பு
Structural	கட்டமைப்புச் சார்ந்த
2.2 AUTOCAD BASICS	
Characteristics	பண்புகள்
Circumference	சுற்றளவு
Command	கட்டளை
Symmetrical	சமச்சீருள்ள
Fulfilment	நிறைவேற்றம், செயல்தீர்வு

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Isometric	சம அளவுத் தோற்றம்
Orthographic	செங்கோண கூட்டுமுறை

3.1 STONES

Bedding	படுகை
Disintegration	சிதைதல்
Distinctly	முற்றிலும்
Predominates	பெரும்பான்மையுடையதாக
Preserving	பாதுகாத்தல்
Contributing	பங்களித்தல்
Tolerable	ஏற்றுக்கொள்ளத்தக்க
Seasoned	பதப்படுத்தப்பட்ட

3.2 BRICKS

Blending	கலத்தல்
Reliability	நம்பகத்தன்மை
Wrapping	போர்த்துதல்
Cohesion	ஒட்டுந்தன்மை
Brittle	உடையக்கூடிய
Kneaded	பிசையப்பட்ட
Accumulation	திரளுதல்
Oxidized	ஆக்ஸிஜனேற்றப்பட்ட
Crystallization	படிகமாக்கல்
Vitrified	கண்ணாடி போன்று மாற்றப்பட்ட,

3.3 SAND

M-Sand	செயற்கை மணல், தயாரிப்பு மணல்
Huge	பெரிய

4.1 CEMENT

Wetting ability	ஈரமாகும் திறன்
Volcanic powder	எரிமலைத்துகள்
Lean mix	குறை கலவை
Ornamental work	அலங்கார வேலைப்பாடுகள்
Tarpaulin	ஒரு வகை அடர்நெகிழி தாள்
Silos	குதிர், பதனக்கலன்

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4.2 MORTAR	
Water resisting property	நீர்த் தடுப்புத் தன்மை
Water saturated soil	நீர்ச்செறிவுள்ள மண்
Re-tempering	மீளப்பக்குவப்படுத்துதல்
Consistency	சீர்பதம்
Erosion	அரித்தல்
Abrasion	தேய்மானம்

4.3 CONCRETE	
Admixtures	துணைச் சேர்க்கைப் பொருள்கள்
Virtue	தனித்தன்மை, சிறந்தபண்பு
Segregation	தனித்தனியே பிரிதல்
Agitated condition	தன்மைமாறா நிலை
Hydration	நீரேற்றம்
Appreciation	பாராட்டத்தக்க
Work ability	பணி எளிமைத் திறன்
Spilling	சிதறச்செய்தல்

5.1 TIMBER	
Decorative	அலங்கரிக்கப்பட்ட
Proportionate	விகிதாச்சாரம்
Nourishment	ஊட்டச்சத்து
Distortion	விலகல்
Adhesive	பிசின்
Trenches	குழிகள், அகழிகள்

5.2 LIME	
Plasticity	இளகுதிறன்
Dissolving	கரையும் தன்மையுடைய, கரைக்கும்
Eminently	மேம்பட்ட
Predominantly	முதன்மையானதாக
Substantial	கணிசமான

5.3 TILES	
Logged area	பதிவு செய்யப்பட்ட பகுதி
Irrigation	பாசனம்
Comparatively	ஒப்பீட்டளவில்
Nonabsorbent	உறிஞ்சாத

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6.1 FOUNDATION

Grillage	அஸ்திவாரத்தைத் தாங்க இரும்பு (அல்லது) மரத்தாலான சட்டத் தொகுப்பு
Gusset plate	உத்திரங்களை இரும்புத் தூண்களோடு இணைக்கப் பயன்படும் முக்கோணவடிவ இரும்புத் தகடுகள்
Raft	கட்டுமானங்களைத் தாங்க அமைக்கப்படும் தட்டையான அமைப்பு
Pile	நிலத்தூண் அடித்தளம் (அல்லது) அடிமானம்
Undulations	அலையலையான, மேடுபள்ளமான
Excavation	குழி, பள்ளம் தோண்டுதல்
Transpiration	ஆவியாக வெளிவிடுதல்
Penetration	ஊடுருவுதல்
Stagnate	தேங்கிநில்

6.2 STONE MASONRY

Masonry	கட்டுமான வேலை
Distinct	தனிவேறுபட்ட, தெளிவாகத் தெரிகிற
Quoins	மூலைக்கற்கள்
Corbel	பளு தாங்குவதற்காகச் சுவரில் வைத்திணைக்கப்பட்ட கல் அல்லது தண்டையக்கட்டு
Spalls	பாறை உடைசல், சிம்பு
Seepage	கசிவு , ஒழுக்கு
String Course	மேற்பரப்பில் உள்ள படுக்கைக் கோட்டுவரி
Furrow	வரிசையாக நீண்ட பள்ளங்களாக்கு
Rubble	கொத்தாத கட்டுமானக் கல்
Ashlar	செங்கல் போல சதுக்கமாக செதுக்கப்பட்ட கட்டுமானக் கல்
Chamfered	சரிவுடைய, சாய் செதுக்கு மூலை
Tensile stress	இழுவிசைத் தகவு

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6.3 BRICK MASONRY

Stretcher	நீட்டம்
Header	தலைப்பி
Closer	செங்கல் பகுதி
Brick bat	செங்கல் துண்டு
Suction	உறிஞ்சும்
Tendency	போக்கு
Scaffolding	சாரக்கட்டு
Consumption	நுகர்வு
Dampness	ஈரத்தன்மை

7 LINTELS AND ARCHES, DOORS AND WINDOWS

Shear resistance	வெட்டு எதிர்ப்பு
Joggled brick lintel	செங்கலால் துருத்தம் செய்யப்படுதல்
Joist	சிறு விட்டம்
Voussoirs	ஆப்புவடிவக் கற்கள்
Apparently	தோற்றநிலை, வெளிப்படையாக
Glued	வஜ்ரபசை
Helical	சுருள்வளைய

8 STAIRS, ROOFS, FLOORS AND FLOORING

Facilitates	வசதிசெய்
Vibrator	அதிர்வு இயந்திரம்
Furring Piece	கட்டச் சட்டங்கள்
Possesses	ஆட்கொள்வது
Wooden Shingles	மர ஓடுகள்
Durability	நீடித்த உழைப்பு
Appearance	தோற்றம்
Corrugations	நெளிவு
Bituminous Washer	தார்பட்டை வளையம்
Sawn	ரம்பத்தால் அறுத்தல்
Alkalis	காரத்தன்மை
Rusting	துருப்பிடித்தல்
Corrode	அரித்தல்
Versatility	பலதுறைப் புலமை, தனித்தன்மை
Aesthetics	அழகியல் சார்ந்த
Occupants	குடியிருப்பவர், வசிப்பவர்
Composite	கூட்டு, கலந்த, இணைந்த

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Basic Civil Engineering

PRACTICAL

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Note:

Atleast ten experiments are to be conducted depending upon the availability of laboratory and equipments in schools. (Ex. No 2 and 6 are compulsory)

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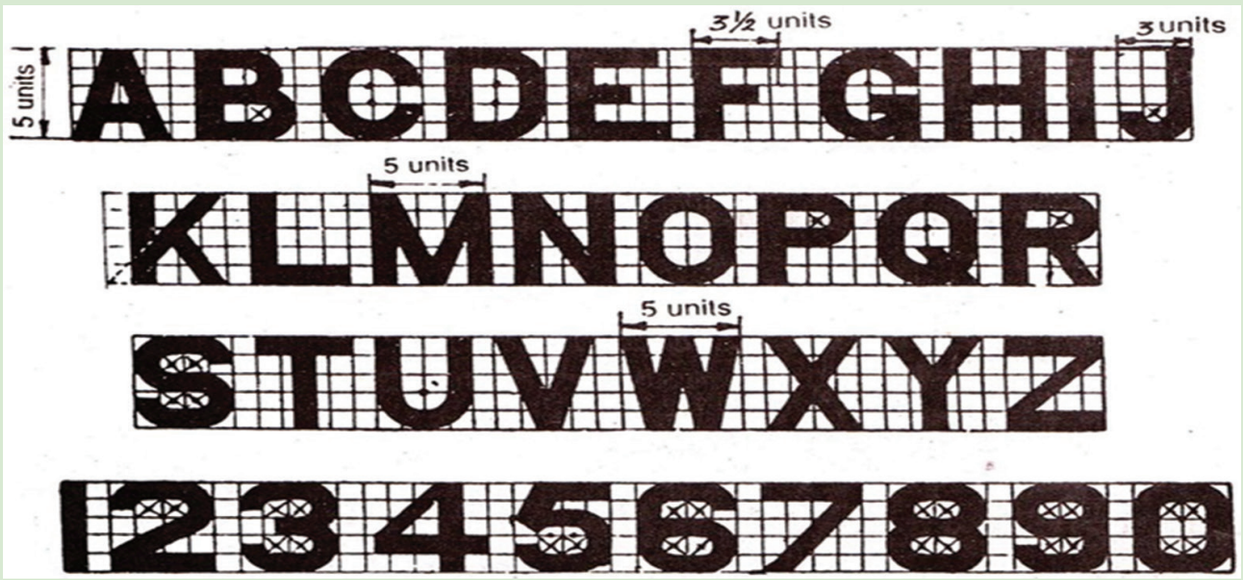
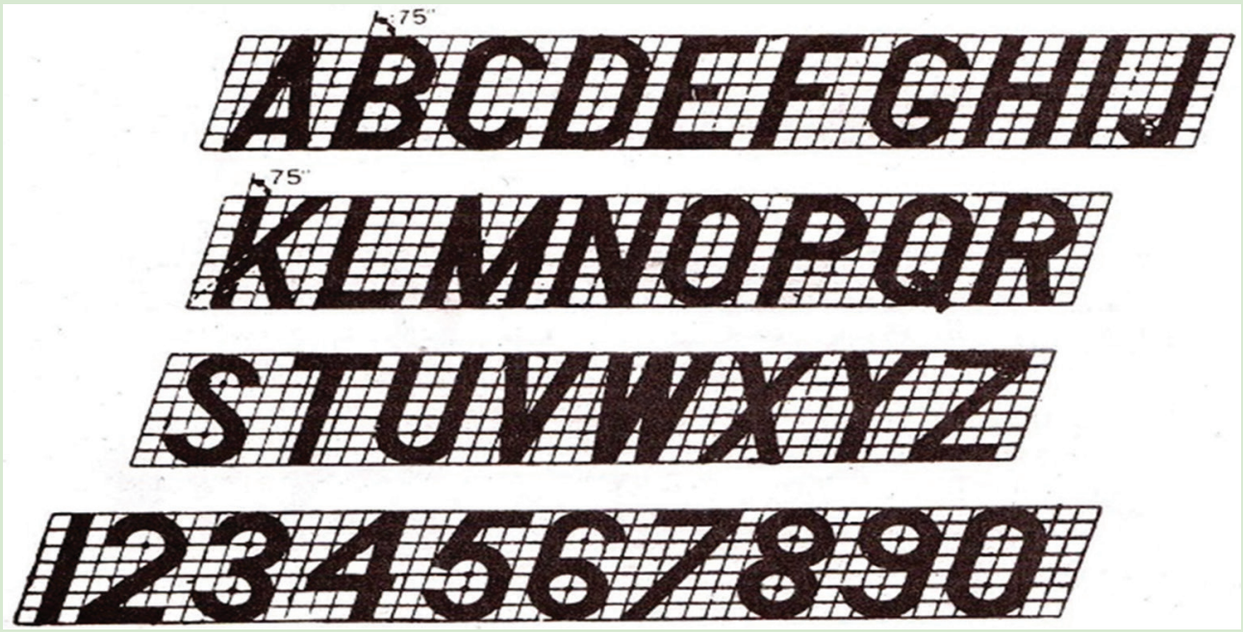
1 LETTERING, NUMBERING AND DIMENSIONING PRACTICE

