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PREFACE

The problem faced today in the learning and teaching of engineering drawing for Environmental Health Sciences students in universities, colleges, health institutions, training of health center emanates primarily from the unavailability of text books that focus on the needs and scope of Ethiopian environmental students.

This lecture note has been prepared with the primary aim of alleviating the problems encountered in the teaching of *Engineering Drawing* course and in minimizing discrepancies prevailing among the different teaching and training health institutions. It can also be used as a reference material for professional sanitarians.

The graphics of engineering design and construction may very well be the most important course of all studies for an engineering or technical career. The indisputable reason why graphics or drawing is so extremely important is that it is the language of the designer, technician, sanitarian, and engineer, used to communicate designs and construction details to others. The language of graphics is written in the form of drawings that represent the shape, size, and specifications of physical objects. The language is read by interpreting drawings so that physical objects can be constructed exactly as originally conceived by the designer.

Acknowledgement

We are delighted to express our thanks to the carter center for the financial, material and moral support with out which this material wouldn’t come to reality.

We are also glad to extend our heart felt appreciation for Ato Esayas Alemayehu, Ato Muluken Eyayu, Ato Wossen Tafere and Ato Dagnew Engidaw for their critical and constructive comments that are found to be highly essential for this lecture note preparation.

We are very happy to be members of the faculty of health sciences, Alemaya university for the fact that working with such faculty are really incomparable.

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CHAPTER ONE

INTRODUCTION TO GRAPHIC COMMUNICATION

Objectives:

At the end of this chapter students should be able to:

- Define graphic communication
- Mention types of drawing
- Explain the difference between different types of drawings
- Mention some of the applications of technical drawings

1.1 Drawing

A drawing is a graphic representation of an object, or a part of it, and is the result of creative thought by an engineer or technician. When one person sketches a rough map in giving direction to another, this is graphic communication. Graphic communication involves using visual materials to relate ideas. Drawings, photographs, slides, transparencies, and sketches are all forms of graphic communication. Any medium that uses a graphic image to aid in conveying a message, instructions, or an idea is involved in graphic communication.

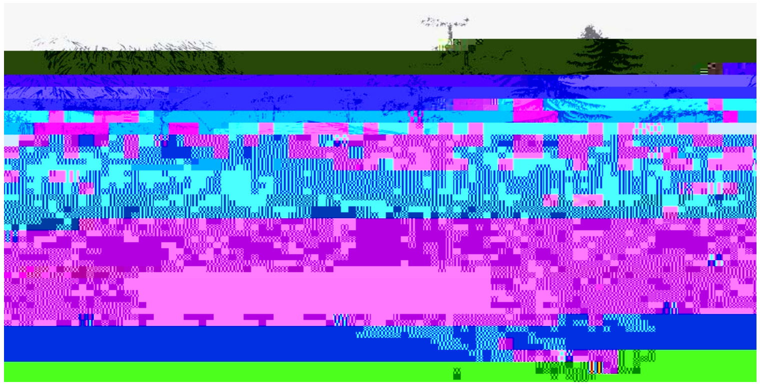


Figure 1.1 Artistic drawings

(Source: Goetsch, Technical drawing 3rd

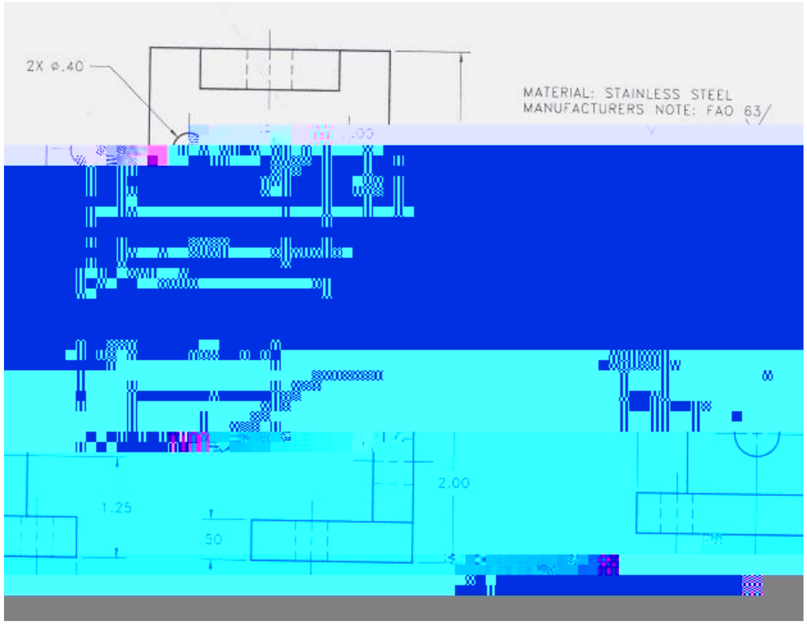


Figure 1.2 Technical Drawings

A. Types of Technical Drawings

Technical drawings are based on the fundamental principles of projections. A *projection* is a drawing or representation of an entity on an imaginary plane or planes. This projection planes serves the same purpose in technical drawing as is served by the movie screen. A projection involves four components

1. The actual object that the drawing or projection represents

2. The eye of the viewer looking at the object
3. The imaginary projection plane
4. Imaginary lines of sight called *Projectors*

The two broad types of projections, both with several sub-classifications, are parallel projection and perspective projection.

Parallel Projection

Parallel Projection is a type of projection where the line of sight or projectors are parallel and are perpendicular to the picture planes. It is subdivided in to the following three categories: *Orthographic, Oblique and Axonometric Projections.*

- *Orthographic projections*: are drawn as multi view drawings, which show flat representations of principal views of the subject.
- *Oblique Projections:* actually show the full size of one view.
- *Axonometric Projections:* are three-dimensional drawings, and are of three different varieties: *Isometric, Dimetric and Trimetric.*

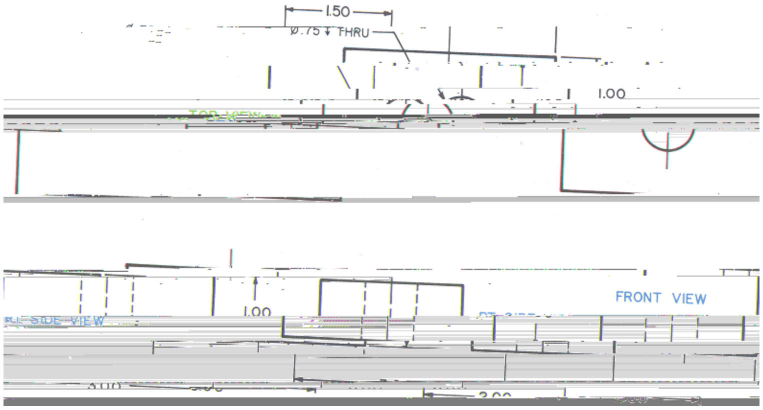


Figure 1.3 Orthographic multi view drawing

Figure 1.4 Oblique drawing

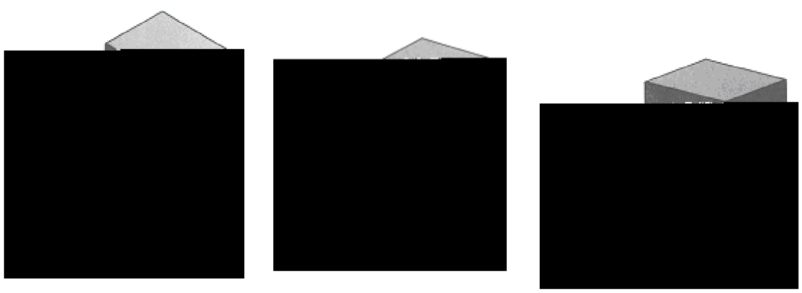


Figure 1.5 Axonometric drawing

Perspective Projection

Perspective projections are drawings which attempt to replicate what the human eye actually sees when it views an object. There are three types of perspective projections: *One-point, Two-point and Three-point Projections.*

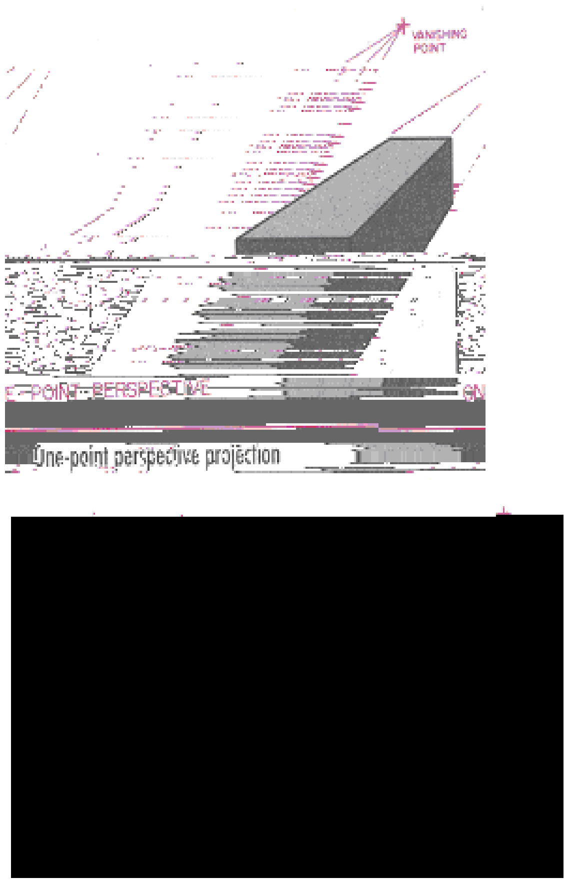


Figure 1.6 Perspective drawing

B. Purpose of Technical Drawings

To appreciate the need for technical drawings, one must understand the design process. The design process is an orderly, systematic procedure used in accomplishing a needed design.

Any product that is to be manufactured, fabricated, assembled, constructed, built, or subjected to any other types of conversion process must first be designed. For example, a house must be designed before it can be built.

C. Application of Technical Drawing

Technical drawings are used in many different applications. They are needed in any setting, which involves design, and in any subsequent forms of conversion process. The most common applications of technical drawings can be found in the fields of manufacturing, engineering and construction.

For instance, Surveyors, civil engineers, sanitarians use technical drawings to document such works as the layout of a new subdivisions, or the marking of the boundaries for a piece of property. Contractors and construction personnel use technical drawings as their blue prints in converting architectural and engineering designs in to reality.

Review questions

1. Discuss the different types of drawing
2. Explain the different application of technical drawing
3. What is graphic communication?

CHAPTER TWO

DRAWING EQUIPMENTS AND THEIR USE

Objectives:

At the end of this chapter students should be able to:

- List the main drawing equipments
- Discuss the use of different drawing equipments

2.1 Introduction

To record information on paper instruments and equipments are needed. Engineering drawing is entirely a graphic language hence instruments are essentially needed. Drawing must be clear, neat and legible in order to serve its purpose. Hence it is extremely important for engineers to have good speed, accuracy, legibility and neatness in the drawing work.

2.2 Important Drawing Equipments

All drawings are made by means of various instruments. The quality of drawing depends to a large extent on the quality, adjustment and care of the instruments.

i. Drawing Paper

Drawing paper is the paper, on which drawing is to be made.

All engineering drawings are made on sheets of paper of strictly defined sizes, which are set forth in the U.S.S.R standards. The use of standard size saves paper and ensures convenient storage of drawings. *Now a day, A3 and A4 are*

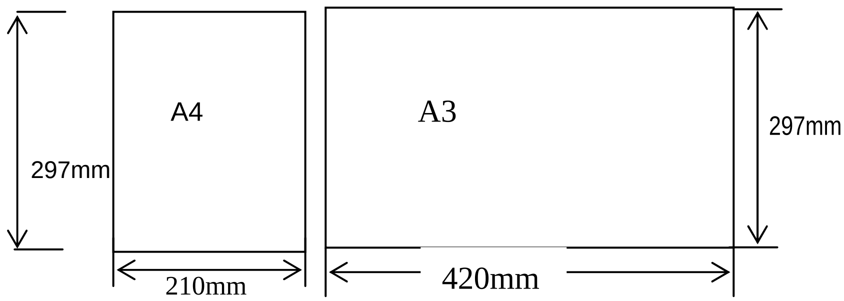
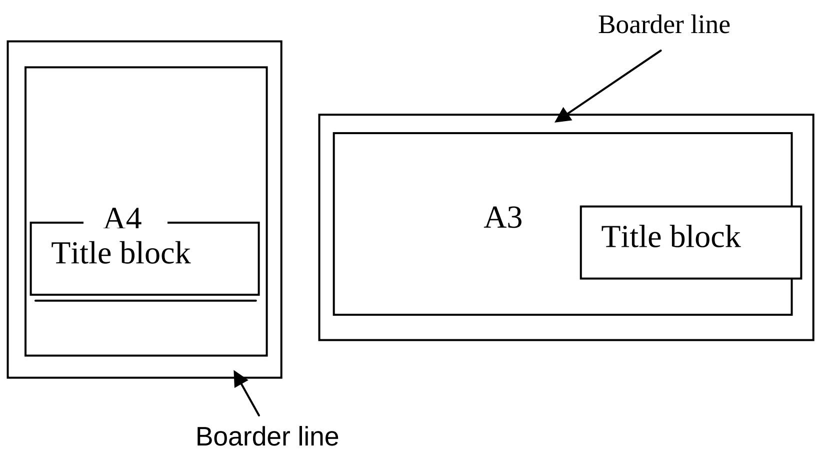


Figure 2.1 A4 and A3 standard papers

Title block is a rectangular frame that is located at the bottom of the sheet. It is recommended that space should be provided in all title blocks for such information as description of title of the drawing, dates, designer (drawer), and name of enterprise or educational institute, size (scale)



Sample for title block

TITLE	
DR.BY GUTEMA KETEMA	
CHECK.BY	
ASSIGN. NO.	
SCALE	INSTIT. AU
DATE 02/02/2003	

Figure 2.2 Sample Title block figure

ii. Triangles (setsquares)

They are used to construct the most common angles (i.e. 30^0, 45^0, 60^0) in technical drawings. The 45^0 x 45^0 and 30^0 x 60^0 triangles are the most commonly used for ordinary work. They are shown in the fig. 2.2 below.

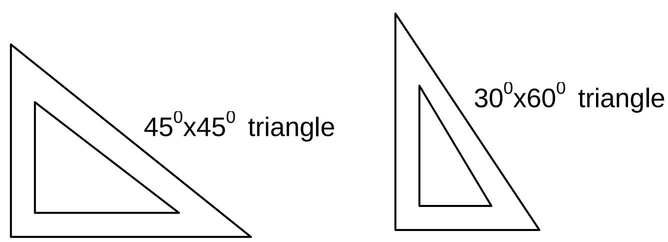


Figure 2.3 triangles or set squares

iii. T- square

It is used primarily to draw horizontal lines and for guiding the triangles when drawing vertical and inclined lines. It is manipulated by sliding the working edge (inner face) of the head along the left edge of the board until the blade is in the required position.