(i) LETTERING AND NUMBERING



Vertical type



Inclined type

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ROUGH DRAWING

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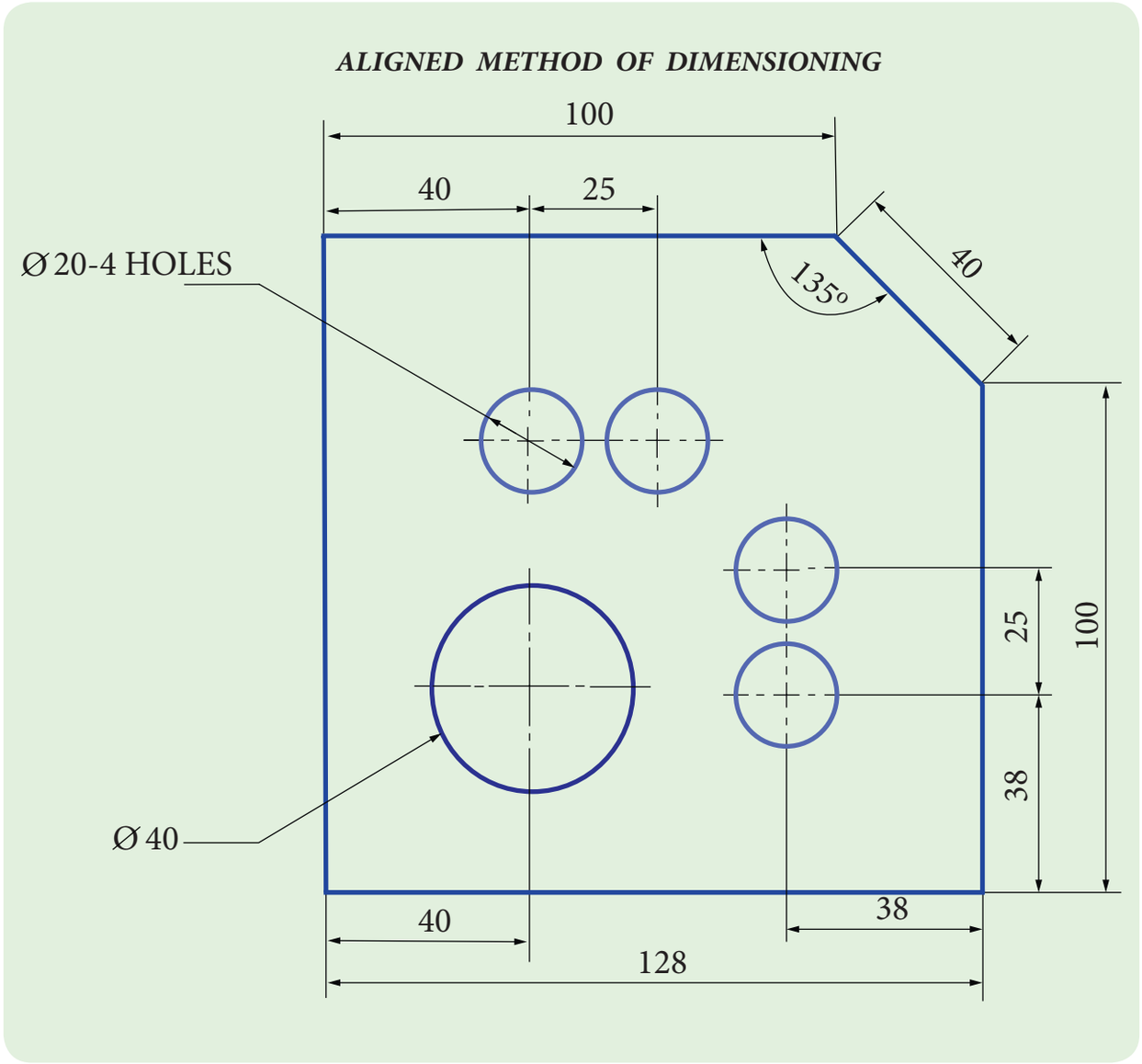
(ii) DIMENSIONING PRACTICE



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ROUGH DRAWING

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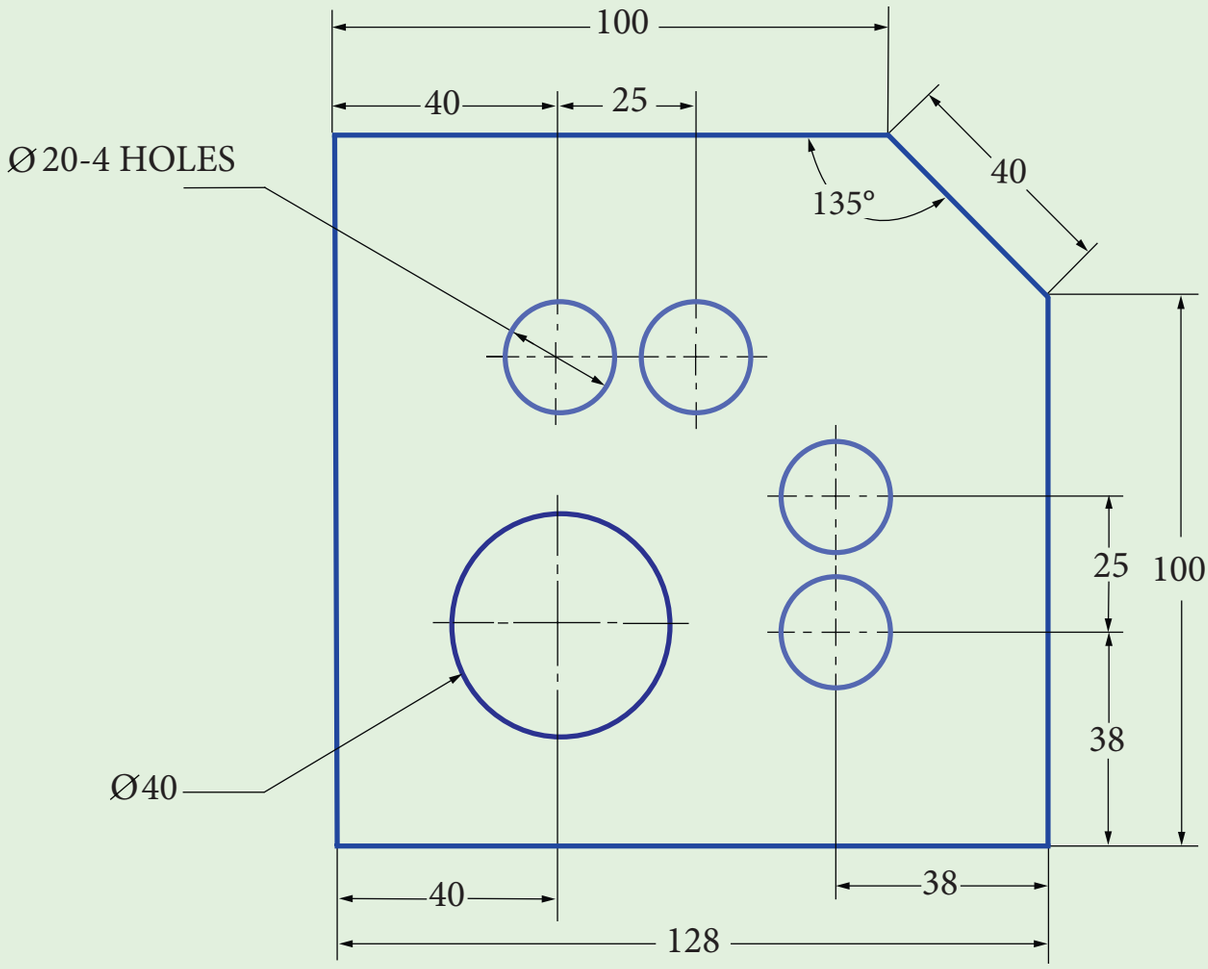
UNI-DIRECTIONAL METHOD OF DIMENSIONING



Note: All dimensions are in millimetres

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ROUGH DRAWING

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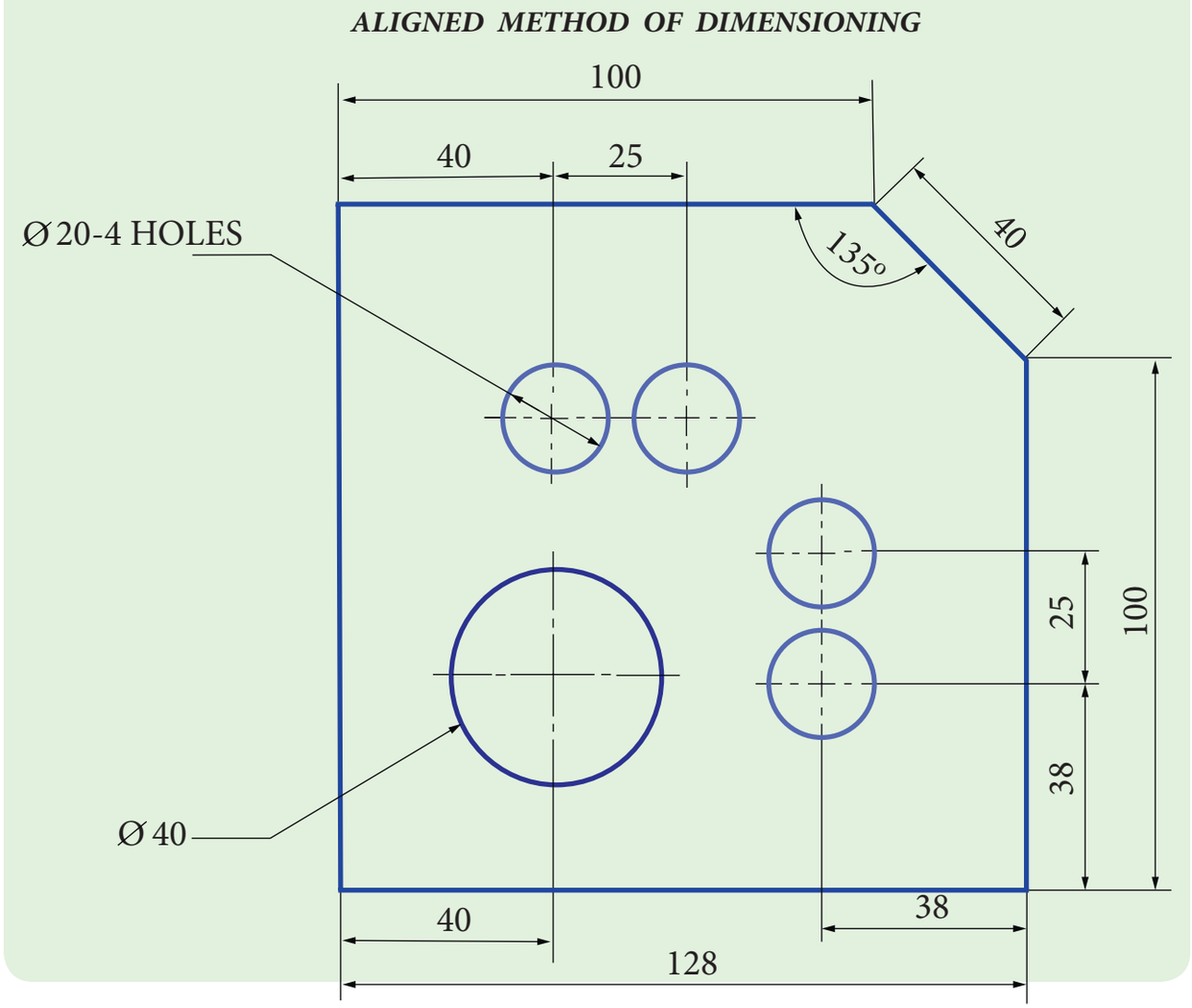
2 DIMENSIONING PRACTICE IN ALIGNED SYSTEM AND UNI-DIRECTIONAL SYSTEM USING AUTO CAD

DIMENSIONING PRACTICE





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COMMANDS

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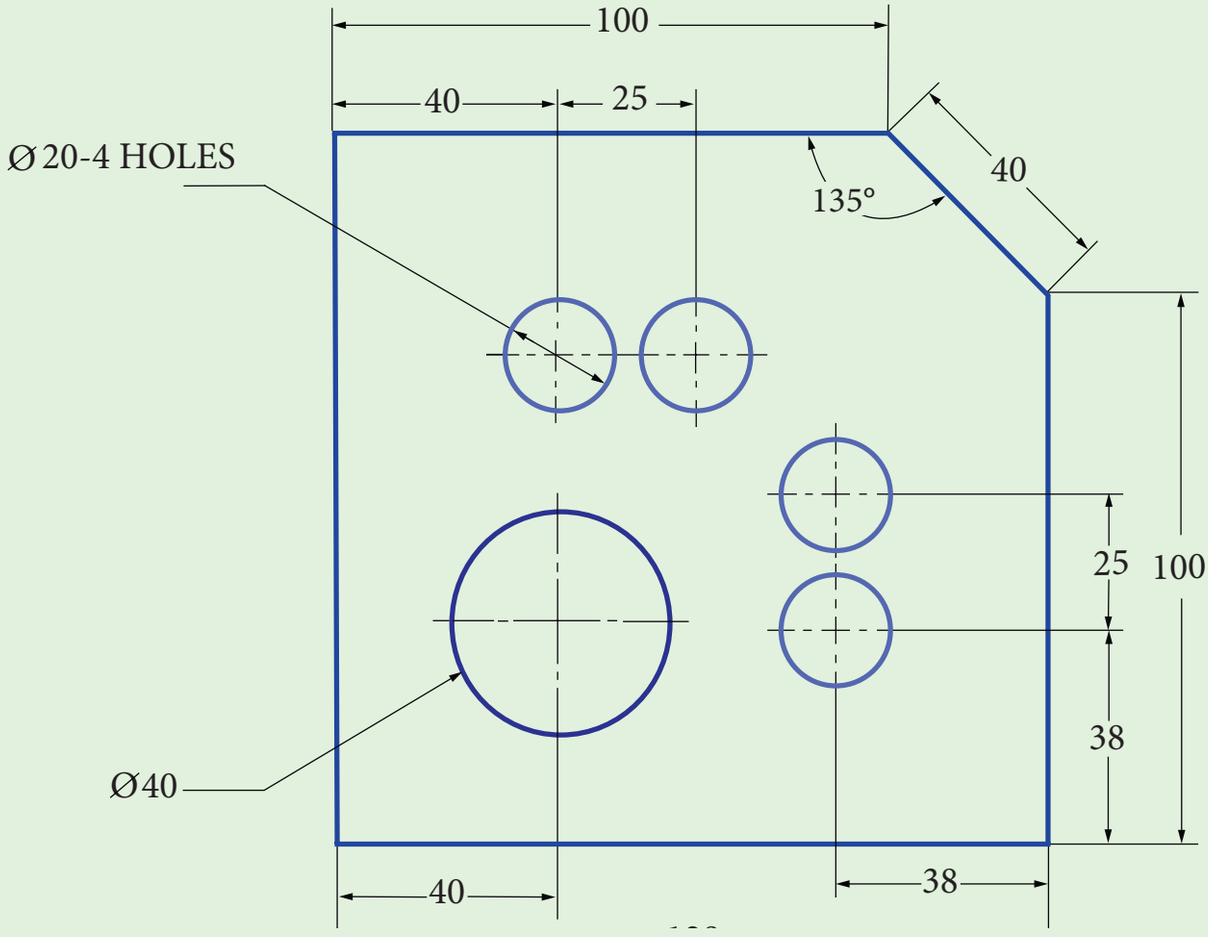
UNI-DIRECTIONAL METHOD OF DIMENSIONING



Note: All dimensions are in millimetres

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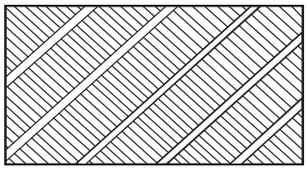
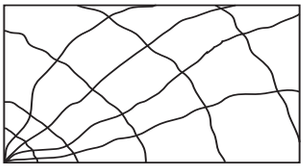
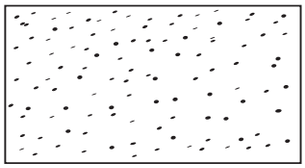
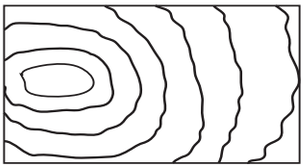
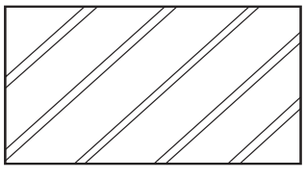
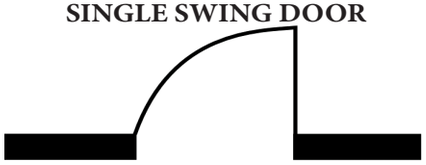
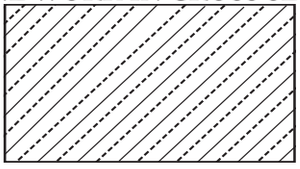
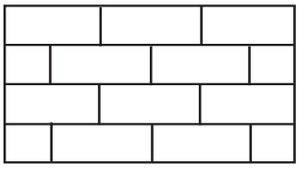
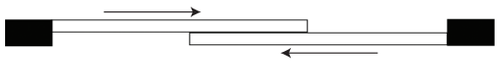
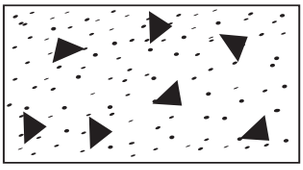
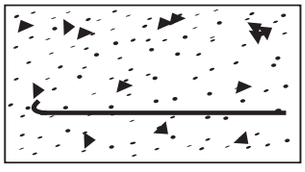
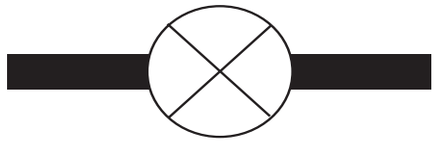
3 SYMBOLS FOR BUILDING MATERIALS AND DOORS

EARTH 	TIMBER IN CROSS SECTION 
SAND 	TIMBER IN LONGITUDINAL SECTION 
BRICK WORK IN CROSS SECTION 	SINGLE SWING DOOR  SINGLE LEAF
STONE WORK IN CROSS SECTION 	SINGLE SWING DOOR  DOUBLE LEAF
BRICK WORK IN ELEVATION 	SLIDING DOOR 
PLAIN CEMENT CONCRETE (PCC) 	ROLLING DOOR 
REINFORCED CEMENT CONCRETE (RCC) 	REVOLVING DOOR 

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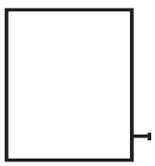
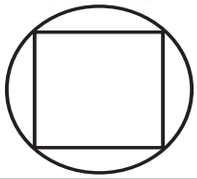
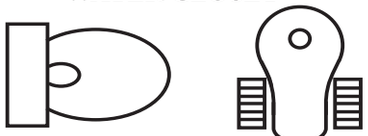
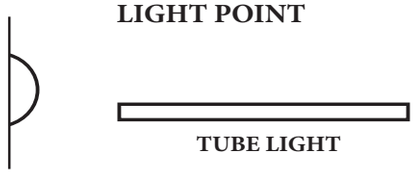
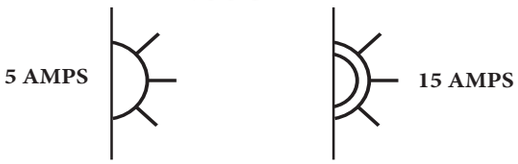
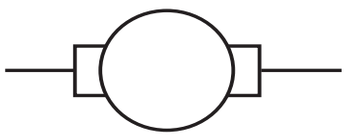
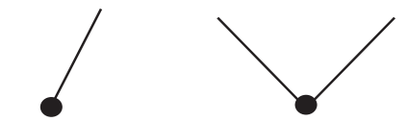
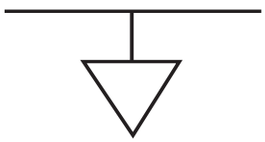
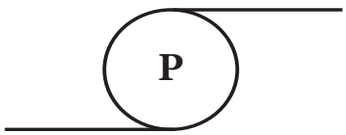
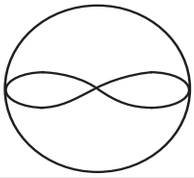
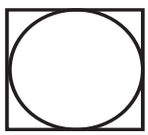
4 SYMBOLS FOR ELECTRICAL AND SANITARY FITTINGS

MAIN SWITCH 	EARTHING 
METER 	WATER CLOSET 
LIGHT POINT 	PLAIN KITCHEN SINK 
PIN SOCKET 	WATER METER (WM) 
SWITCH 	FIRE EXTINGUISHER(FE) 
CEILING FAN 	PUMP 
EXHAUST FAN 	RAIN WATER OUTLET (RWO) 

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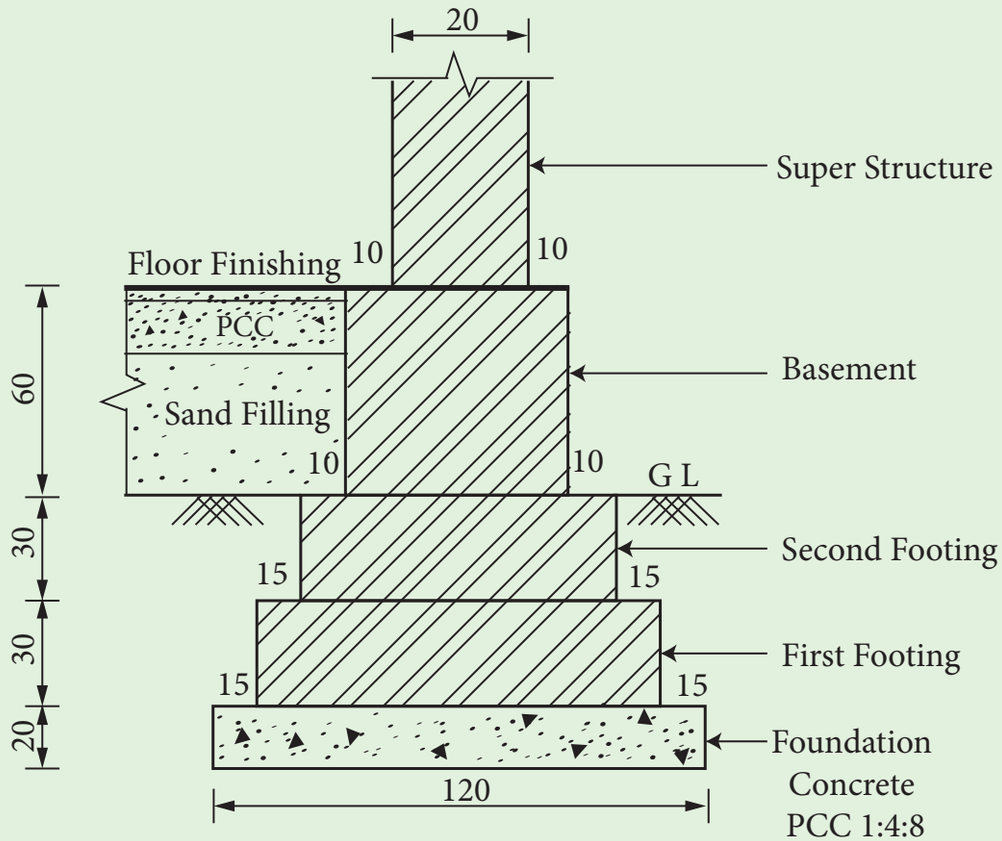
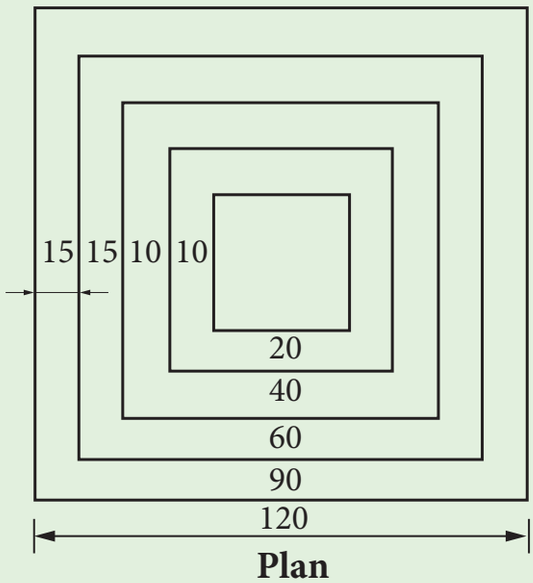
5 FOUNDATION - CROSS SECTION

(i) LOAD BEARING WALL FOUNDATION



Section



Plan

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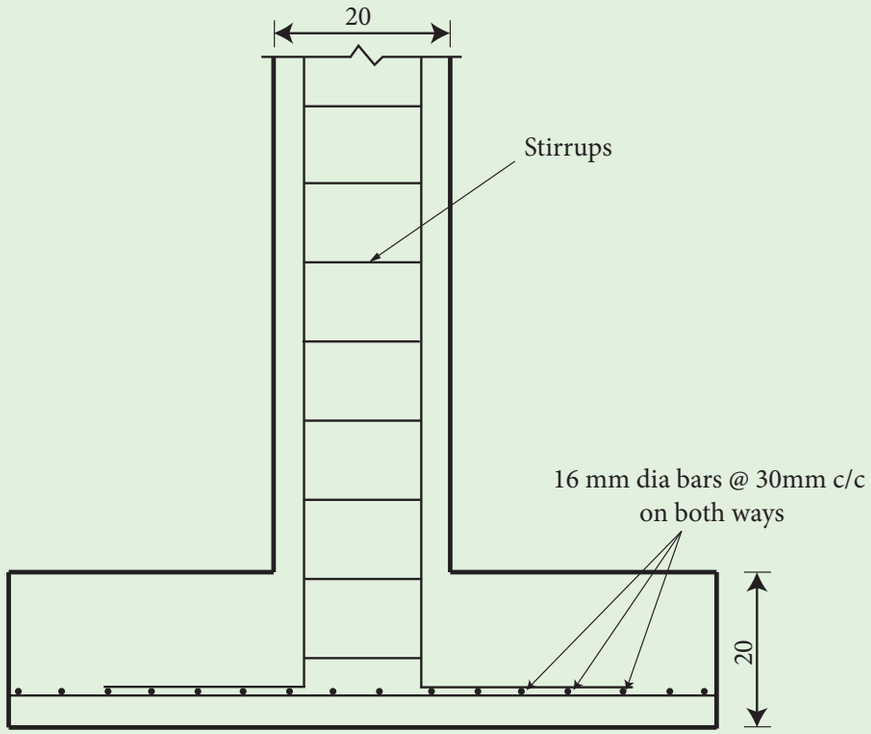
(ii) ISOLATED FOOTING