T-square

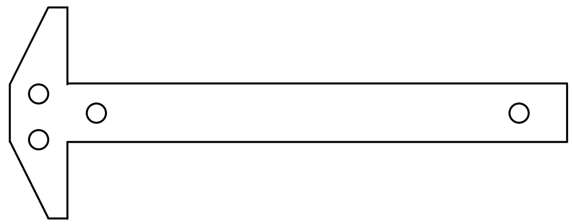
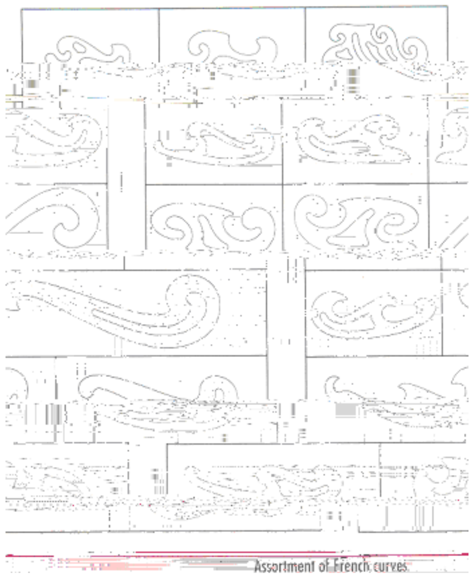


Figure 2.4 T-square

iv. French curve

It is used to draw irregular curves that are not circle arcs. The shape varies according to the shape of irregular curve.



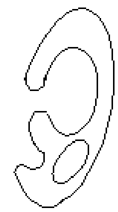


Figure 2.5 French curves

v. Protractor

It is used for laying out and measuring angle.

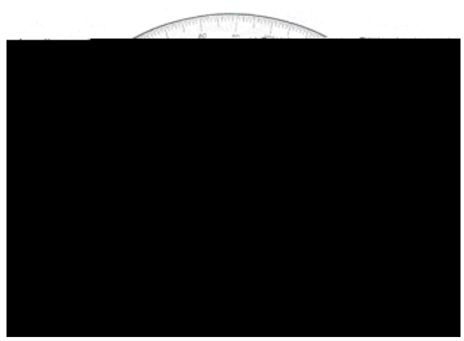
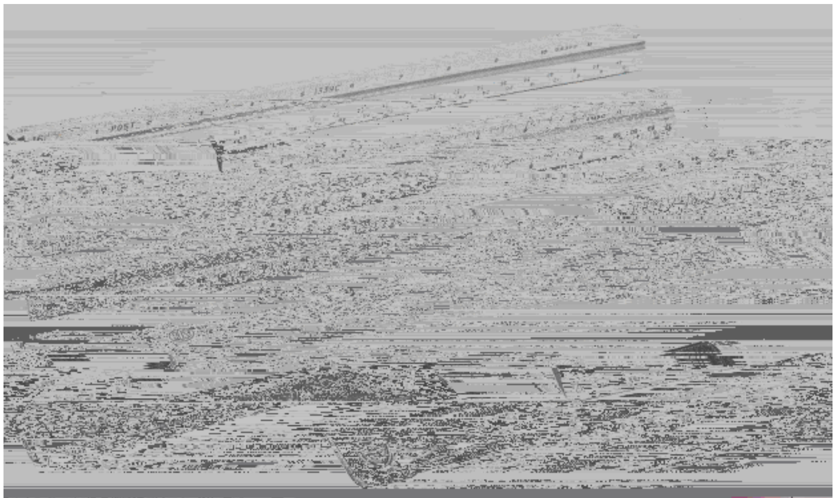


Figure 2.6 Protractor

vi. Scale (ruler)

A number of kinds of scales are available for varied types of engineering design. **Figure** fig 2**.7** Scales with beveled edges graduated in mm are usually used.



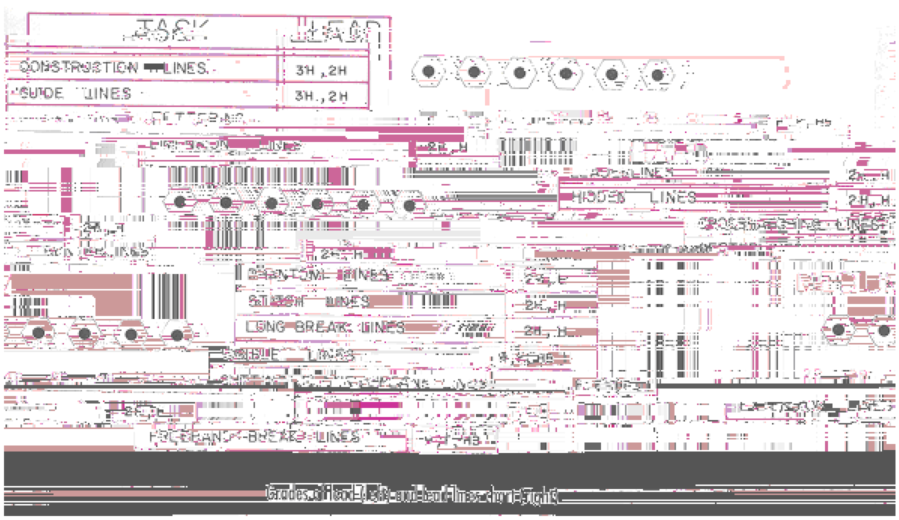
A variety of drafting scales

vii. Pencil

The student and professional man should be equipped with a selection of good, well-sharpened pencil with leads of various degrees of hardness such as: 9H, 8H, 7H, and 6H (hard); 5H& 4H (medium hard); 3H and 2H (medium); and H& F (medium soft). The grade of pencil to be used for various purposes depends on the type of line desired, the kind of paper employed, and the humidity, which affects the surface of the paper. Standards for line quality usually will govern the selection. For instance,

- **6H** is used for light construction line.
- **4H** is used for re-penciling light finished lines (dimension lines, center lines, and invisible object lines)
- **2H** is used for visible object lines
- **F** and **H** are used for all lettering and freehand work.

Table 2.2. Grade of pencil (lead) and their application



viii. Compass

It is used to draw circles and arcs both in pencil and ink. It consists of two legs pivoted at the top. One leg is equipped with a steel needle attached with a screw, and other shorter leg is, provided with a socket for detachable inserts.

viiii. Divider

Used chiefly for transferring distances and occasionally for dividing spaces into equal parts. i.e. for dividing curved and straight lines into any number of equal parts, and for transferring measurements.

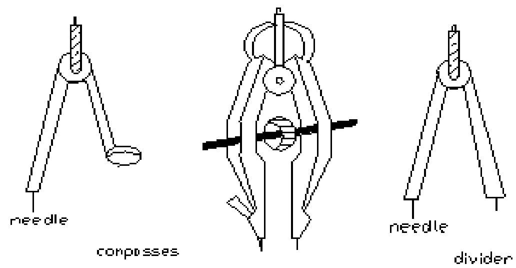


Figure 2.8 Compass and divider

X. Template

A template is a thin, flat piece of plastic containing various cutout shapes. It is designed to speed the work of the drafter and to make the finished drawing more accurate. Templates are available for drawing circles, ellipses, plumbing's, fixtures etc. Templates come in many sizes to fit the scale being used on the drawing. And it should be used wherever possible to increase accuracy and speed.

Drawing board is a board whose top surface is perfectly smooth and level on which the drawing paper is fastened.

Clinograph (Adjustable set square)-its two sides are fixed at 90^0 and the third side can be adjusted at any angle.

Rubber or eraser- extra lines or curves which are not required in the drawing are to be rubbed out or erased. Hence a rubber or eraser are required in the drawing work. Erasers are available in many degrees of hardness, size and shape.

Eraser shield –it is an important device to protect lines near those being erased. It is made up of thin metal plate in which gaps of different widths and lengths are cut.

Tracing paper – it is a thin transparent paper. Figures below it can be seen easily and traced out in pencil ink.

Drawing ink- it is used for making drawings in ink on tracing paper.

Review questions

1. Mention the main drawing equipments
2. Explain the use of different drawing equipments
3. Discuss the different type of pencils with their use

CHAPTER THREE

LETTERING AND LINES

Objectives:

At the end of this chapter students should be able to:

- Write letters according to the standard
- Explain the different line types
- Mention the application of each line type in technical drawings

3.1 Letter Styles

Letter styles are generally classified as *Gothic, Roman, Italic and Text.* They were all made with speedball pens, and are therefore largely single-stroke letters. If the letters are drawn in outline and filled in, they are referred to as “filled- in” letters. The plainest and most legible style is the *gothic* from which our single-stroke engineering letters are derived. The term *roman* refers to any letter having wide down ward strokes and thin connecting strokes. *Roman* letters include *old romans* and *modern roman*, and may be vertical or inclined. Inclined letters are also referred to as *italic*, regardless of the letter style; *text* letters are often referred to as *old English*.

[redacted]

3.2 Technique of Lettering

"Any normal person can learn to letter if he is persistent and intelligent in his efforts." While it is true that" *Practice makes perfect,"* it must be understood that practice alone is not enough; it must be accompanied by continuous effort to improve.

There are three necessary steps in learning to letter:

1. Knowledge of the proportions and forms of the letters, and the order of the strokes.
2. Knowledge of composition- the spacing of the letters and words.
3. Persistent practice, with continuous effort to improve.

Guide Lines

Extremely light horizontal guidelines are necessary to regulate the height of letters. In addition, light vertical or inclined guidelines are needed to keep the letters uniformly vertical or inclined. Guidelines are absolutely essential for good lettering, and should be regarded as a welcome aid, not as an unnecessary requirement.

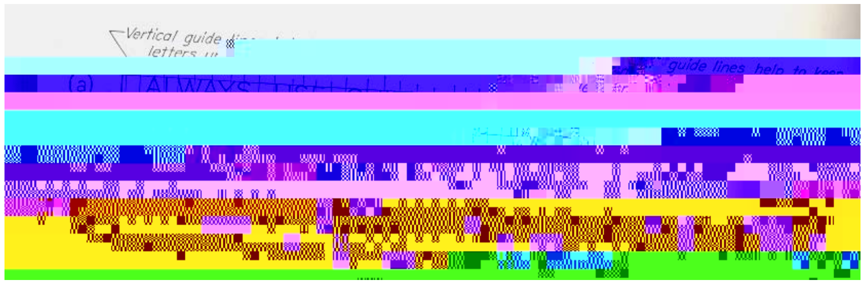


Figure 3.2 Guide lines

Make guidelines light, so that they can be erased after the lettering has been completed. Use a relatively hard pencil such as a 4H to 6H, with a long, sharp, conical point.

A. Guidelines for Capital Letters

On working drawings, capital letters are commonly made 3mm high, with the space between lines of lettering from ¾ th to the full height of the letters. The vertical guidelines are not used to space the letters (as this should always be done by eye while lettering), but only to keep the letters uniformly vertical, and they should accordingly be drawn at random.

Figure 3.3 Guide lines for capital letters

A guideline for inclined capital letters is somewhat different. The spacing of horizontal guidelines is the same as for vertical capital lettering. The American Standard recommends slope of approximately 68.2^0 with the horizontal and may be established by drawing a “sloped triangle”, and drawing the guidelines at random with T-square and triangles.

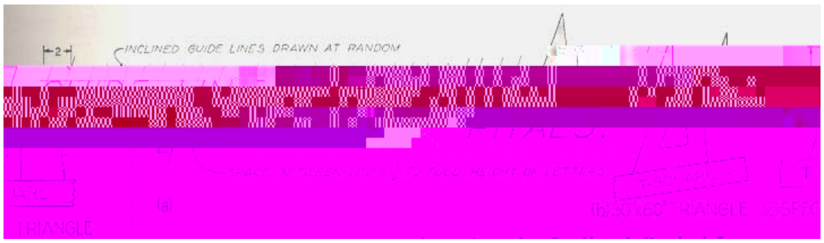


Figure 3.4 Guide lines for inclined capital letters

B. Guidelines for Lower-Case Letters

Lower-case letters have four horizontal guidelines, called the *cap line, waistline, and base line* and *drop line.* Strokes of letters that extend up to the cap line are called *ascenders,* and those that extend down to the drop line, *descenders. Since* there are only five letters ***(p, q.g, j, y)*** that have descenders, The term single stoke or one stoke does not mean that the entire letter is made without lifting the pencil. But the width of the stroke is the width of the stem of the letter.

Single stoke lettering

The L-E-F Group

- The L is made in two strokes.
- The first two strokes of the E are the same for the L, the third or the upper stoke is lightly shorter than the lower and the last stroke is the third as long as the lower
- F has the same proportion as E

The V-A-K Group

- V is the same width as A, the A bridge is one third up from the bottom.
- The second stroke of K strikes stem one third up from the bottom and the third stroke branches from it.

The M-W Group

- are the widest letters
- M may be made in consecutive strokes of the two verticals as of N
- W is made with two V's

The O-Q-C-G Group

- The O families are made as full circles and made in two strokes with the left side a longer arc than the right.
- A large size C and G can be made more accurately with an extra stroke at the top.

The D- U-J Group

- The top and bottom stokes of D must be horizontal, fail line to observe this is a common fault with beginners
- U is formed by two parallel strokes to which the bottom stroke be added.
- J has the same construction as U, with the first stroke omitted.

The P-R-B Group

- The number of stokes depends up on the size of the letter.
- The middle line of P and R are on centerline of the vertical line.