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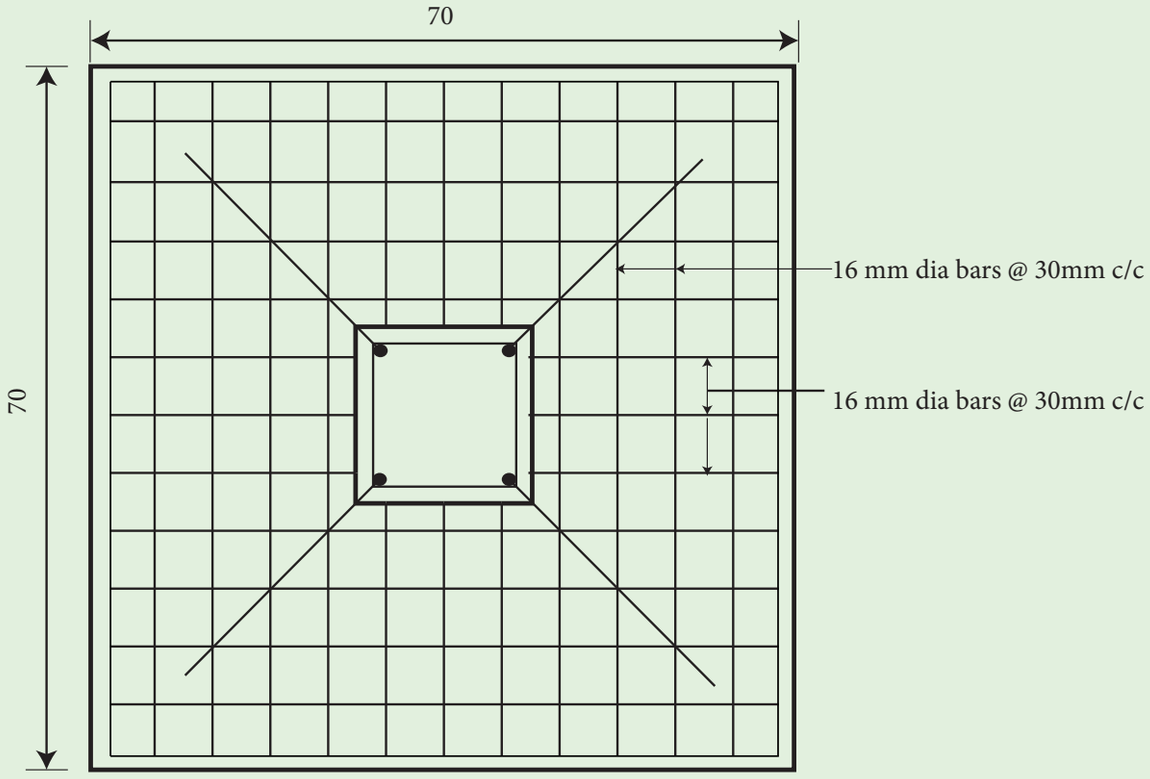

Plan Showing Arrangment of Reinforcement

Note: All dimensions are in centimetres.

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ROUGH DRAWING

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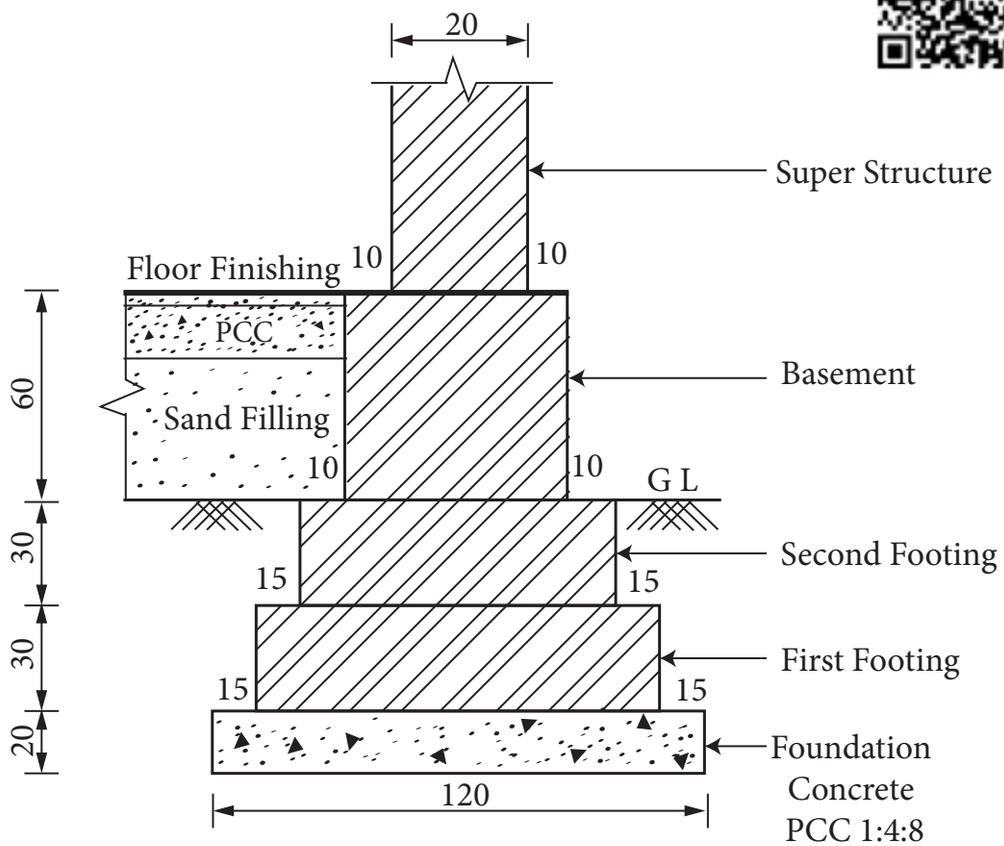
6 FOUNDATION - CROSS SECTION USING AUTO CAD

(i) LOAD BEARING WALL FOUNDATION



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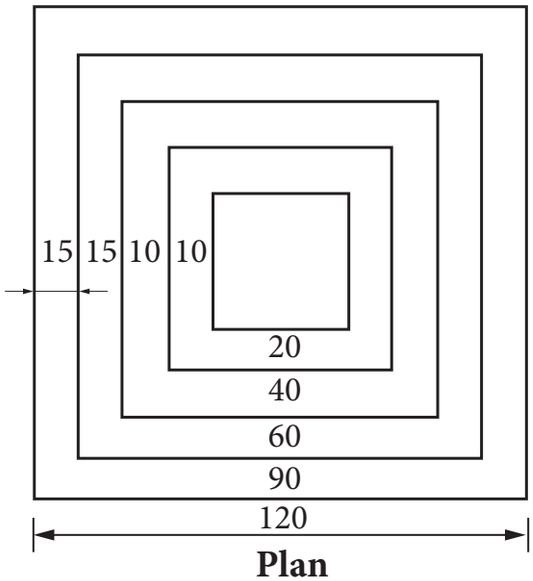

Plan

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COMMANDS

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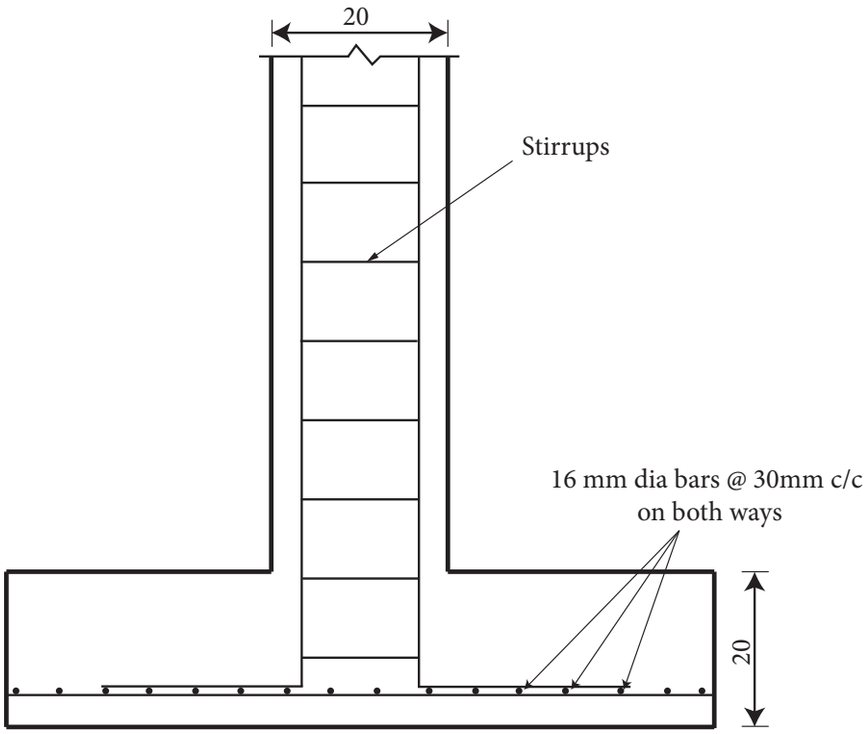
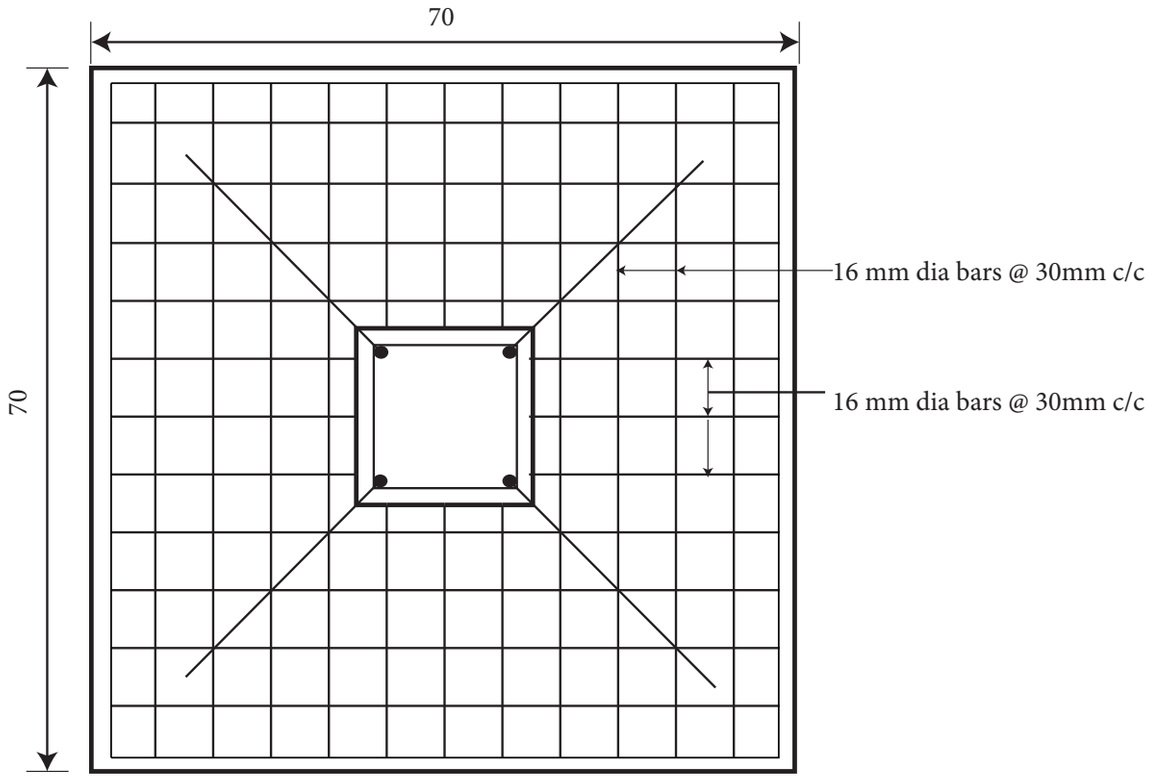
(ii) ISOLATED FOOTING



Section



Plan Showing Arrangment of Reinforcement

Note: All dimensions are in centimetres.

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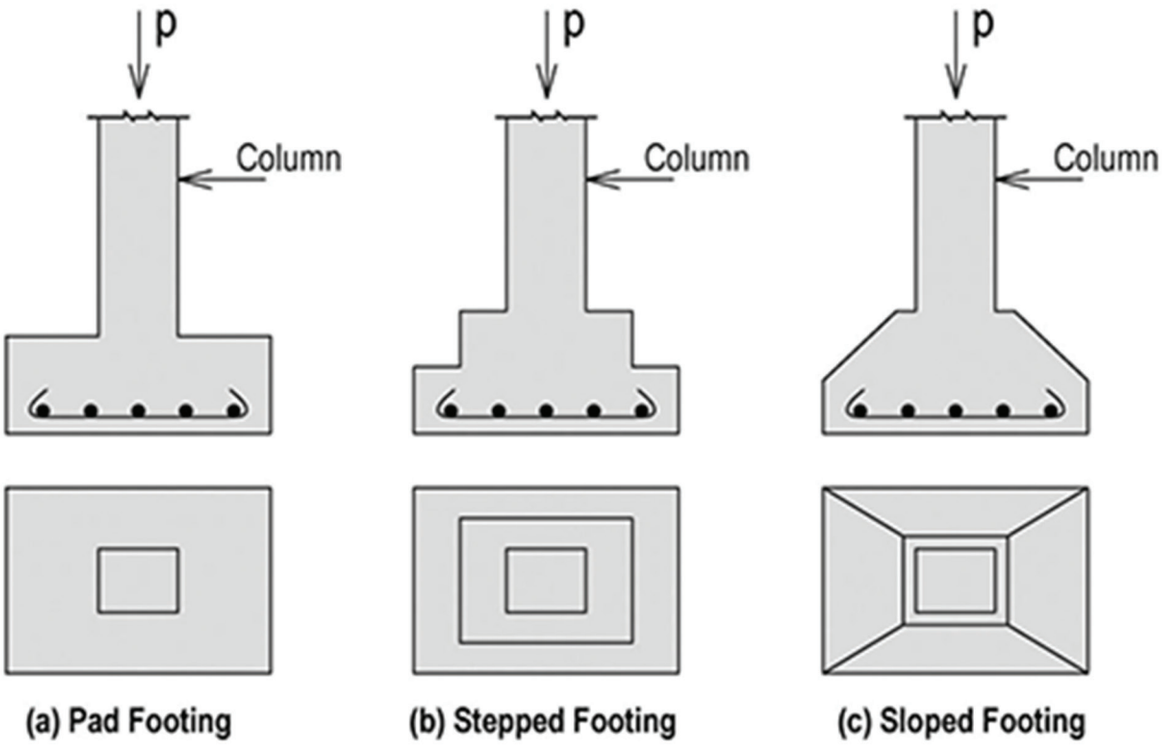

TYPES OF ISOLATED FOOTING

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Building Materials

7 DETERMINE THE NORMAL CONSISTENCY FOR THE GIVEN SAMPLE OF CEMENT

Aim

To find out the normal consistency value for the given sample of cement.

Apparatus and Materials Required



1. Vicat Apparatus
2. 10mm Dia Plunger
3. Mould
4. Non Porous Plate
5. Weighing Balance
6. Measuring Jar and Water
7. A Container
8. Trowel
9. Clock
10. Cement Sample (200 grams)

Procedure

1. Take 200 grams of cement.
2. Fix the plunger with the vicat apparatus and adjust the pointer to pointout zero on the vicat's scale when the plunger is placed above the non porous plate.
3. Add 20% of water [(20/100) × 200 = 40 ml] to the cement and prepare the paste.
4. Fill the prepared paste in the mould while the mould is placed above the non porous plate.
5. Bring the plunger just above the paste and allow it to penetrate the paste freely.
6. Note down weather the pointer points towards 5mm to 7mm on the vicat's scale.
7. If not, repeat the above steps by increasing the percentage of water upto which the pointer points 5mm to 7mm on the scale.
8. That is the percentage of normal consistency for that cement sample.

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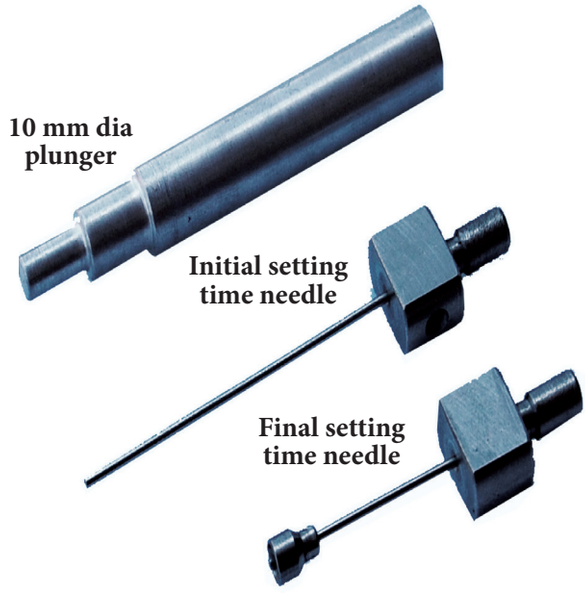
Vicat Apparatus



Tabulation

S.No	Percentage of Water	Amount of Water Added (ml)	Pointers Reading (mm)
1			
2			
3			
4			
5			

Result

The Normal consistency for the given cement sample is_____%

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8 DETERMINE THE INITIAL SETTING TIME FOR THE GIVEN SAMPLE OF CEMENT

Aim

To find out the initial setting time of given sample of cement.



Apparatus and Materials Required

1. Vicat Apparatus
2. Needle (1 sq mm in c/s)
3. Mould
4. Non Porous Plate
5. Weighing Balance
6. Measuring Jar and Water
7. A Container
8. Trowel
9. Clock
10. Cement Sample (200 grams)

Procedure

1. Take 200 grams of cement
2. Fix the needle for initial setting time with the apparatus and adjust the pointer to point zero in the vicat's scale when the needle is placed above the plate.
3. Add 0.85 times of normal consistency value of water with the cement. Note the time (T_1) of adding water and prepare the paste.

Wt. of cement sample	= 200 grams
Percentage of water added	= 0.85 × Normal consistency value
	=
	=

4. Fill the prepared paste in the mould while it is placed above the plate.
5. Bring the needle just above the paste and allow it to penetrate the paste freely.
6. Note the measurement on the scale.
7. In the beginning, it penetrates completely. It is then taken out and dropped at a new place after some time.
8. This procedure is repeated until the pointer points 5mm to 7mm in the vicat's scale.
9. Note the time (T_2). Subtract the time noted in point 3 from it (T_2-T_1).
10. That is the time of initial setting for that sample.

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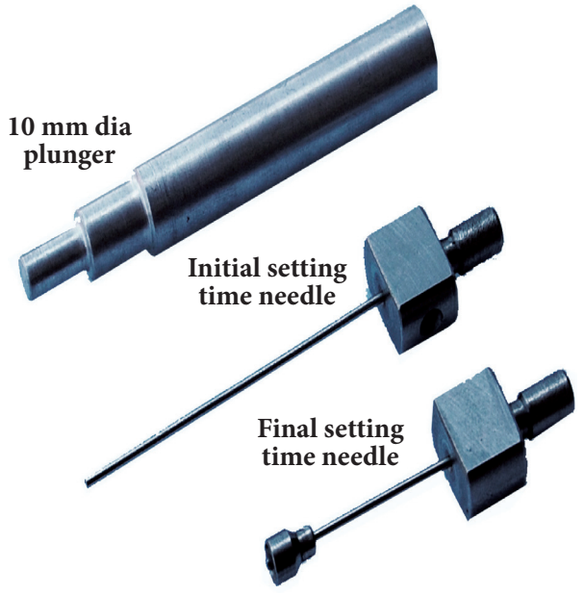
Vicat Apparatus



Tabulation

S.No	Time (Minutes)	Pointer's Reading (mm)
1		
2		
3		
4		
5		

Result

The initial setting time of the given cement sample is _____ minutes.

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9 DETERMINE THE FINENESS VALUE FOR THE GIVEN CEMENT SAMPLE

Aim

To find out the fineness value of the given sample of cement.

Materials and Apparatus Required

1. I.S. Sieve No. 9 (90 micron)
2. Weighing Balance
3. Trowel
4. Cement Sample (100 gms)

Procedure

1. 100 gms of cement is taken using weighing balance. Let it be 'W_1' gms.
2. The cement is placed in I.S. 90 micron sieve and the sieve is shaked for about 15 minutes.
3. The residue in the sieve is taken and weighed using weighing balance. Let it be 'W_2' gms.
4. The Fineness value of cement is worked out by using the formula.

$$\text{Fineness Value} = \frac{W_1 - W_2}{W_1} \times 100$$



I.S. Sieve no 9 (90 micron)

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Set of Sieves with Sieve Shaker

Note

The residue should not exceed 10% for ordinary Portland cement and 5% for rapid hardening cement.

Observation

Wt. of cement sample taken (W_1)=

Wt. of residue in the sieve (W_2) =

Fineness value $= \frac{W_1 - W_2}{W_1} \times 100$ =

=

Result

The Fineness value of the given cement sample is _____%

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10 DETERMINE THE VOIDS RATIO FOR THE GIVEN SAND SAMPLE

Aim

To determine the voids ratio for the given sand sample.

Definition

It is defined as the volume of voids to the volume of solids present in the soil. It has no units.

$$\text{Voids ratio 'e'} = \frac{\text{volume of voids}}{\text{volume of solids}} = \frac{V_v}{V_s} = \frac{V_g + V_w}{V_s}$$

Apparatus and Materials Required

1. Weighing Balance
2. Bucket
3. Sand
4. Water
5. 16mm dia, 600 mm length tamping rod

Procedure

1. Take a clean dry bucket and weigh it (W_1 grams).
2. Take about 1/3 rd bucket of clean sand and tamp it 25 times. Do the same twice to fill the bucket.
3. Weigh the bucket with sand (W_2 grams).
4. Now fill the bucket with sand, with water and weigh it (W_3 grams).
5. Empty the bucket, fill it with water and weigh it (W_4 grams).

Observation

1. Weight of the empty bucket (W_1 grams) =
2. Weight of the bucket + sand (W_2 grams) =
3. Weight of the bucket + sand + water (W_3 grams) =
4. Weight of the bucket + water (W_4 grams) =

$$\text{Voids ratio 'e'} = \frac{W_3 - W_2}{(W_4 - W_1) - (W_3 - W_2)} =$$

Where

V_v = Volume of voids
V_s = Volume of solids
V_g = Volume of air
V_w = Volume of water

Result

Voids ratio of the given sand sample is = _____

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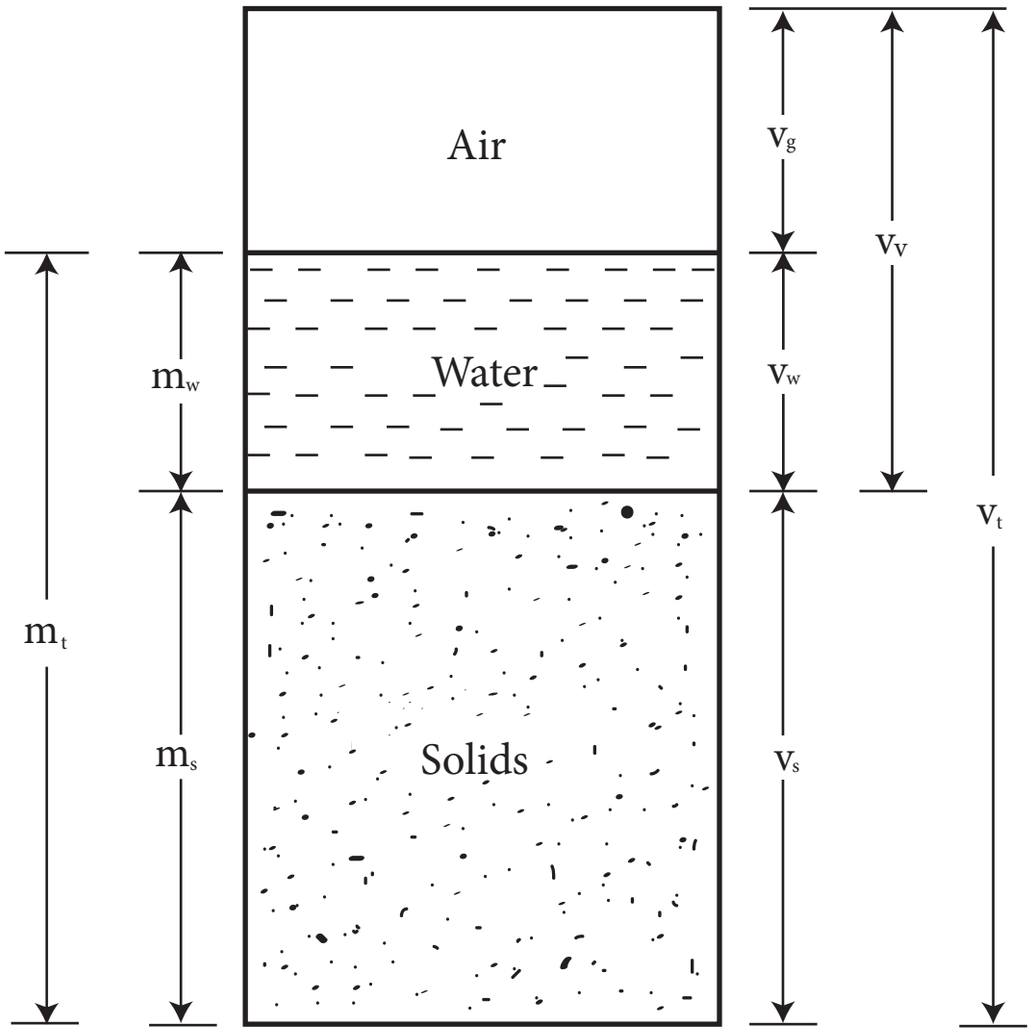
Bucket and Tamping Rod



Soil Phase Diagram

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11 DETERMINE THE POROSITY FOR THE GIVEN SAND SAMPLE

Aim

To determine the Porosity for the given sand sample.