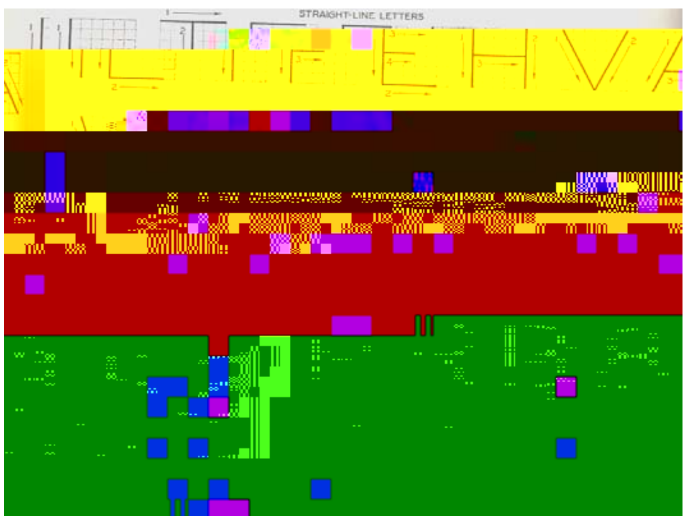


Figure 3.5 Order of strokes for capital letters

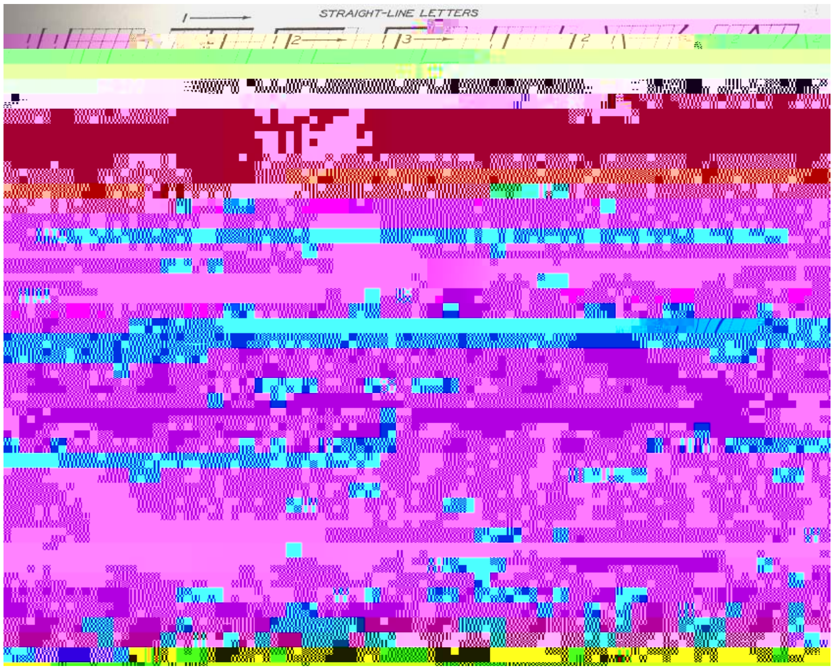


Figure 3.6 Order of strokes for inclined capital letters

3.3 Spacing of Letters

Uniformity in spacing of letters is a matter of equalizing

There should also be a distinct contrast in the thickness of different kinds of lines, particularly between the thick lines and thin lines.

In technical drawings, make construction lines so light that they can barely be seen, with a hard sharp pencil such as 4H to 6H. For visible lines, hidden lines, and other “thick” lines use relatively soft pencils, such as F or H. All thin lines except construction line must be thin, but dark. They should be made with a sharp medium grad pencil, such as H or 2H.

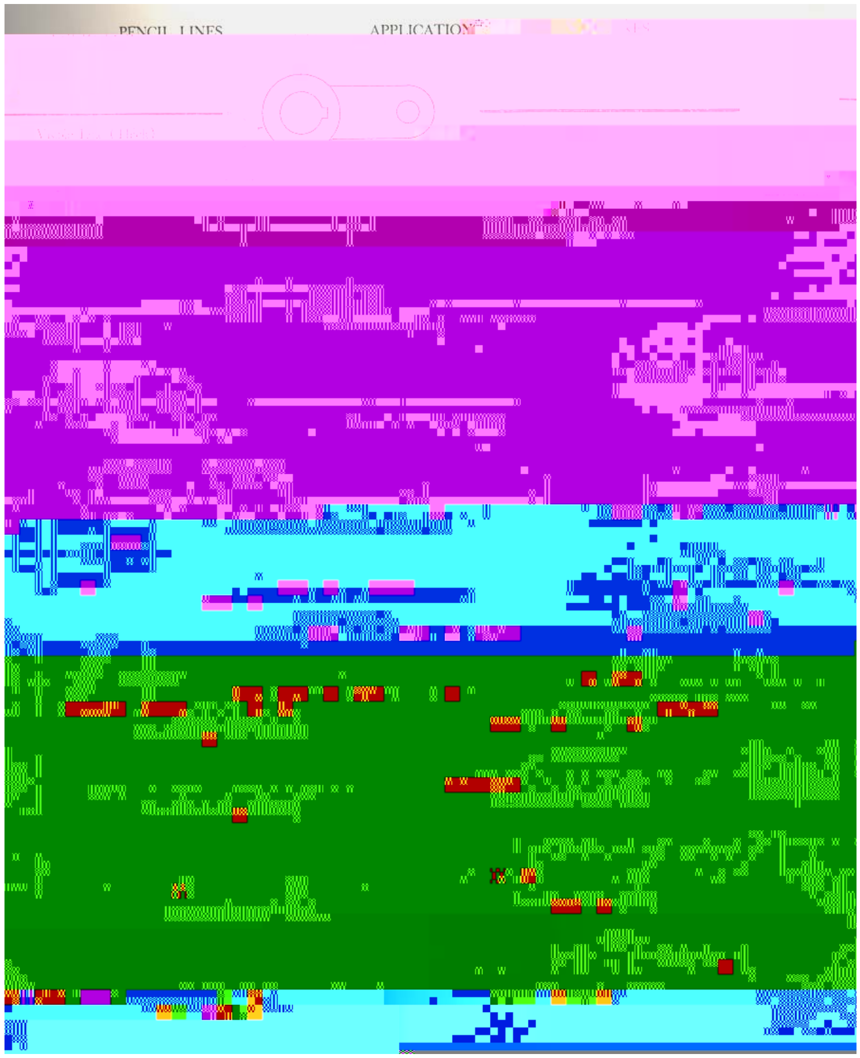


Figure 3.7 Conventional lines

CHAPTER FOUR

GEOMETRIC CONSTRUCTION

Objectives:

At the end of this chapter students should be able to:

- Define geometric nomenclatures like angles, lines etc
- Discuss the steps to construct different geometric figures like lines, arcs, polygon, ellipse etc

4.1 Introduction

Strict interpretation of geometric construction allows use of only the compass and an instrument for drawing straight lines, and with these, the geometer, following mathematical theory, accomplishes his solutions. In technical drawing, the principles of geometry are employed constantly, but instruments are not limited to the basic two as T-squares, triangles, scales, curves etc. are used to make constructions with speed and accuracy. Since there is continual application of geometric principles, the methods given in this chapter should be mastered thoroughly. It is assumed that students using this book understand the elements of plane geometry and will be able to apply their knowledge.

of small, mechanically drawn crossbars, as described by a pint in space.

Straight lines and curved lines are considered parallel if the shortest distance between them remains constant. The symbol used for parallel line is //. Lines, which are tangent and at 90^0 are considered perpendicular. The symbol for perpendicular line is ⊥.

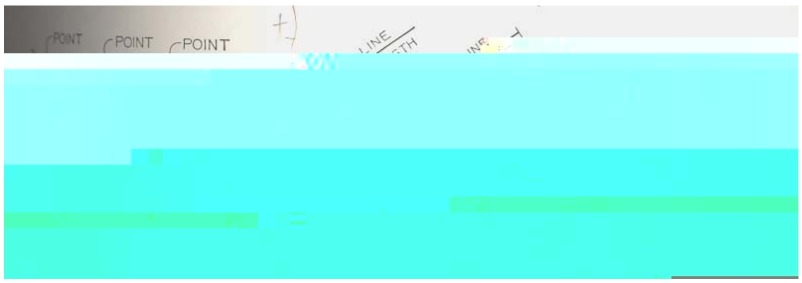


Figure 4.1 Points and lines

C. ANGLE

An angle is formed by the intersection of two lines. There are three major kinds of angles: right angels, acute angles and obtuse angles. The right angle is an angle of 90^0, an acute angle is an angle less than 90^0, and an obtuse angle is an angle more than 90^0. A straight line is 180^0. The symbol for an angle is < (singular) and <'s (Plural). To draw an angle, use the drafting machine, a triangle, or a protractor.

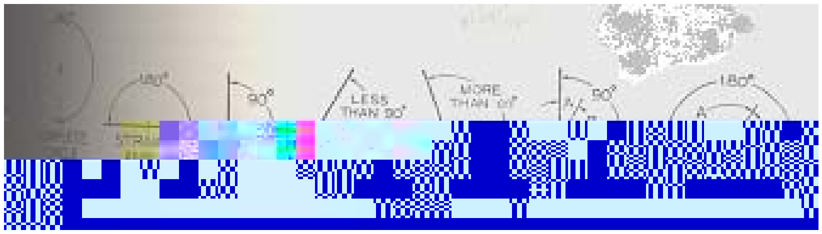


Figure 4.2 Angles

D. TRIANGLES

A triangle is a closed plane figure with three straight sides and their interior angles sum up exactly 180^0. The various kinds of triangles: a right triangle, an equilateral triangle, an isosceles triangle, and an obtuse angled triangle.

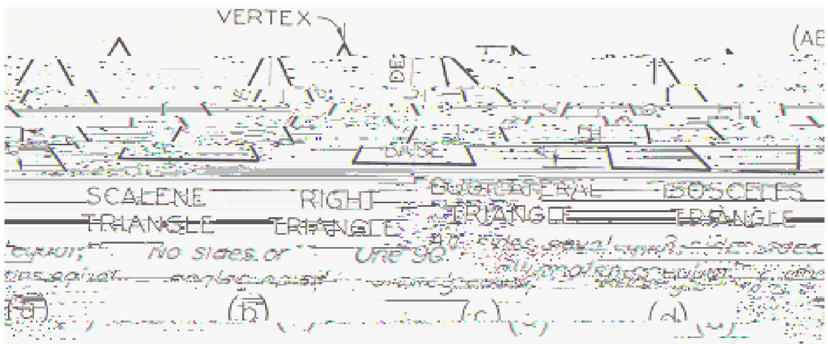
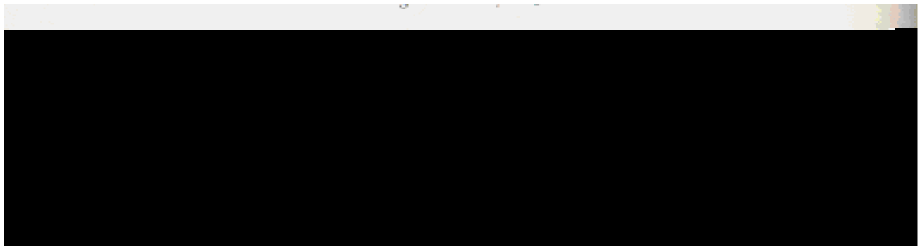
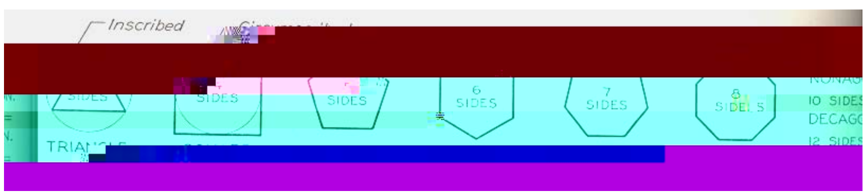


Figure 4.3 Triangles




Inscribed
SIDES
SIDES
SIDES
6 SIDES
7 SIDES
10 SIDES
TRIANGLE

♦ *A semi circle* is half of the circle.

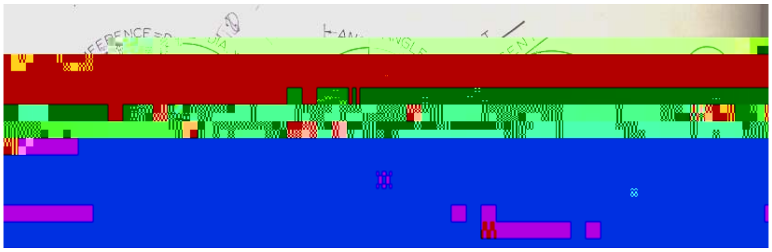


Figure 4.6 Circle

H. SOLIDS

They are geometric figures bounded by plane surfaces. The surfaces are called *faces*, and if these are equal regular polygons, the solids are *regular polyhedra*

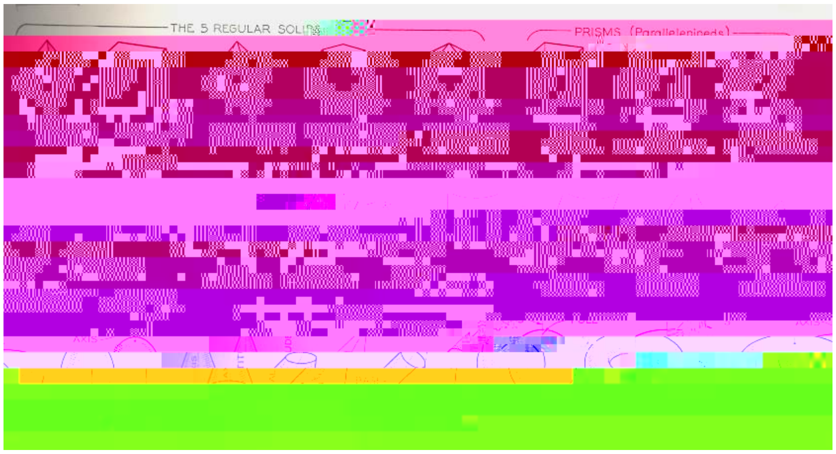


Figure 4.7 Solids

4.3 Techniques of Geometric constructions

To construct the above mentioned geometric figures, we have to know some principles and procedures of geometric construction. Thus, the remaining of this chapter is devoted to illustrate step-by-step geometric construction procedures used by drafters and technicians to develop various geometric forms.

A. How to Bisect a Line or an Arc

To bisect a line means to divide it in half or to find its center point. In the given process, a line will also be constructed at the exact center point at exactly 90^0.

Given: Line A-B

Step 1: Set the compass approximately two-thirds of the length of line A-B and swing an arc from point A.

Step 2: Using the exact same compass setting, swing an arc from point B.

Step 3: At the two intersections of these arcs, locate points D and E

Step 4: Draw a straight-line connecting point D with point E. Where this line intersects line A-B, it bisects line A-B. Line D-E is also perpendicular to line A-B at the exact center point.

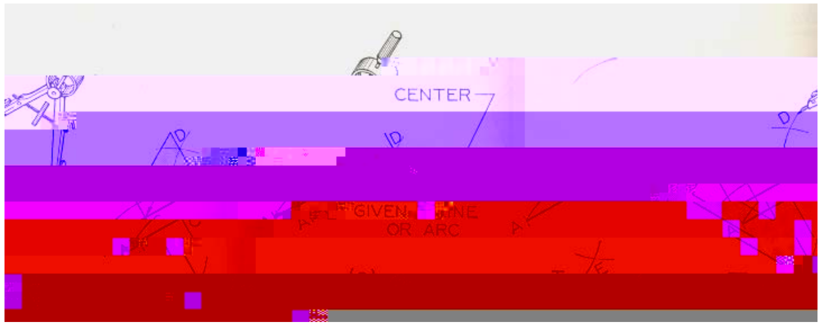


Figure 4.8 Example on how to bisect a line or arc

B. HOW TO DIVIDE A LINE IN TO Number of EQUAL PARTS

Given: Line A-B

Step 1: Draw a construction line AC that starts at end A of given line AB. This new line is longer than the given line and makes an angle of not more than 30^0 with it.