Definition

Porosity of the sand is the ratio of volume of voids to the volume of given sand mass. It is mentioned in percentage.

$$\text{Porosity 'n'} = \frac{\text{volume of voids}}{\text{Total volume of sand}} \times 100$$



Apparatus and Materials Required

1. Weighing Balance
2. Bucket
3. Sand
4. Water
5. 16mm dia, 600mm length tamping rod

Procedure

1. Take a clean dry bucket and weigh it (W_1 grams).
2. Take about 1/3rd bucket of clean sand and tamp it 25 times. Do the same twice to fill the bucket.
3. Weigh the bucket with sand (W_2 grams).
4. Now fill the bucket with sand, with water and weigh it (W_3 grams).
5. Now empty the bucket, fill it with water and weigh it (W_4 grams).

Observation

1. Weight of the empty bucket (W_1 grams). =
2. Weight of the bucket + sand (W_2 grams). =
3. Weight of the bucket + sand + water (W_3 grams). =
4. Weight of the bucket + water (W_4 grams). =

$$\text{Porosity 'n'} = \frac{(W_3 - W_2)}{(W_4 - W_1)} \times 100 \quad =$$

Where

V_v = Volume of voids
V_s = Volume of solids
V_g = Volume of air
V_w = Volume of water

Result

Porosity of the given sand sample is ____%

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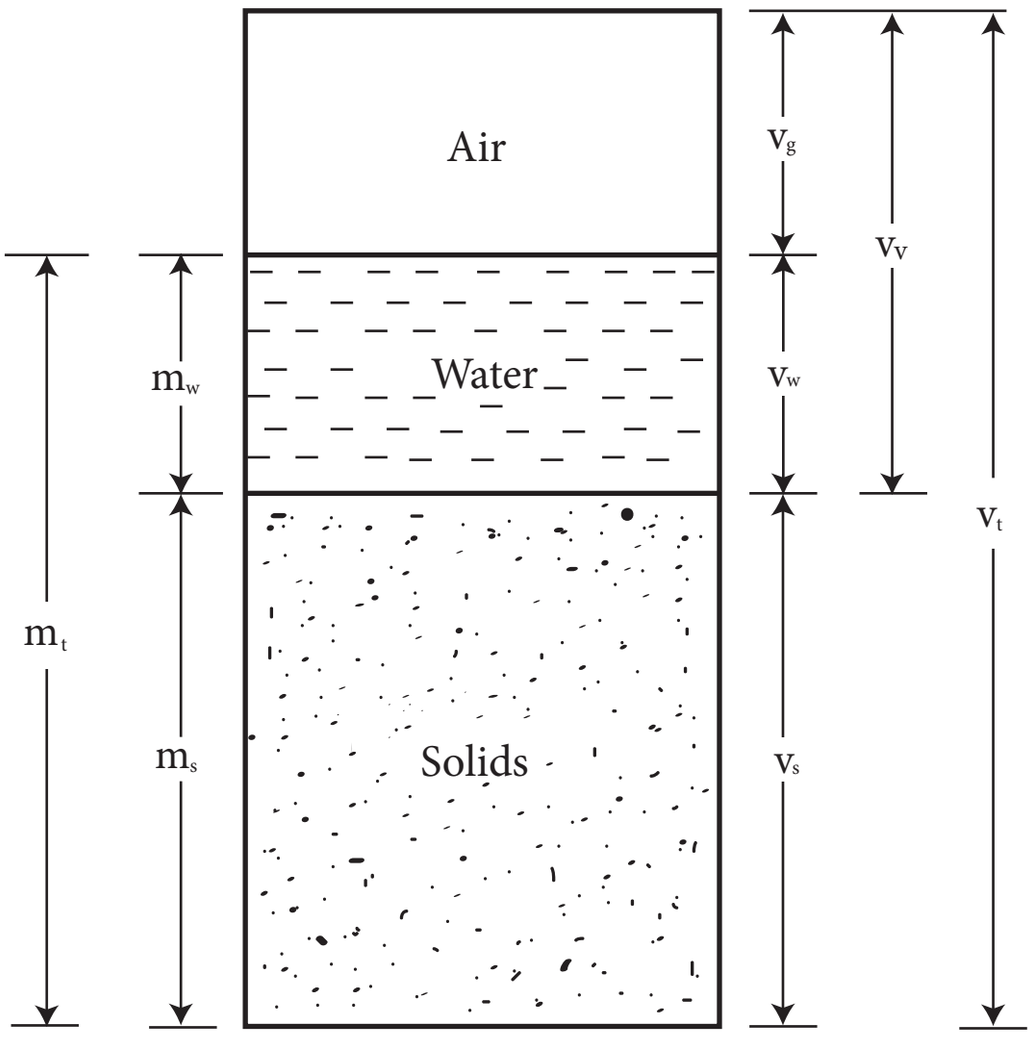
Bucket and Tamping Rod



Soil Phase Diagram

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12 DETERMINE THE BULK DENSITY FOR THE GIVEN SAND SAMPLE

Aim

To determine the Bulk Density of the given sand sample.

Definition

Bulk density of the sand is the ratio between the weight of sand and its volume. (Unit = gram/ cc)

$$\text{Bulk Density 'Y'} = \frac{\text{Weight of sand}}{\text{Volume of sand}}$$

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Apparatus and Materials Required

1. Weighing Balance
2. Bucket
3. Sand
4. Water
5. 16mm dia, 600mm length tamping rod

Procedure

1. Take a clean dry bucket and weigh it. (W_1 grams).
2. Take about 1/3rd bucket of clean sand and tamp it 25 times. Do the same twice to fill the bucket.
3. Weigh the bucket with sand. (W_2 grams).
4. Now fill the bucket with sand, with water and weigh it. (W_3 grams).
5. Now empty the bucket, fill it with water and weigh it. (W_4 grams).

Observation

1. Weight of the empty bucket (W_1 grams) =
2. Weight of the bucket + sand (W_2 grams) =
3. Weight of the bucket + sand + water (W_3 grams) =
4. Weight of the bucket + water (W_4 grams) =

$$\text{Bulk density 'Y'} = \frac{W_2 - W_1}{W_4 - W_1} =$$

Where

V_v = Volume of voids
V_s = Volume of solids
V_g = Volume of air
V_w = Volume of water

Result

Bulk density of the given sand sample is = _____ g/cc

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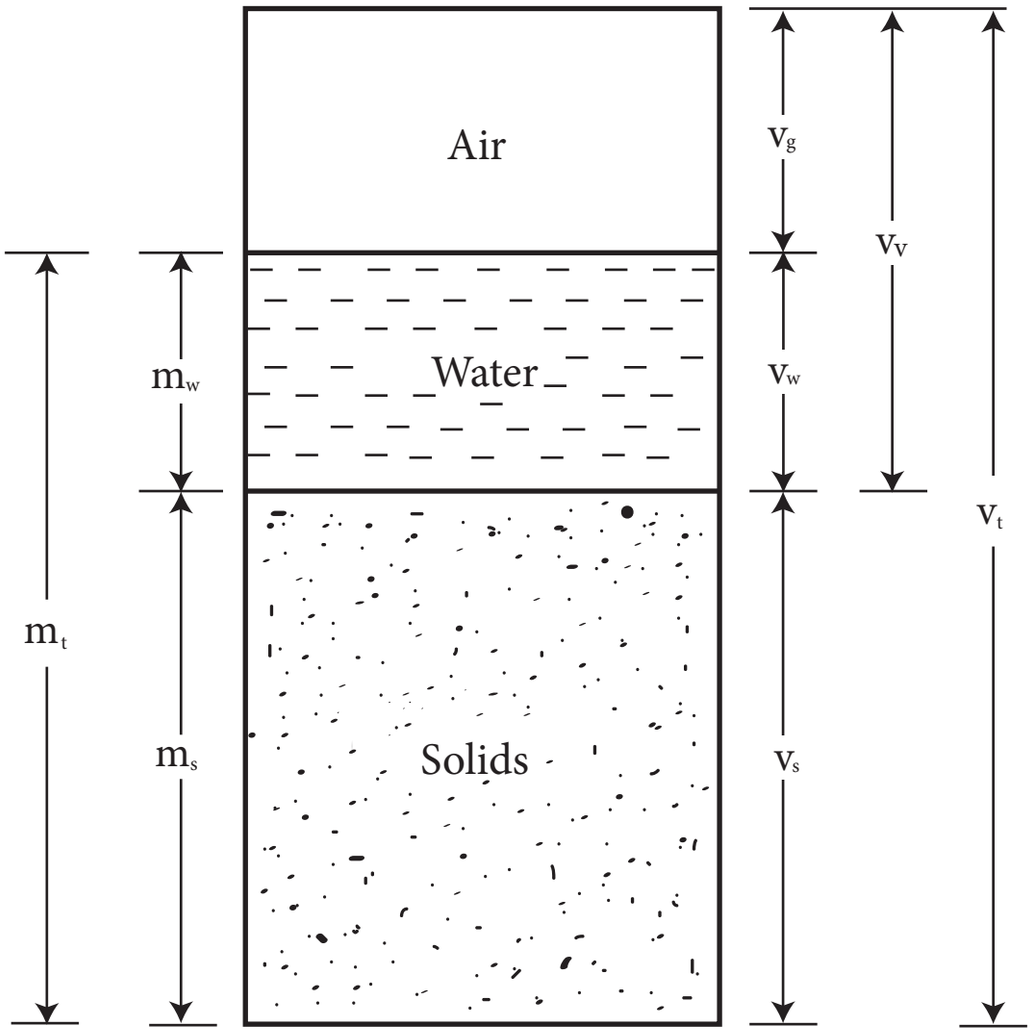
Bucket and Tamping Rod



Soil Phase Diagram

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Building Construction

13 SETTING OUT OF FOUNDATION FOR SINGLE ROOM BUILDING

Aim:

To mark the center line of a building for excavation of foundation.

Apparatus and Materials required

1. Measuring Tape
2. Tri Square
3. Bundle of String
4. Hammer
5. Pegs
6. Lime Powder

Procedure

1. All the vegetations in the construction site are removed and levelled.
2. Study thoroughly the plan of building. For example, take the inner measurements of a room as 4.80 × 3.30m.
3. Prepare the centre line sketch for that plan.
4. The wall thickness of the building is 0.20m, so the centre line distance of the room is 5.00 × 3.50m.
5. Mark the center line of front wall 1 & 2. Tie a string tightly in it.
6. Mark the center line distance of the front wall in it and name it as 'A' and 'B'.
7. Set out a perpendicular line from 'B'. Extend the ends and name it as 3 and 4. Tie a string in it also.
8. Mark the point 'C' as per centre line sketch in it.
9. Continue the same procedure until it reaches point 'A'.
10. Now, we can get a rectangle bounded by strings.
11. The diagonals 'AC' and 'BD' should be checked for the correctness. (AC = BD).
12. Mark the half of the width of the foundation on either side of the centre line using lime powder.