Step 2: Find a scale that will approximately divide the line AB in to the number of parts needed (11 in the example below), and mark these divisions on the line AC. There are now ‘n’ equal divisions from A to D that lie on the line AC (11 in this example).

Step 3: Set the adjustable triangle to draw a construction line from point D to point B. Then draw construction lines through each of the remaining ‘n-1’ divisions parallel to the first line BD by sliding the triangle along the straight edge. The original line AB will now be accurately divided.

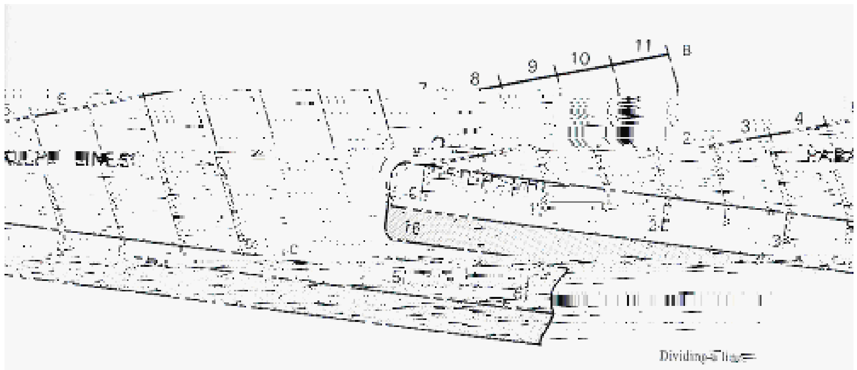


Figure 4.9 Example on how to divide a line in to a number of equal parts

C. How to Bisect an Angle

To bisect an angle means to divide it in half or to cut it in to two equal angles.

Given: Angle BAC

Step 1: Set the compass at any convenient radius and swing an arc from point A

Step 2: Locate points E and F on the legs of the angle, and swing two arcs of the same identical length from points E and F, respectively.

Step 3: Where these arcs intersect, locate point D. Draw a straight line from A to D. This line will bisect angle BAC and establish two equal angles: CAD and BAD.

done correctly, the arc or circle should pass through each point.

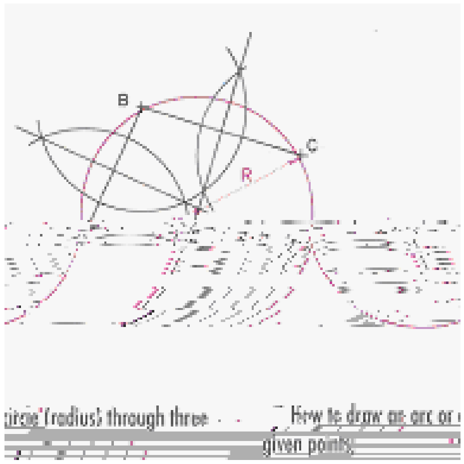


Figure 4.11 Example on how to draw an arc or circle

E. How to Draw a Line Parallel to a Straight Line at a Given Distance

Given: Line A-B, and a required distance to the parallel line.

Step 1: Set the compass at the required distance to the parallel line. Place the point of the compass at any location on the given line, and swing a light arc whose radius is the required distance.

Step 2: Adjust the straight edge of either a drafting machine or an adjusted triangle so that it line sup with line A-B, slide the straight edge up or down to the extreme high point, which is the tangent point, of the arc, then draw the parallel line.

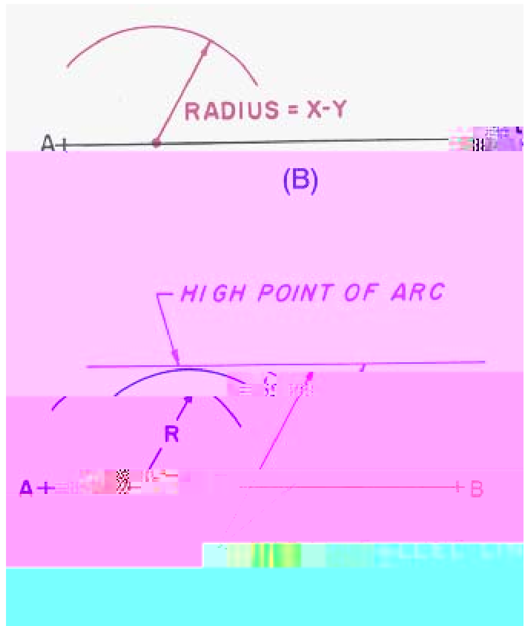
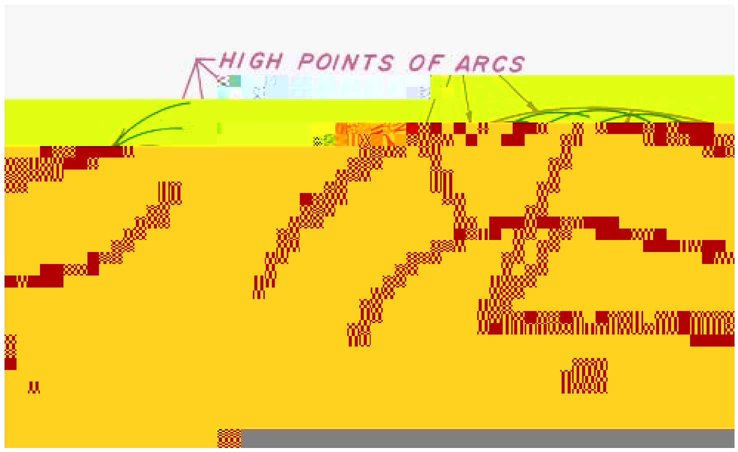


Figure 4.12 Example on how to draw parallel line

F. How to Draw a Line Parallel to a Line Curved Line at a Given Distance

Given: Curved line A-B, and a required distance to the parallel line,

Step 1: Set the compass at the required distance to the parallel line. Starting from either end of the curved


HIGH POINTS OF ARCS

Step 2: Swing larger but equal arcs (R2) from each of points S and T to cross each other at point U.

Step 3: A line from P to U is perpendicular to line A-B at point P

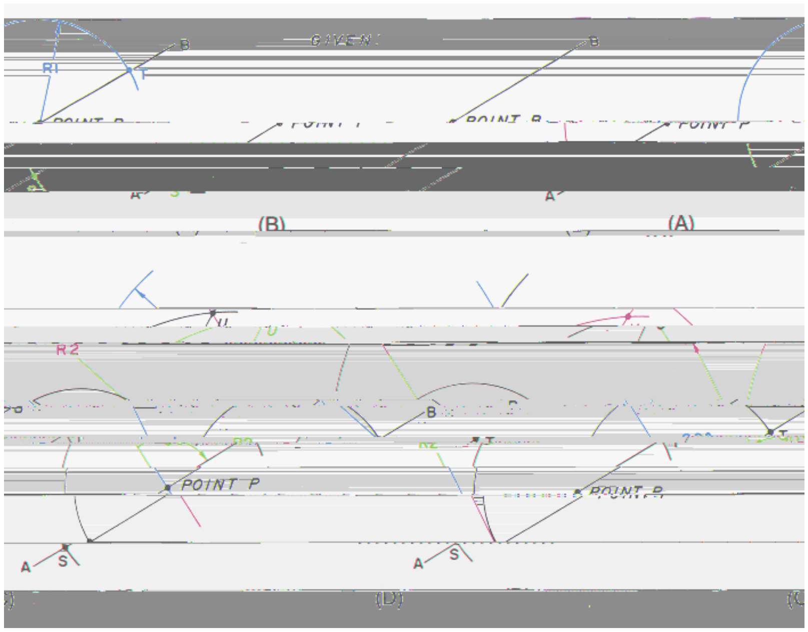


Figure 4.14 Example on how to draw a perpendicular line, to a point outside the line

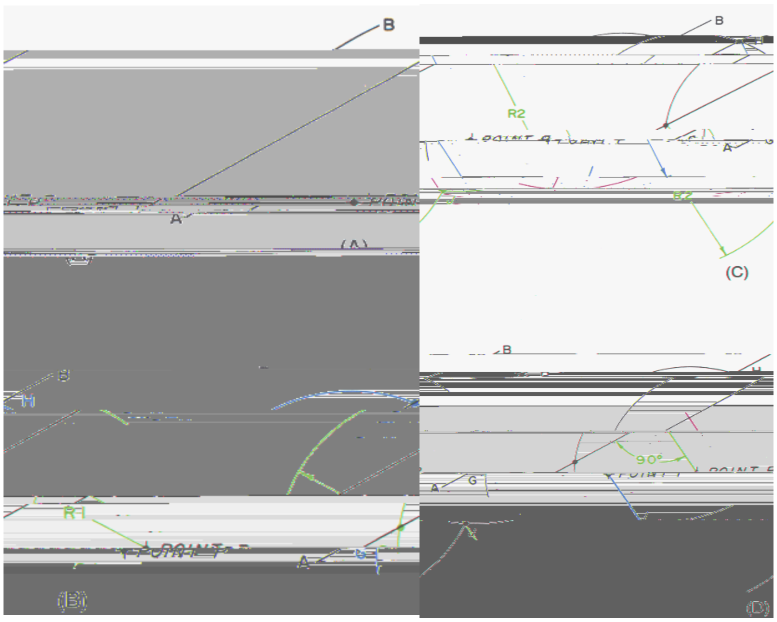
I. How to Draw a Perpendicular to a line from a Point Not on the Line

Given: Line A-B and point P

Step 1: Using P as a center, swing an arc (R1) to intercept line A-B at points G and H.

Step 2: Swing larger, but equal length arcs (R2) from each of the points G and H to intercept each other at point J.

Step 3: Line P-J is perpendicular to line A-B



J. How to Draw a Triangle with Known Lengths of Sides

Given: lengths 1, 2, and 3.

Step 1: Draw the longest length line, in this example length 3, with ends A and B. Swing an arc (R1) from point A whose radius is either length 1 or length 2; in this example length 1.

Step 2; using the radius length not used in step 1, swing an arc (R2) from point B to intercept the arc swung from point A at point

Step 3: Connect A to C and B to C to complete the triangle

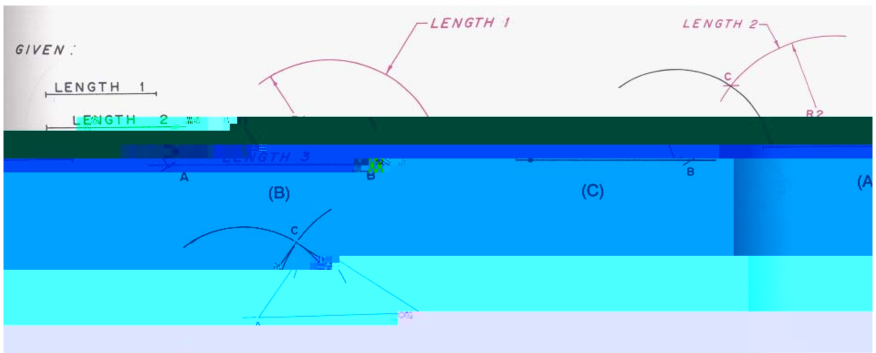
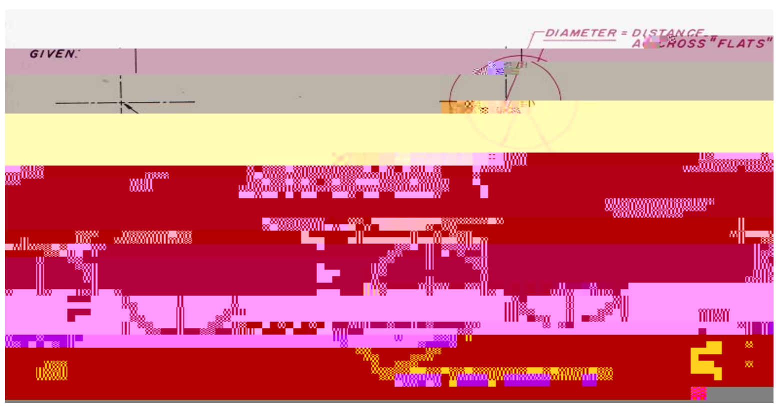


Figure 4.17 Example on how to draw triangles with given sides

K. How to Draw a Square

Method-1

Given: The locations of the center and the required distance



Method-2

Given one side AB. Through point A, draw a perpendicular. With A as a center, and AB as radius; draw the arc to intersect the perpendicular at C. With B and C as centers, and AB as radius, strike arcs to intersect at D. Draw line CD and BD.

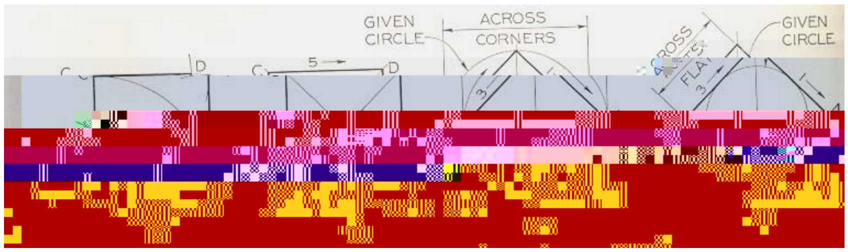


Figure 4.19 Example on how to draw square with given side

L. How to Draw A Pentagon (5 Sides)

Given: The locations of the pentagon center and the diameter that will circumscribe the pentagon.

Step 1: Bisect radius OD at C.

Step 2: With C as center, and CA as radius, strike arc AE. With A as center, and AE as radius, strike arc EB.

Step 3: Draw line AB, then set off distances AB around the circumference of the circle, and draw the sides through these points.

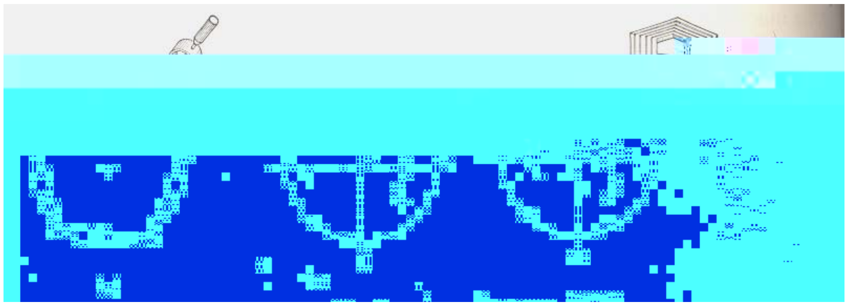


Figure 4.20 Example on how to draw pentagon with a given side

M. How to Draw A Hexagon (6 Sides)

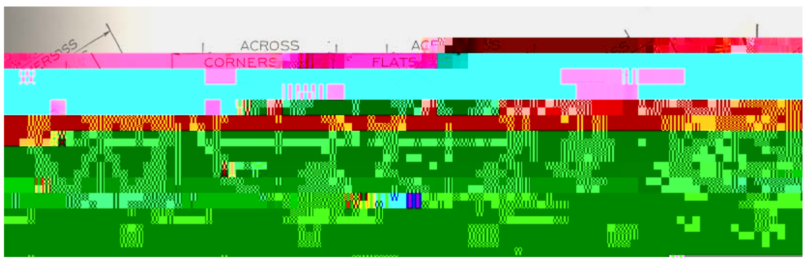
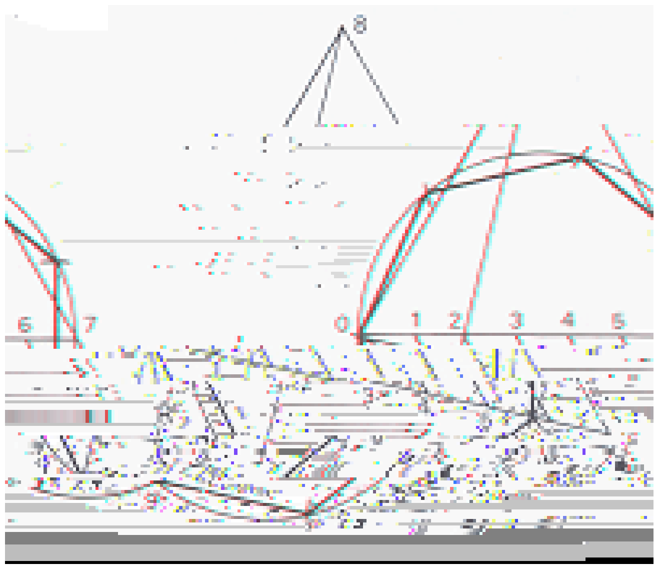


Figure 4.21 Example on how to draw hexagon with a given side

N. To Draw Any Sided Regular Polygon

To construct a regular polygon with a specific number of sides, divide the given diameter using the parallel line method as shown in fig below. In this example, let us assume seven-sided regular polygon. Construct an equilateral triangle (0-7-8) with the diameter (0-7) as one of its sides. Draw a line from the apex (point 8) through the second point on the line (point 2). Extend line 8-2 until it intersects the circle at point 9. Radius 0-9 will be the size of each side of the figure. Using radius 0-9 step off the corners of the seven sides polygon and15.035dc4 Tw.7w(s15u7[ch s:5(s)-2 i



Step 2: Set off the radius of the required circle on the perpendicular.

Step 3: Draw circle with radius CP.

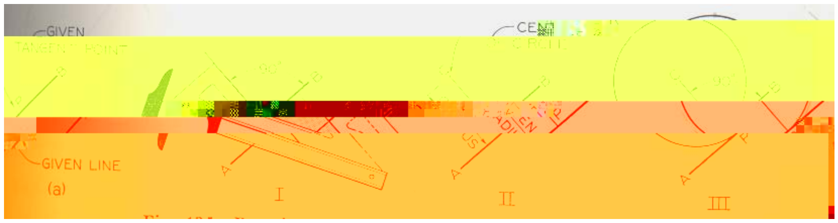


Figure 4.23 Example on how to draw a tangent to a line

P. To Draw a Tangent to A Circle through a Point

Method-1

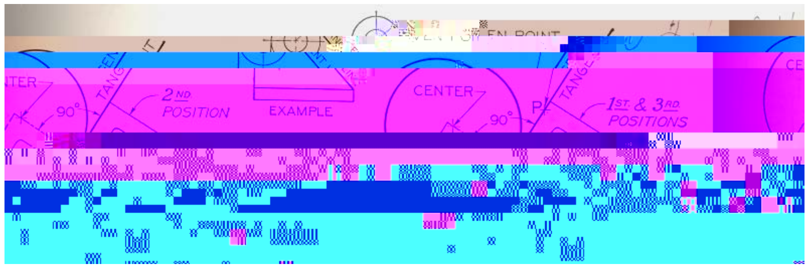
Given*: Point P on the circle.*

Move the T-square and triangle as a unit until one side of the triangle passes through the point P and the center of the circle; then slide the triangle until the other side passes through point P, and draw the required tangent.

Method-2

Given: Point P outside the circle

Move the T-square and triangles as a unit until one side of the triangle passes through point P and, by inspection, is the tangent to the circle; and then slide the triangle until the other side passes through the center of the circle, and lightly mark


CENTER
90°
2ND POSITION
EXAMPLE
CENTER
90°
1ST & 3RD POSITIONS

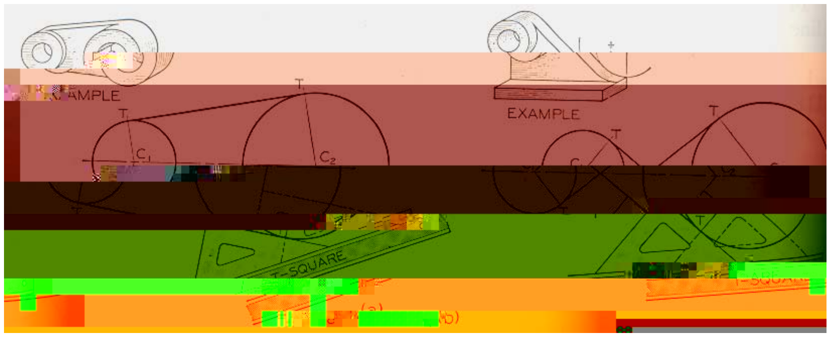


Figure 4.25 Example on how to draw a tangent to two circles

R. HOW TO CONSTRUCT AN ARC TANGENT TO an Angle

Given: A right angle, lines A and B and a required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius from line A and one from line B.

Step 2: From the extreme high points of each radius, construct a light line parallel to line A and another line parallel to line B.

Step 3: Where these lines intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius. Allow the radius swing to extend past the required area. It is important to locate all tangent points (T.P) before darkening in.

S. How to Construct an Arc Tangent to Two Radii or Diameters

Given: Diameter A and arc B with center points located, and the required radius.

Step 1: Set the compass at the required radius and, out of the way, swing a radius of the required length from a point on the circumference of given diameter A. Out of the way, swing a required radius from a point on the circumference of a given arc B.

Step 2: From the extreme high points of each radius, construct a light radius out side of the given radii A and B.

Step 3: Where these arcs intersect is the exact location of the required swing point. Set the compass point on the swing point and lightly construct the required radius. Allow the radius swing to extend past the required area.

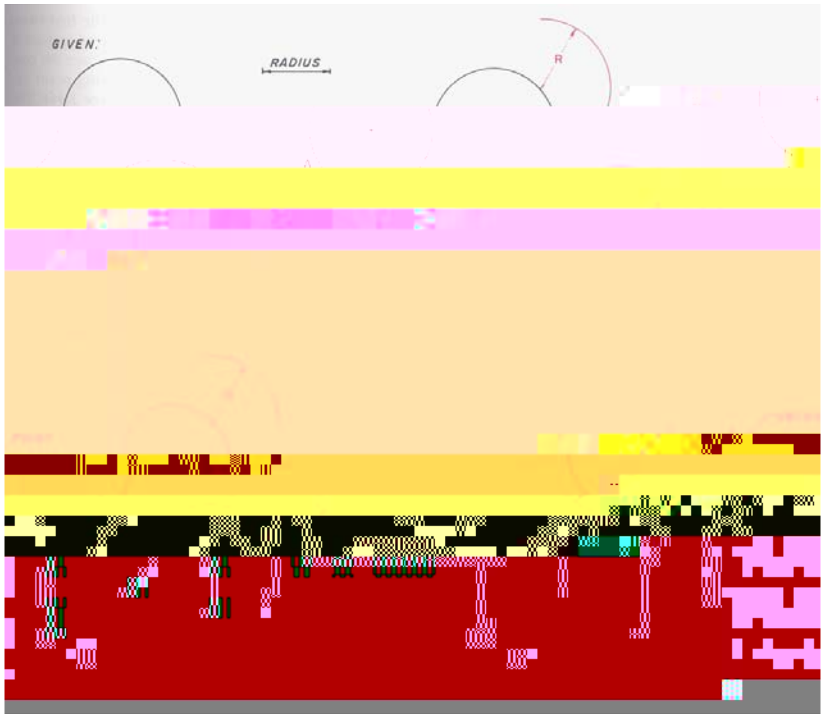


Figure 4.27 Example on how to draw an arc tangent to two radii or diameter

T. To Draw an Ellipse (By Four-Centered Method)

Join 1 and 3, layoff 3-5 equal to 01-03. This is done graphically as indicated in the fig. Below by swinging 1 around to 5 with O as center where now 03 from 05 is 3-5; the required distance. With 3 as center, an arc from 5 to the diagonal 1-3 locates 6. Bisect 1-6 by a perpendicular crossing 0-1 at 9 and intersecting 0-4 produced (if necessary) at 10.

Make 0-9’ equal to 0-9, and 0-10’ equal to 0-10. Then 9, 9’, 10, and 10’ will be centers for four tangent circle arcs forming a curve approximating the shape of an ellipse.

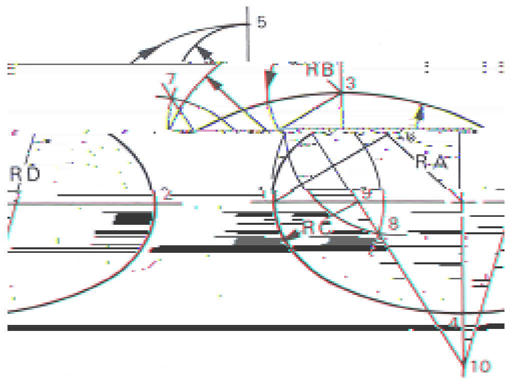


Figure 4.28 Example on ellipse construction using four centered method

U. How to Draw an Ogee Curve

An ogee curve is used to join two parallel lines. It forms a gentle curve that reverses itself in a neat symmetrical geometric form.

Given: Parallel lines A-B and C-D

Step 1: Draw a straight line connecting the space between the parallel lines. In this example, from point B to point C.

Step 2: Make a perpendicular bisector to line B-C to establish point X.

Step 3: Draw a perpendicular from line A-B at point B to intersect the perpendicular bisector of B-X, which locates the first required swing center. Draw a perpendicular from line C-D at point C to intersect the perpendicular bisector of CX, which locates the second required swing center.

Step 4: Place the compass point and adjust the compass lead to point B, and swing an arc from B to X. Place the compass point on the second swing point and swing an arc from X to C. This completes the ogee curve.

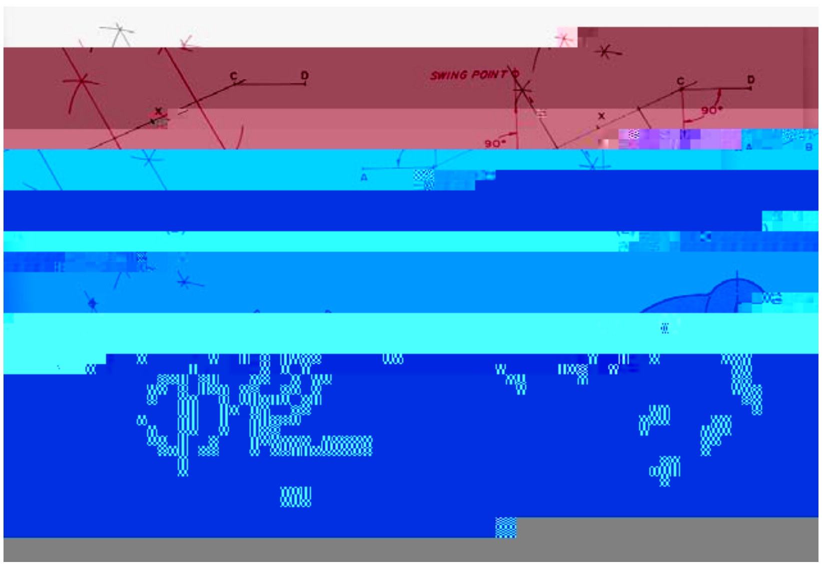


Figure 4.29 Example on ogee curve construction

Review questions

1. The side of a certain triangle is 2 cm. Construct an equilateral triangle based on the given side by using compass and ruler.

2. Show the procedure how to divide a line in to number of equal parts

3. Draw a line parallel to straight line AB at 2cm distance.

CHAPTER FIVE

5.1 Introduction

All forms of engineering and technical work require that a two-dimensional surface (paper) be used to communicate ideas and the physical description of a variety of shapes. Here projections have been divided in to two basic categories; *pictorial and multi view*. This simple division separates single view projections (*oblique, perspective and isometric)* from multi view projections (*orthographic)*. Theoretically, projections can be classified as convergent and parallel, or divided in to three systems of projection: *perspective, oblique, and orthographic*. Division of types based on whether the drawing is a one view or multi view projection sufficiently separate projection types in to those used for engineering

Before we get started on any technical drawings, let's get a good look at this strange block (figure 5.1) from several angles.

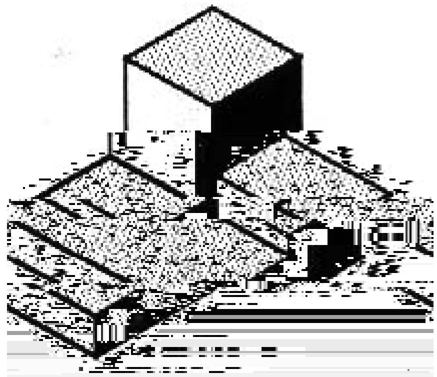


Figure 5.1 Machine block

5.1.1 Isometric Drawing

The representation of the object in figure 5.2 is called an isometric drawing. This is one of a family of three-dimensional views called pictorial drawings. In an isometric drawing, the object's vertical lines are drawn vertically, and the horizontal lines in the width and depth planes are shown at 30 degrees

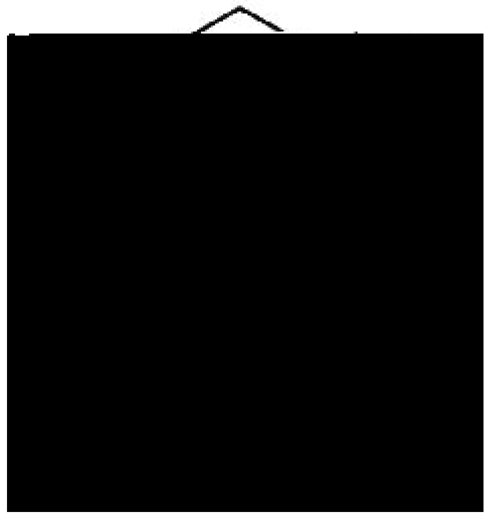


Figure 5.2 Isometric drawing

Any engineering drawing should show everything: a complete understanding of the object should be possible from the drawing. If the isometric drawing can show all details and all dimensions on one drawing, it is ideal.