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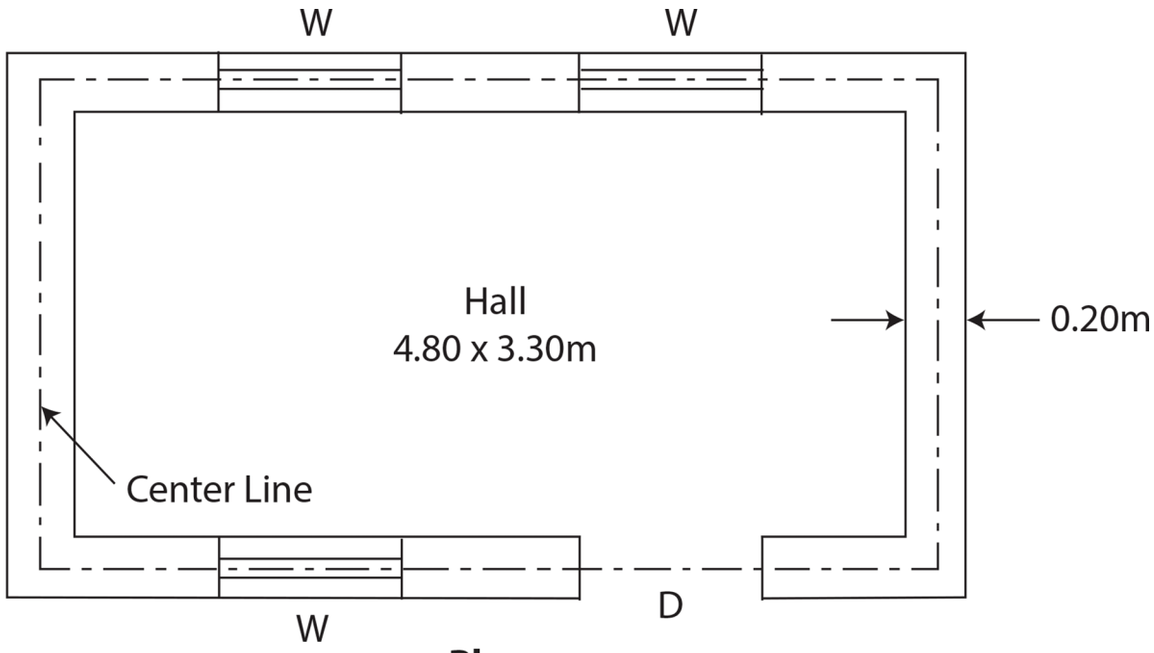
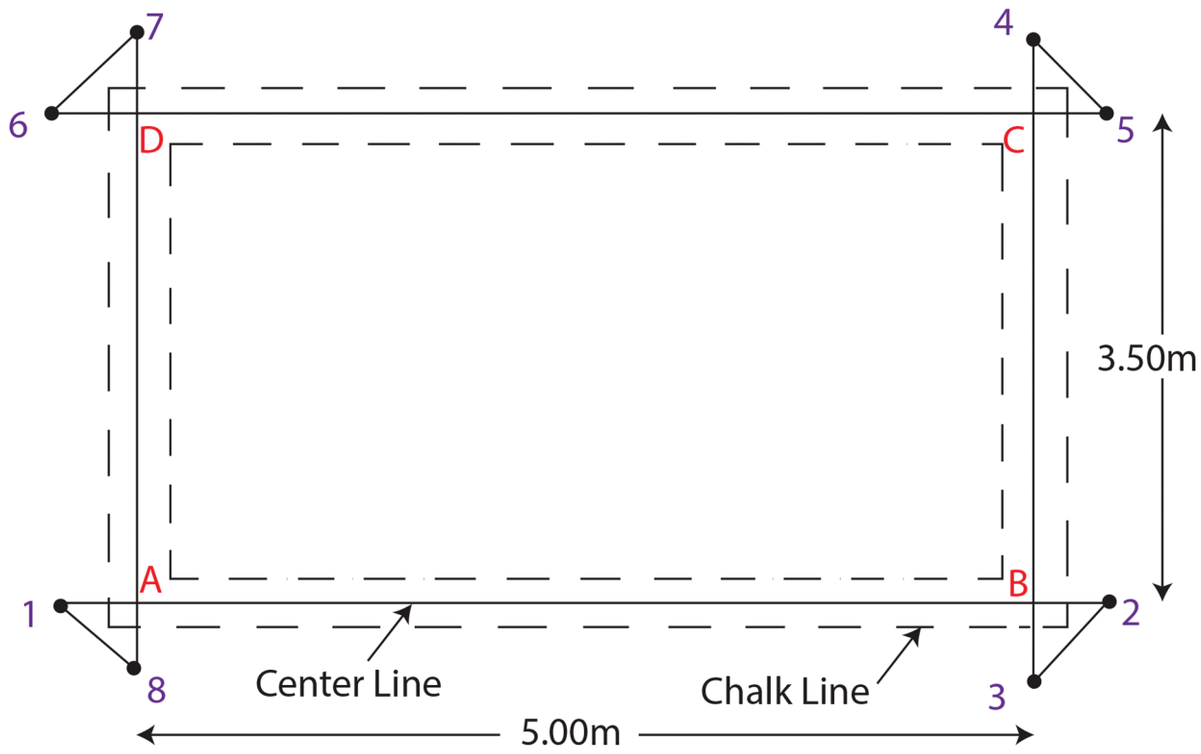


Plan



Marking Plan

Result

Thus a building is set out at site for excavation.

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14 CONSTRUCT A BRICK MASONRY (ONE BRICK THICKNESS) IN ENGLISH BOND

Aim

To know the arrangement of bricks for 200 mm wall thickness at right angled corner in English bond.



Tools and Materials Required

1. Bricks
2. Mortar
3. Trowel
4. Straight Edge
5. Plumb Bob
6. Sprit Level
7. Manson's Square

Procedure

Features of English bond

1. It consists of headers and stretchers in alternate course .
2. A queen closer is placed next to the quoin header in each course to the full thickness of the wall to create bond.
3. If the wall thickness is in multiples of full bricks , the same course will show either headers (or) stretchers on face and back.
4. If the wall thickness is in multiples of odd number of half bricks, the same course will show headers on the face and stretches on the back (or) stretchers on face and headers on the back.
5. Continuous vertical joints are avoide in this bond.

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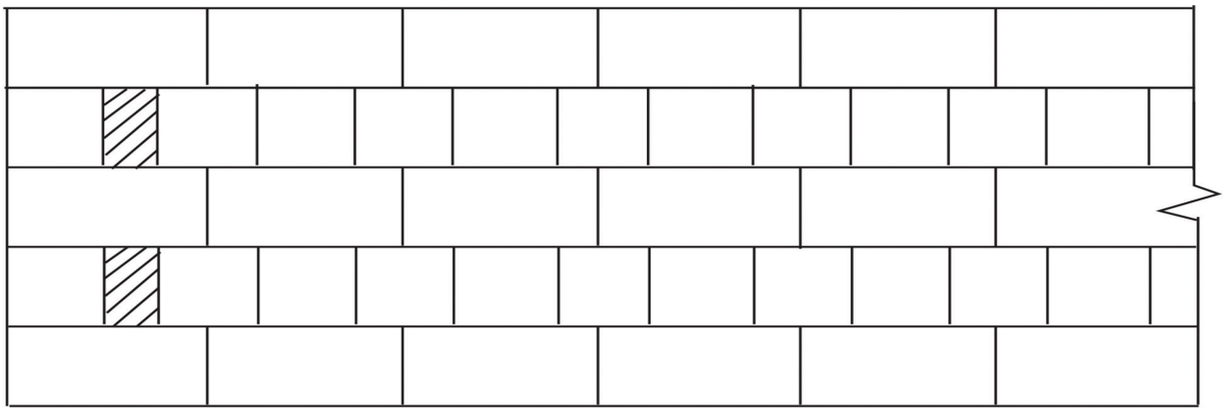
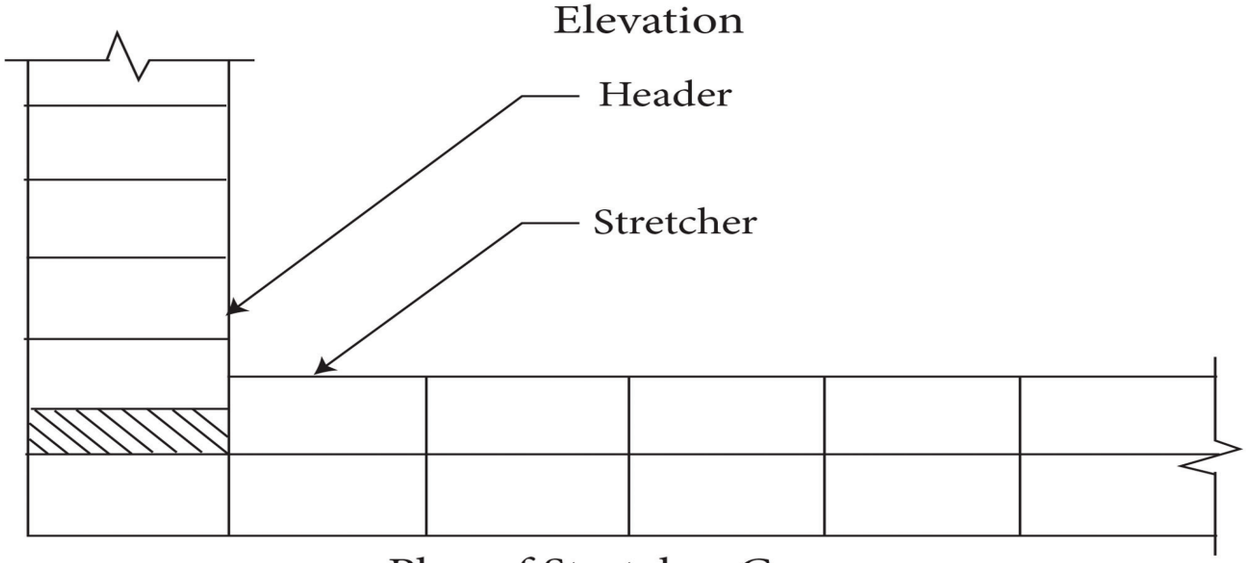
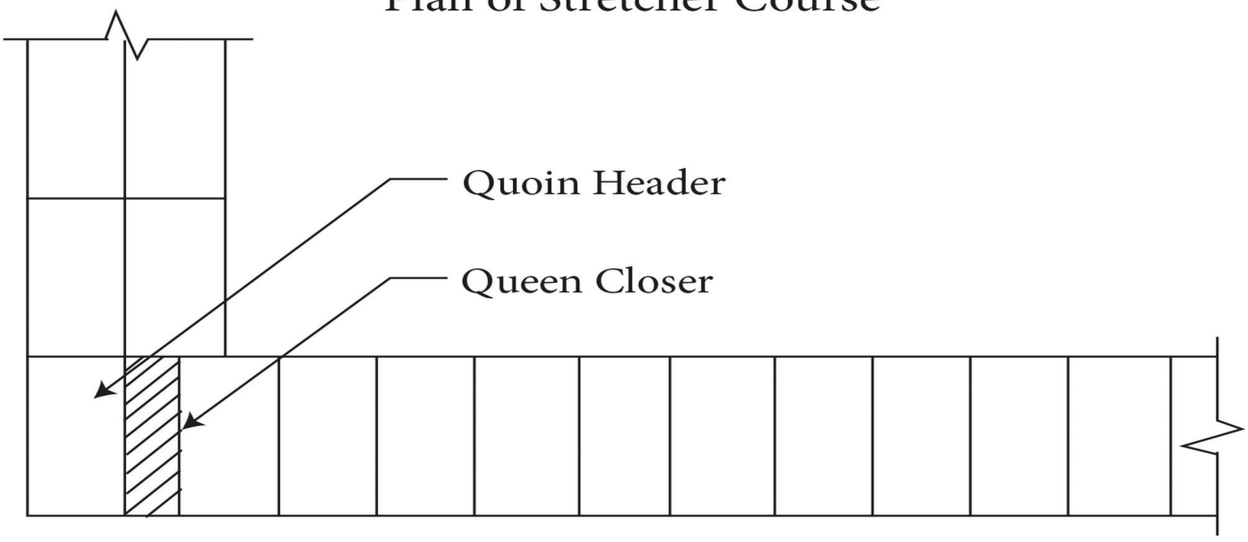
ENGLISH BOND - ONE BRICK WALL