One can pack a great deal of information into an isometric drawing. Look, for instance, at the instructions for a home woodworker in figure 5.2. Everything the designer needs to convey to the craftsperson is in this one isometric drawing.

However, if the object in figure 5.2 had a hole on the back side, it would not be visible using a single isometric drawing. In order to get a more complete view of the object, an orthographic projection may be used.

5.1.2 Orthographic or Multi view Projection

Imagine that you have an object suspended by transparent threads inside a glass box, as in figure 5.3.

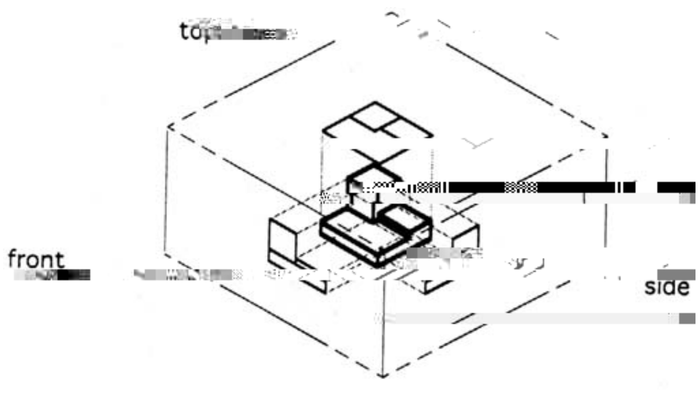


Figure 5.3 Orthographic projection

Then draw the object on each of three faces as seen from that direction. Unfold the box (figure 5.4) and you have the three views. We call this an "orthographic" or "multi view" drawing.

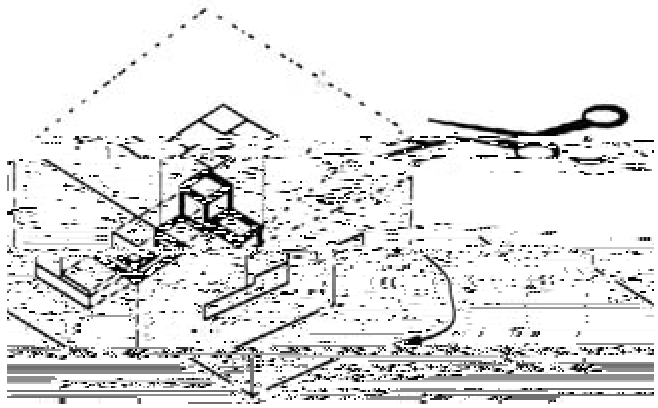


Figure 5.4 the creation of an orthographic multi view drawing

Figure 5.5 shows how the three views appear on a piece of paper after unfolding the box.

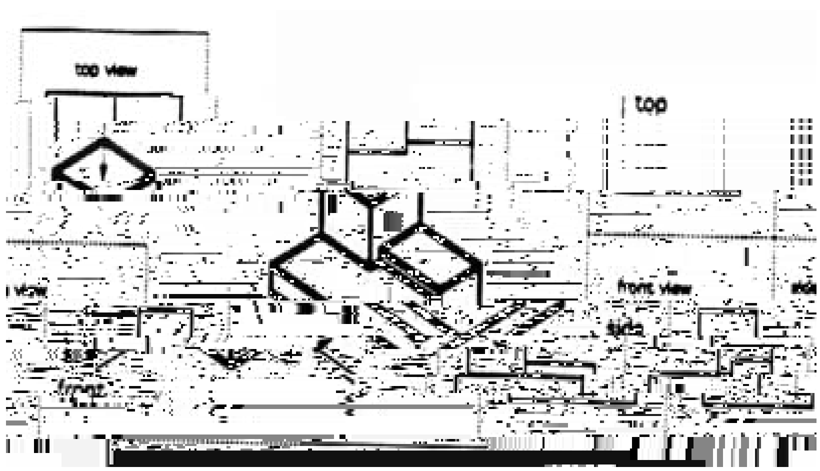


Figure 5.5 a multi view drawing and its explanation

Which views should one choose for a multi view drawing? The views that reveal every detail about the object. Three views are not always necessary; we need only as many views as are required to describe the object fully. For example, some objects need only two views, while others need four. The circular object in figure 5.6 requires only two views.

[redacted]

Figure 5.6 an object needing only two orthogonal views

5.2 Theory of Multi view Projections

Multi view orthographic projection is the primary means of graphic communication used in engineering work. Drawings are used to convey ideas, dimensions, shapes, and procedures for the manufacture of the object or construction of a system. Orthographic proj projection. The finished drawing is then reproduced and sent to the shop or to the job site.

To design and communication every detail to manufacturing groups (Engineers, technicians) descriptions must be prepared. This description must show every aspect of the shape and size of each pa <<and of the complete structure. Because of this necessity graphics is the fundamental method of communication only as a supplement, for notes and specifications, is the word language used.

Shape is described by projection that is by the process of causing<an image to be formed by rays of sight taken in a pt <icular direction from an object to a picture plane. Methods of projection vary according to the direction in which the rays of sight are taken to the plane. When the rays are perpendicular to the plane, the projective method is *Orthographic*. If the rays are a<<an angle to the plane, the projective method is called *oblique*. Rays taken to a pt <icular station point result in *perspective*

The *Glass Box method*, used primarily for descriptive geometry problems, requires that the user imagine that the object, points, lines, planes etc are enclosed in a transparent “box”. Each view of the object is established on its corresponding glass box surface by means of perpendicular projectors originating at each point of the object and extending to the related box surface. The box is hinged so that it can be unfolded on to one flat plane (the paper).

The lines of sight representing the direction from which the object is viewed. In figure 5.7, the vertical lines of sight (A) and horizontal lines of sight (B) are assumed to originate at infinity. The line of sight is always perpendicular to the image plane, represented by the surfaces of the glass box (top, front, and right side). Projection lines(c) connect the same point on the image plane from view to view, always at right angle.

A point is projected up on the image plane where its projector, or line of sight, pierces that image plane. In the figure 5.8, point 1, which represents a corner of the given object, has been projected on to the three primary image planes. Where it is intersects the horizontal plane (top image plane), it is identified as $1_{H'}$ when it intersects the frontal plane (front image plane), it is identified as 1_F, and where it intersects the profile plane (right side image plane), it is labeled 1_P.

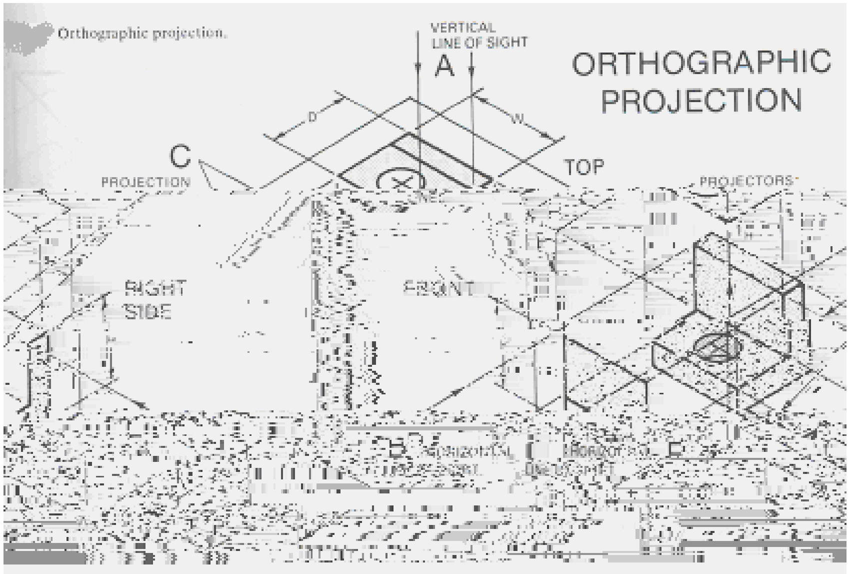


Figure 5.7 Glass box methods

Figure 5.8 Orthographic projection of objects

B. Orthographic views

It is the picture or view or thought of as being found by extending perpendiculars to the plane from all points of the object. This picture, or projection on a frontal plane, shows the shape of the object when viewed from the front but it does not tell the shape or distance from front to real. Accordingly, more than one protection is required to describe the object.

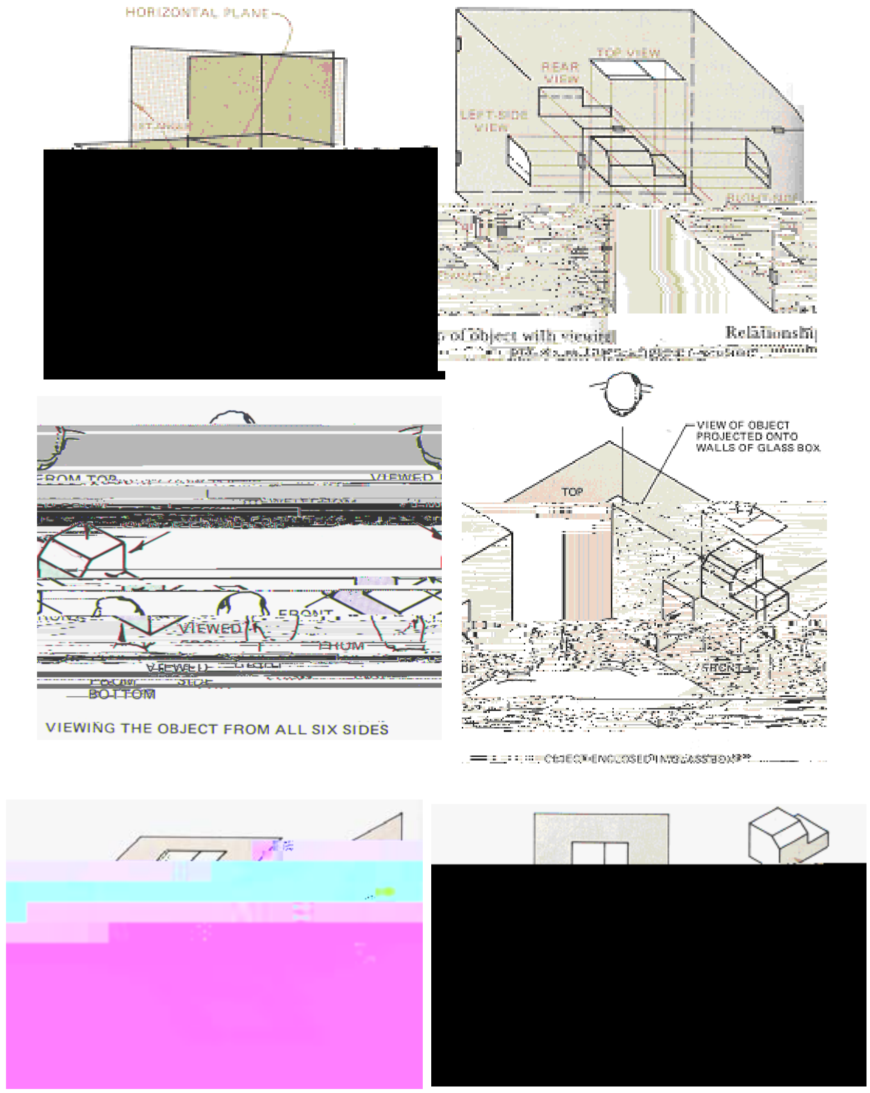


Figure 5.9 Principal Picture Planes

In actual work, there is rarely an occasion when all six principal views are needed on one drawing. All these views are principal views. Each of the six views shows two of the three dimensions of height, width and depth.

The six principal views of an object or the glass box have previously been presented in the type of orthographic projection known as

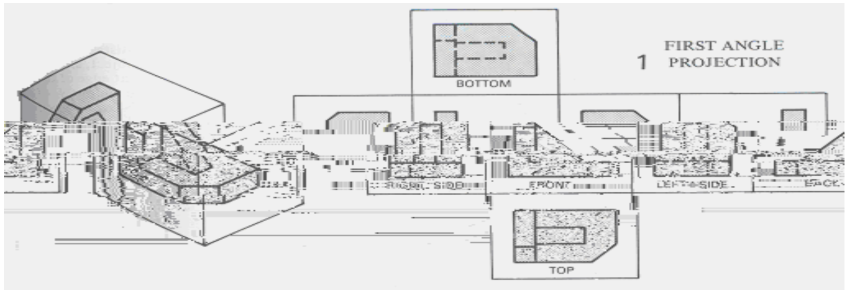


Figure 5.11 First angle projections

5.2.2 Classification of surfaces and Lines in Orthographic Projections

Any object, depending upon its shape and space position may or may not have some surfaces parallel or perpendicular to the planes of projection.

Surfaces are classified according to their space relation ship with the planes of projection i.e. *horizontal, frontal* and surface limit is a line that indicates the reversal of direction of a curved surface.

A. Horizontal, Frontal and Profile Surfaces

The edges (represented by lines) bounding a surface may be in a simple position or inclined to the planes of projection depending up on the shape or position, the surface takes is name from the plane of projection. Thus, a horizontal line is a line in a horizontal plane; a frontal line is a line in a frontal plane; and a profile line is a line in a profile plane. When a line is parallel to two planes, the line takes the name of both planes as horizontal frontal, horizontal- profile, or frontal – profile.

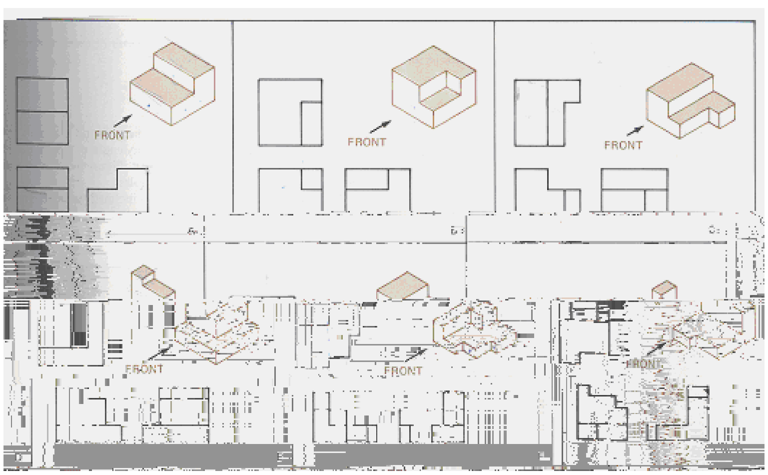


Figure 5.12 Examples of objects having parallel surfaces to the principal planes

B. Inclined Surfaces

An edge appears in true length when it is parallel to the plane of projection, as a point when it is perpendicular to the plane and shorter than true length when it is inclined to the plane. Similarly, a surface appears in trey shape when it is parallel to the planes of projection, as alien when it is perpendicular to the plane, and fore shortened when it inclined to the plane. An object with its face parallel to the plans of projection as figure

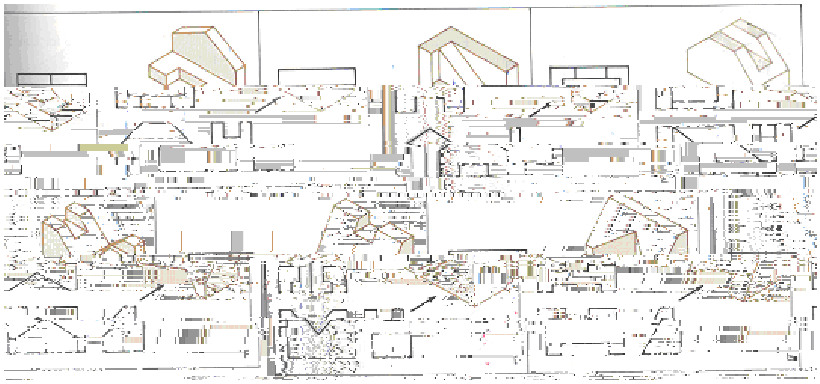


Figure 5.13 Examples of objects having inclined surfaces

C. Oblique Surfaces

A line that is not parallel to any plane of projection is called an oblique skew line and it does not show in true shape in any of the views, but each of the bounding edges shows interval length in one view and is fore shortened in the other two views,

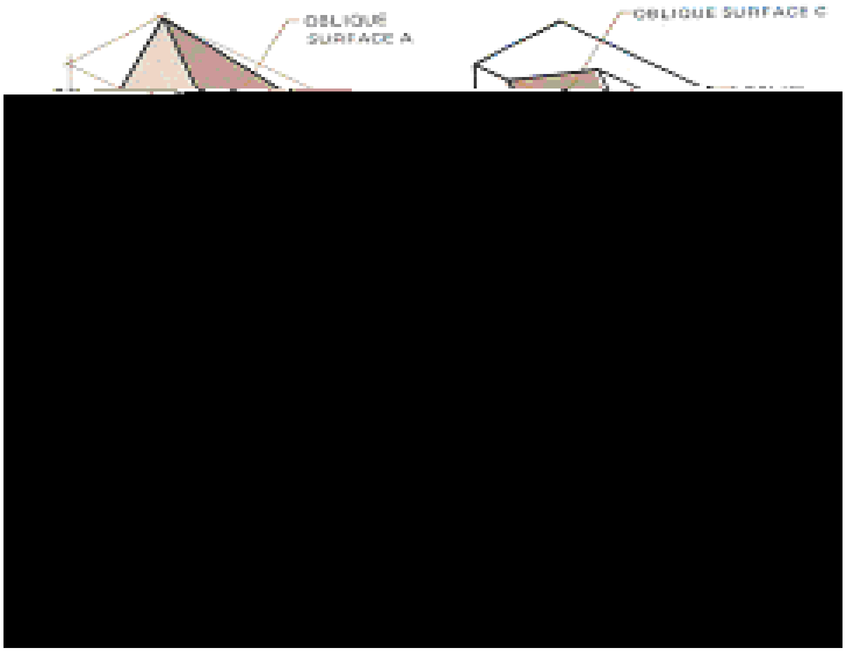


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figure 5.15, the drilled hole that is visible in the top-side view is hidden in the front and right side views, and there fore it is indicated in these views by a dashed line showing the hole and the shape as left by the drill.

Figure 5.15 Examples of objects having hidden surfaces

Particular attention should be paid to the execution of these dashed lines. It carelessly drawn, they ruin the appearance of a drawing. Dashed lines are drawn lighten full lines, of short dashes uniform in length with the space between there very short, about ¼ of the length of the dash.

This view shows the shape of the object when viewed from the side and the distance from bottom to top and front to rear. The horizontal and profile planes are rotated in to the same plane as the frontal plane. Thus, related in the same plane, they give correctly the three dimensional shape of the object.

E. Curved Surfaces

To represent curved surfaces in orthographic projections, center lines are commonly utilized. All the center lines, which are the axes of symmetry, for all symmetrical views are a part of views.

1. Every part with an axis, such as a cylinder will have the axis drawn as center line before the part is drawn.
2. Every circle will have its center at the intersection of two mutually perpendicular center lines.

The standard symbol for center lines on finished drawings is a fine line made up of alternate long and short dashes.

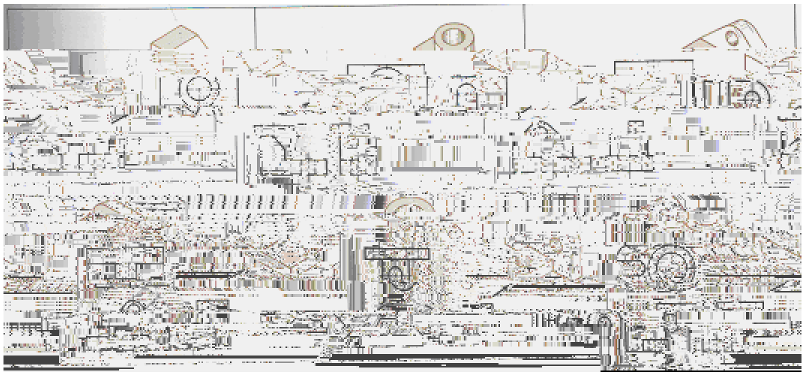


Figure 5.16 Examples of objects having curved surfaces

5.2.3 Precedence of lines

In any view there is likely to be a coincidence of lines. Hidden portions of the object may project to coincide with visible portions Center lines may occur where there is a visible or hidden out line of some part of the object.

Since the physical features of the object must be represented full and dashed lines take precedence over all other lines since visible out line is more prominent by space position, full lines take precedence over dashed lines. A full line could cover a dashed line, but a dashed line could not cover a full line. It is evident that a dashed line could not occur as one of the boundary lines of a view.

approximately as they appear to the observer. This type of drawing is called *pictorial drawing.* Since pictorial drawing shows only the appearances of objects, it is not satisfactory for completely describing complex or detailed forms.

As we have seen in the previous chapters, the four principal types of projection are:

- ♦ Multi view projection
- ♦ Axonometric projection
- ♦ Oblique projection
- ♦ Perspective projection

All except the regular multi view projection are pictorial types since they show several sides of the ob9lse-.0002.-7o sel sngul Allcra

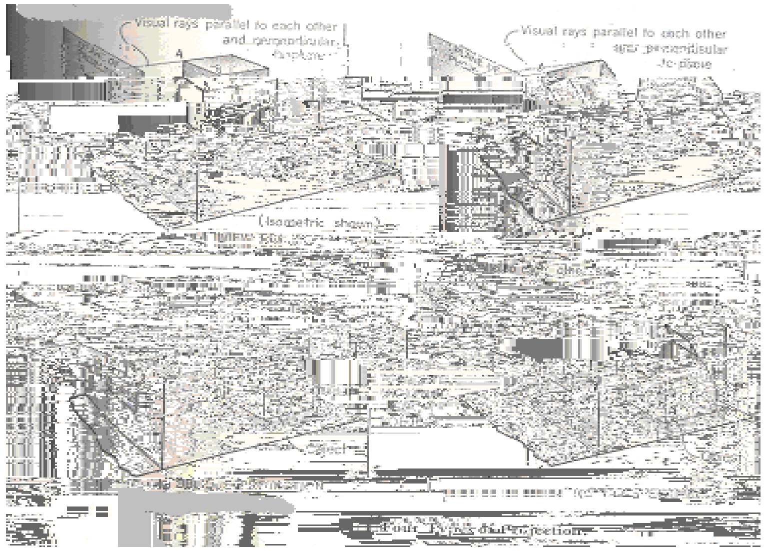


Figure 5.17 types of projection

In both *multi view projection and axonometric projection*, the observer is considered to be at infinity, and the visual rays are perpendicular to the plane of projection. There fore, both are classified as *Orthographic Projections.*

In *Oblique projection*, the observer is considered to be at

The distinguishing feature of axonometric projection, as compared to multi view projection, is the inclined position of the object with respect to the plane of projection. Since the principal edges and surfaces of the object are inclined to the plane of projection, the lengths of the lines, the sizes of the angle, and the general proportions of the object vary with the infinite number of possible positions in which the object may be placed with respect to the plane of projection. Three of these are shown below.

In these cases the edges of the cube are inclined to the plane of projection, and therefore foreshortened. The degree of foreshortening of any line depends on its angle with the plane of projection; the greater the angle the greater the foreshortening. If the degree of the foreshortening is determined for each of the three edges of the cube which meet at one corner, scales can be easily constructed for measuring along these edges or any other edges parallel to them. It is customary to consider the three edges of the cube which meet at the corner nearest to the observer as the *axonometric axes.*

Axonometric projections are classified as

a) *Isometric projection*
b) *Dimetric Projection*
c) *Trimetric Projection,* depending up on the number of scales of reduction required.

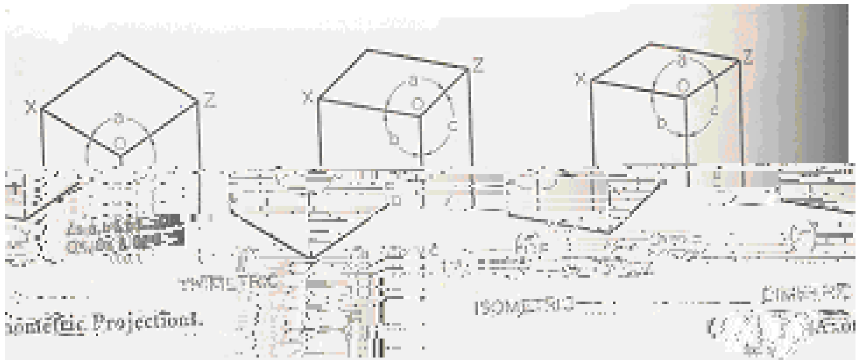


Figure 5.18 Axonometric projections

Since the most widely used method of axonometric projection is Isometric, we will only see isometric projection in detail.

5.3.1 Isometric Projection

To produce an isometric projection (Isometric means “equal measure”), it is necessary to place the object so that its principal edges or axes, make equal angles with the plane of projection, and are therefore foreshortened equally. In this position the edges of a cube would be projected equally and would make equal angles with each other (120^0).

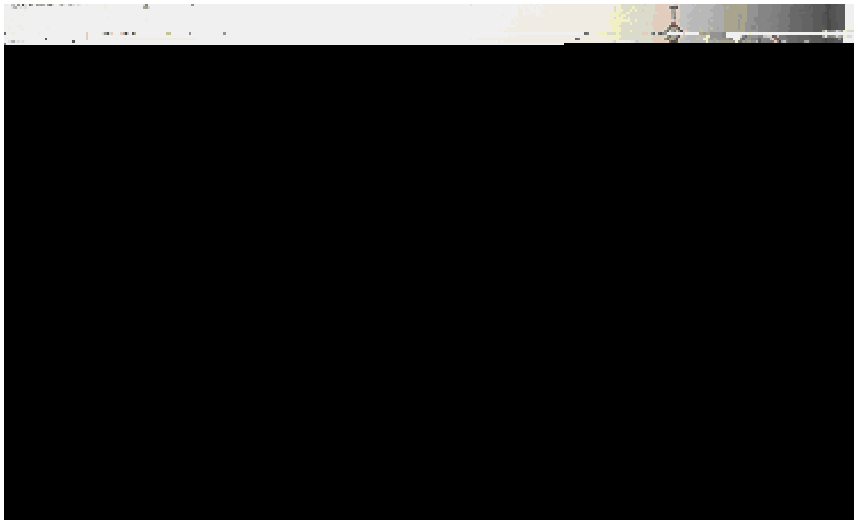


Figure 5.19 Isometric Projection

In the figure above, the projections of the axes OX, OY and OZ make angles of 120^0 with each other, and are called the *isometric axes.* Any line parallel to one of these is called an *Isometric line;* a line which is not parallel is called a *non-isometric line.* It should be noted that the angles in the isometric projection of the cube are either 120^0 or 60^0 and that all projections of 90^0 angles. In an isometric projection of a cube, the faces of the cube or any planes parallel to them are called *Isometric planes.*

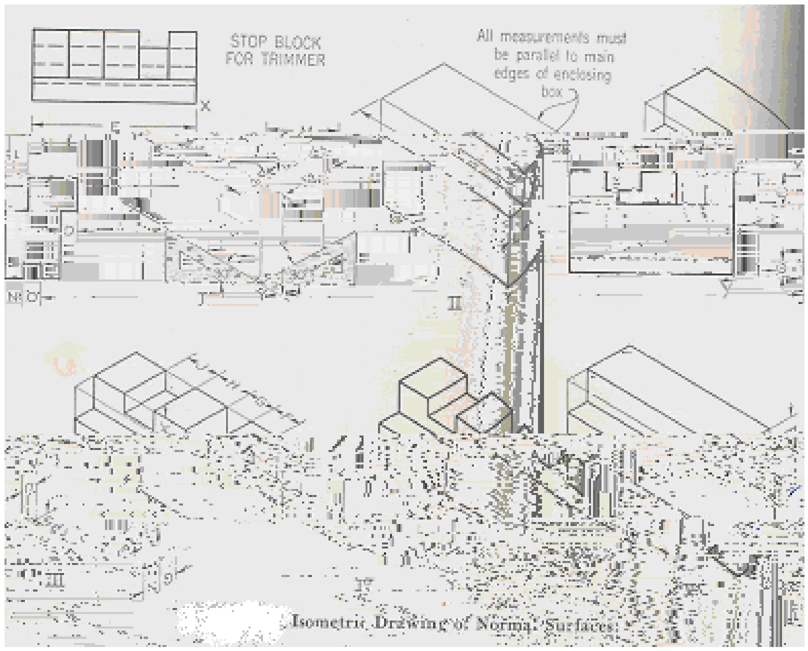
5.3.2 Isometric Drawing

When a drawing is prepared with an isometric scale or other wise as the object is actually projected on a plane of projection, it is an *isometric projection*. But when it is prepared with an ordinary scale, it is an *isometric drawing*. The isometric drawing is 22.5% larger than the isometric projection, but the pictorial value is obviously the same in both.

Since the isometric projection is foreshortened and an isometric drawing is full size, it is customary to make an isometric drawing rather than an isometric projection, because it is so much easier to execute and, for all practical purposes, is just as satisfactory as the isometric projection.

The steps in constructing an isometric drawing of an object composed only of normal surfaces, as illustrated in figure 5.20 .Notice that all measurements are made parallel to the main

The method of constructing an



Isometric Drawing of Normal Surfaces

Box Construction

Objects of rectangular shape may be more easily drawn by means of *box construction*, which consists simply in imagining the object to be enclosed in a rectangular box whose sides coincide with the main faces of the object. For example, in fig below, the object shown in two views is imagined to be enclosed in a construction box.

This box is then drawn lightly with construction lines, I, the irregular features are then constructed, II, and finally, III, the required lines are made heavy.