Elevation



Plan of Stretcher Course



Plan of Header Course

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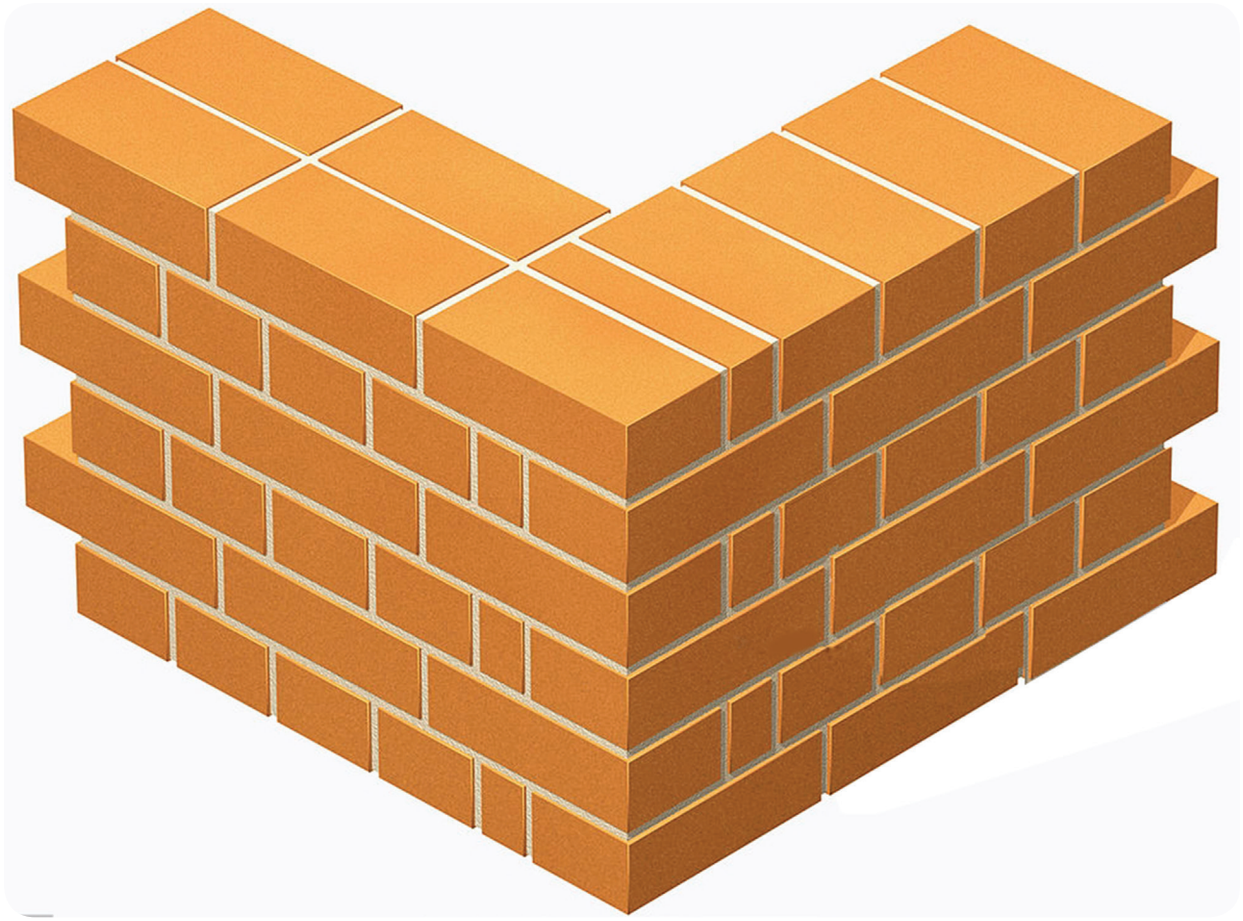

ISOMETRIC VIEW OF ENGLISH BOND

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15 CONSTRUCT A BRICK MASONRY (ONE BRICK THICKNESS) IN FLEMISH BOND

Aim

To know the arrangement of bricks for 200 mm wall thickness at right angled corner in Flemish bond.

Tools and Materials Required

1. Bricks
2. Mortar
3. Trowel
4. Straight Edge
5. Plumb Bob
6. Sprit Level
7. Manson's Square

Procedure

Features of Flemish bond

1. It consists of headers and stretchers alternately in every course .
2. A queen closer is placed next to the quoin header in alternate course to create bond.
3. If the wall thickness is in multiples of odd number of half bricks ,more brick bats are to be used.
4. This bond has lesser strength when compared with English Bond.
5. There may be a chance for occurring continuous vertical joints in this bond.
6. The appearance of this bond is good.

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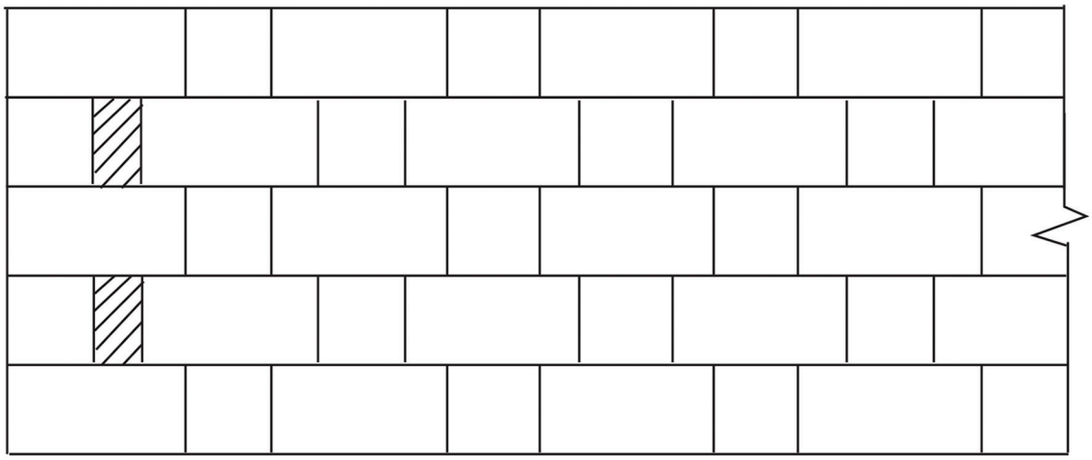
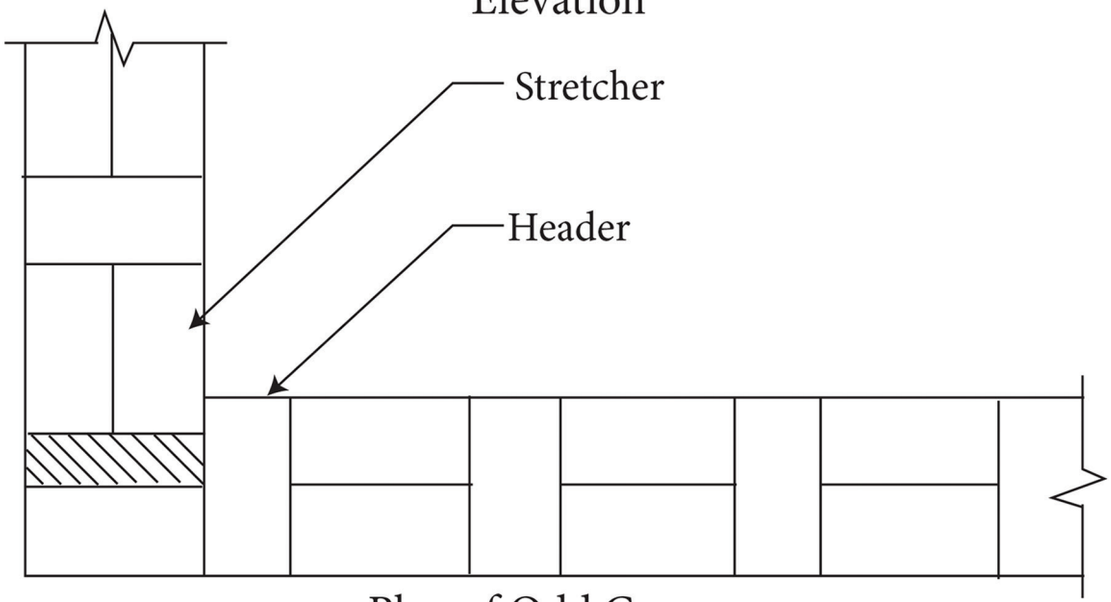
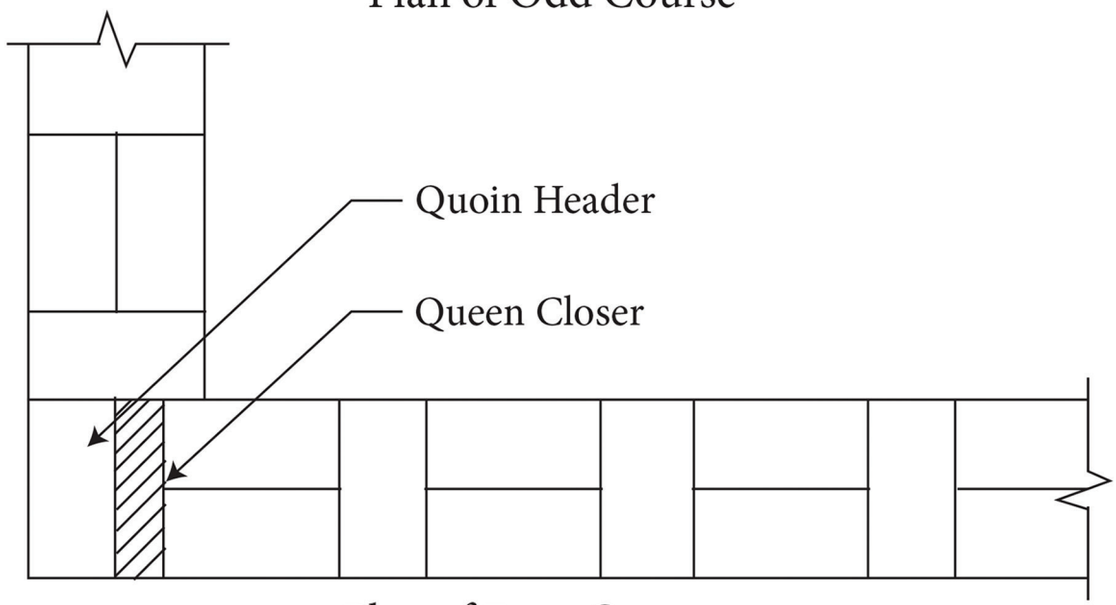
FLEMISH BOND - ONE BRICK WALL



Elevation



Plan of Odd Course



Plan of Even Course

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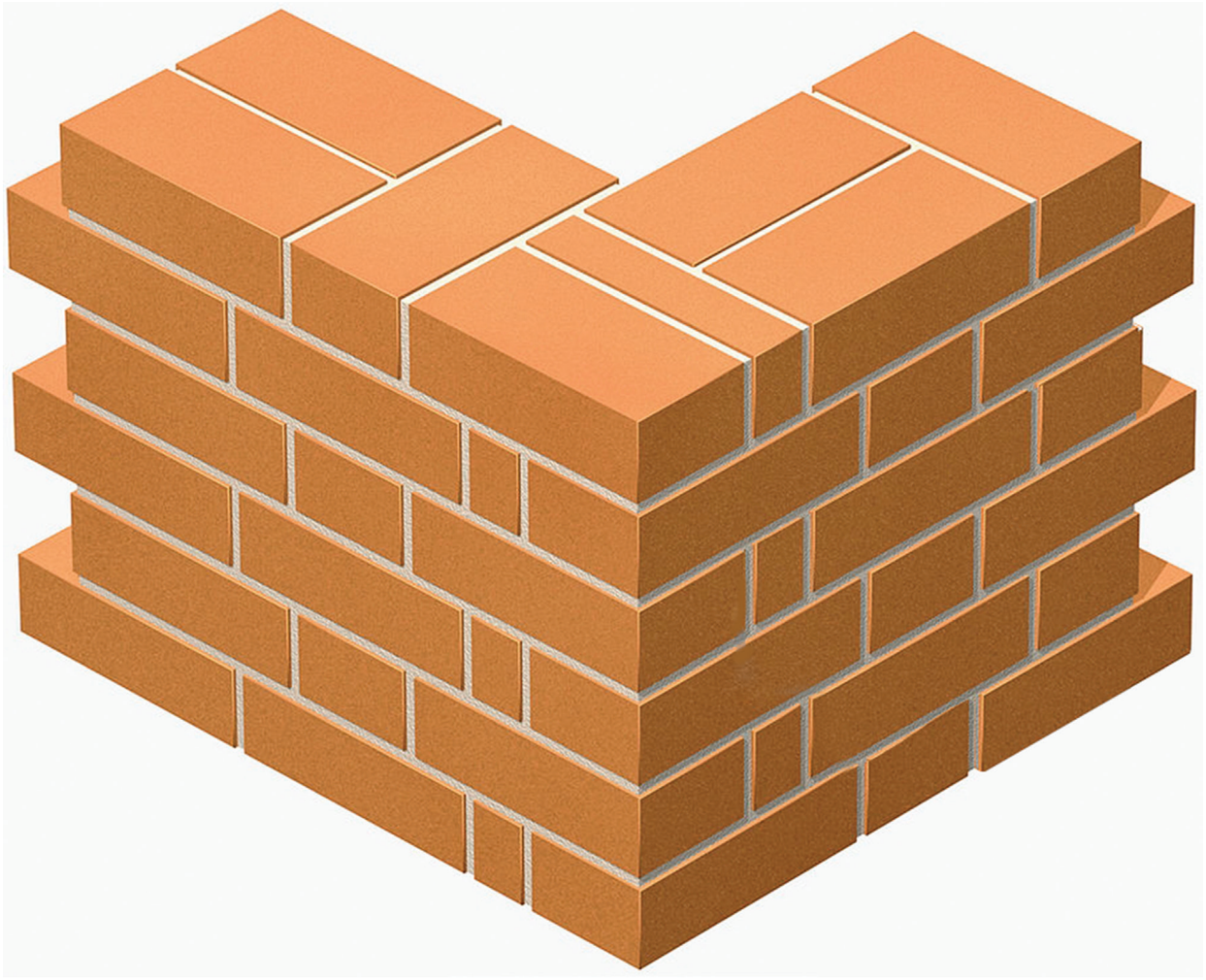

ISOMETRIC VIEW OF FLEMISH BOND

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