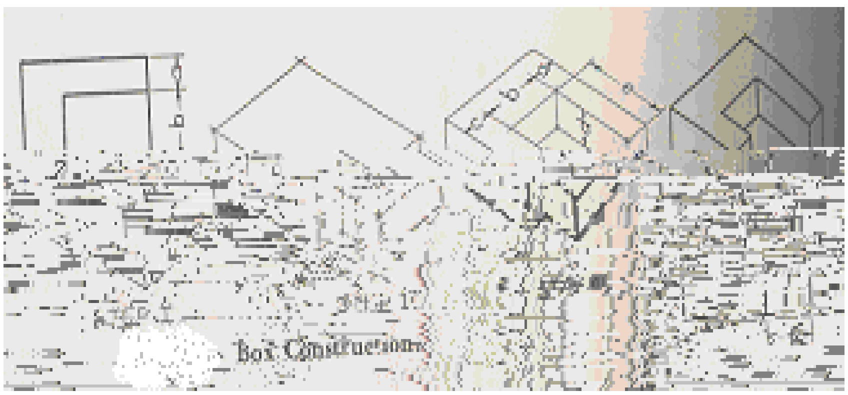


Figure 5.21 isometric box constructions

Review question

1. Explain the purpose and theory of multi view projections
2. Construct a box for isometric and oblique drawings based on the technical drawing procedure.
3. Describe “Glass box method“ of orthographic projections.

CHAPTER SIX

SECTIONING

Objectives:

At the end of this chapter, the students should be able to:

- Describe the purpose of sectioning in technical

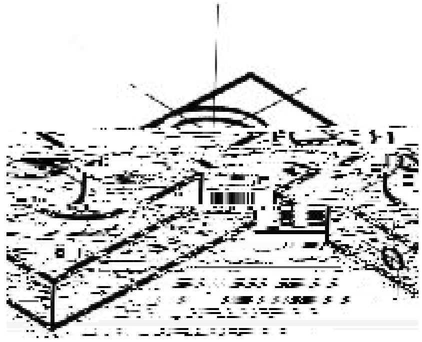
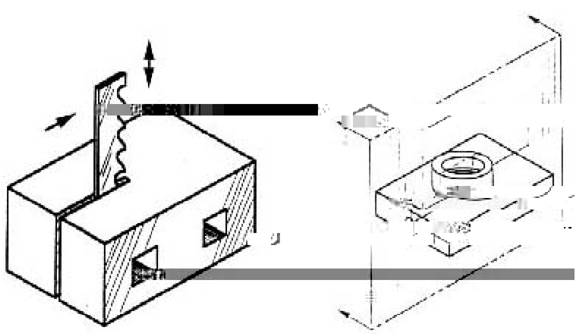


Figure 6.1 An isometric drawing that does not show all details

We can get around this by pretending to cut the object on a plane and showing the "sectional view". The sectional view is applicable to objects like engine blocks, where the interior details are intricate and would be very difficult to understand through the use of "hidden" lines (hidden lines are, by



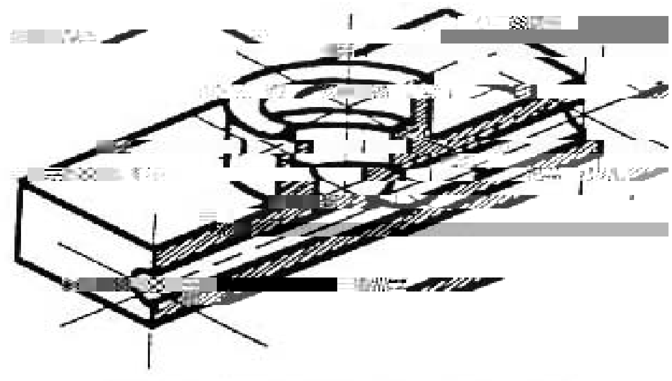


Figure 6.3 sectioning the object in figure 6.1

Take away the front half (figure 6.3) and what you have is a full section view (figure 6.4).

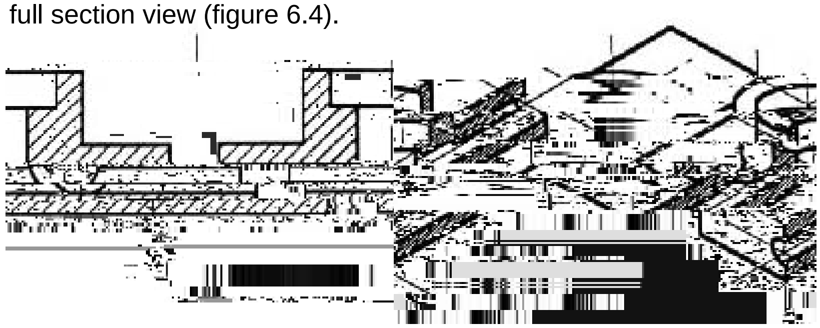


Figure 6.4 Sectioned isometric and orthogonal views

The cross-section looks like figure 6.4 when it is viewed from straight ahead.

In short, when the interior of the object is complicated or when the component parts of a machine are drawn assembled, an attempt to show hidden portions by the customary dashed lines in regular or graphic views often results in a confusing networks, which is difficult to draw and almost impossible to read clearly.

In case of this kind, to aid in describing the object, one or more views are drawn to show the object as if a portion has been cut away to show the interior.

For some simple objects where the orthographic un sectioned views can be easily read, sectional views are often preferable because they show clearly and emphasis the solid portions, the voids, and the shape.

Cross-Sectional Views

A cross-sectional view portrays a cut-away portion of the object and is another way to show hidden components in a device.

Imagine a plane that cuts vertically through the center of the pillow block as shown in figure 6.5 (a) and (b). Then imagine removing the material from the front of this plane, as shown in figure 6.5 (b).

Fig-2.9222 TDal 6.5 Section of an object with circular holes

make than isometric drawings. Seasoned engineers can interpret orthogonal drawings without needing an isometric drawing, but this takes a bit of practice.

The top "outside" view of the bearing is shown in figure 6.7. It is an orthogonal (perpendicular) projection. Notice the direction of the arrows for the "A-A" cutting plane.

Figure 6.7 The top “out side” view of the bearing

6.2 HOW SECTIONS ARE SHOWN

To clearly draw the sectional views, we have to understand the following terminologies.

A. Cutting Plane Lines

The cutting plane line indicates the path that an imaginary cutting plane follows to slice through an object. Think of the cutting plane line as a saw blade that is used to cut through the object. The cutting-plane line is represented by a thick black dashed line.

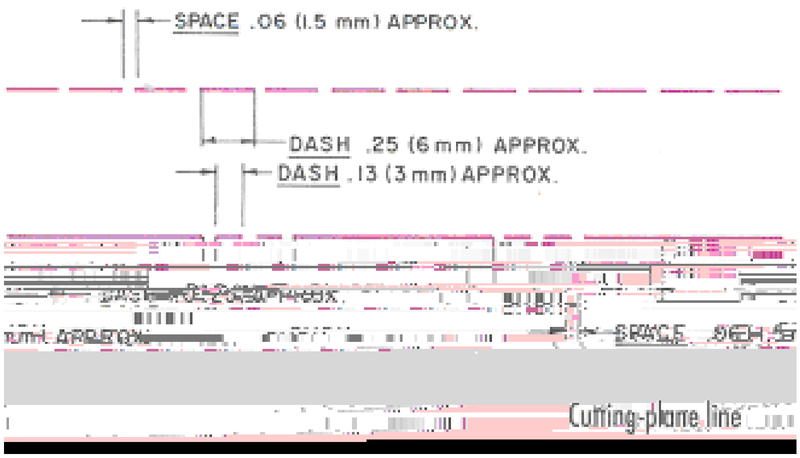


Figure 6.8 cutting plane lines

B .Direction of Sight

The drafter must indicate the direction in which the object is to be viewed after it is sliced or cut through. This is accomplished by adding a short leader and arrowhead to the ends of the cutting-plane. And these arrows indicate the direction of sight.

Figure 6.9 The direction of sight

C. Section Lining

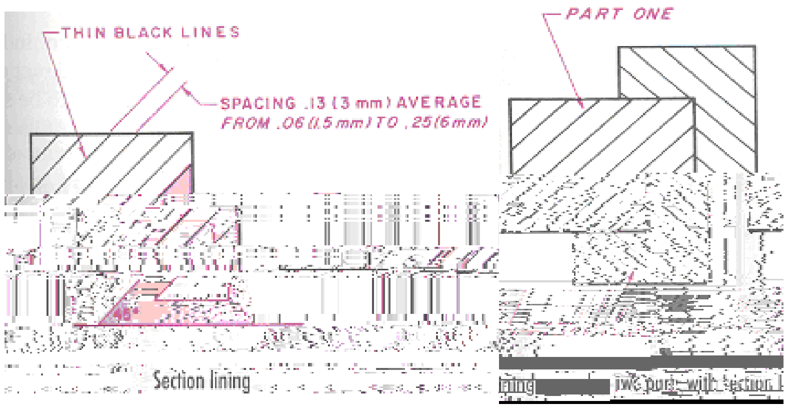


Figure 6.10 Section lining

6.3 MULTSECTION VIEWS

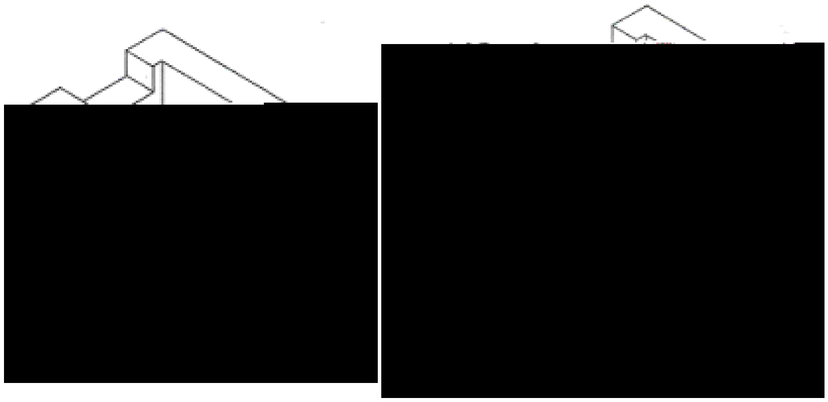
The different kinds of sections used today are:

- Full section
- Offset section
- Half section
- Broken-out section
- Revolved section
- Auxillary section etc.

In this part, we only consider the most commonly used types of sections.

Full Section

It is simply a section of one of



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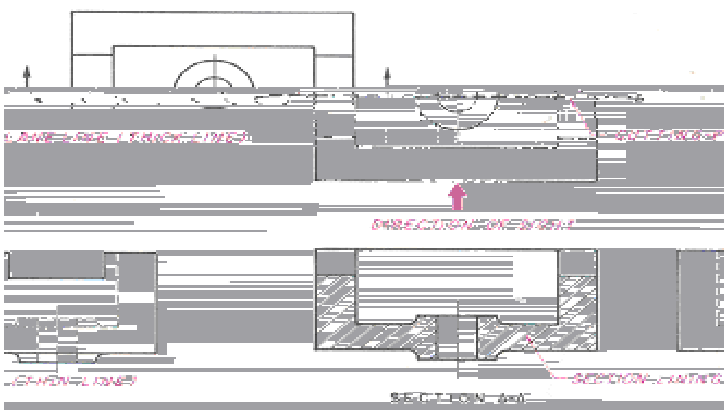
Given: Regular three views of an object



Offset Section

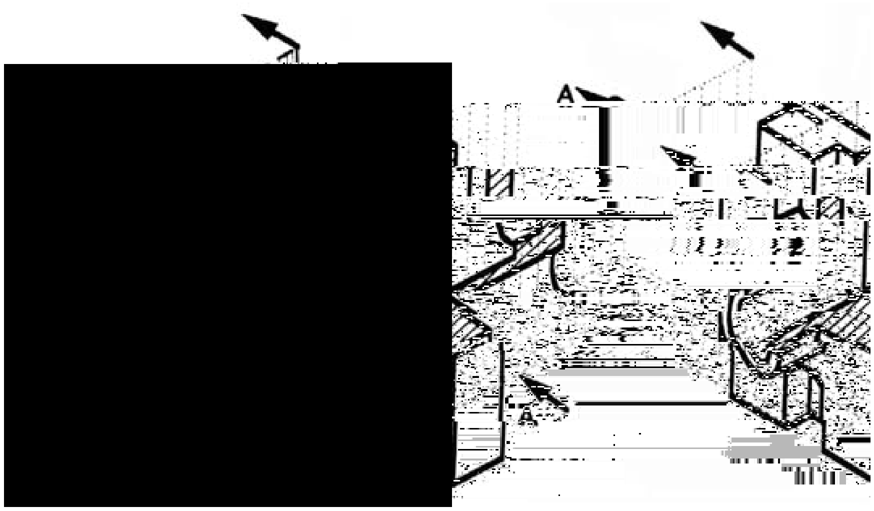
Many times, important features do not fall in a straight line as they do in a full section. These important features can be illustrated in an offset section by bendi

[redacted]

[redacted]

Half-Sections

A half-section is a view of an object showing one-half of the view in section, as in figure 6.13 (a) and (b)

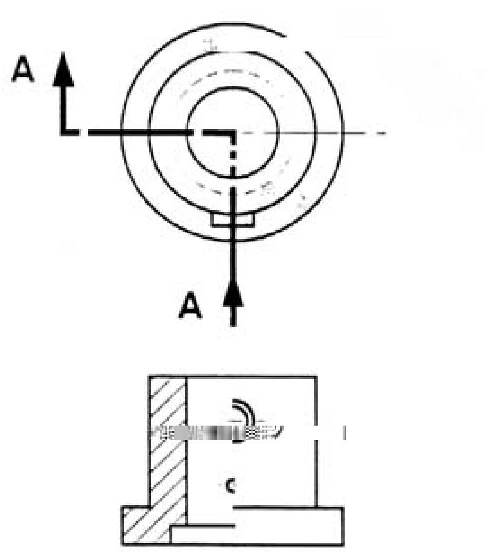


(b [redacted]

Figure 6.13 (a) Full and sectioned isometric views (b) Front view and half section

The diagonal lines on the section drawing are used to indicate the area that has been theoretically cut. These lines are called *section lining* or *cross-hatching*. The lines are thin and are usually drawn at a 45-degree angle to the major outline of the object. The spacing between lines should be uniform.

A second, rarer, use of cross-hatching is to indicate the material of the object. One form of cross-hatching may be



Usually hidden (dotted) lines are not used on the cross-section unless they are needed for dimensioning purposes. Also, some hidden lines on the non-sectioned part of the drawings are not needed (figure 6.13) since they become redundant information and may clutter the drawing.

Review questions

1. Describe the purpose of sectioning in technical drawings
2. What is “direction of sight” in sectioning?
3. Mention the difference between offset section and full section.

CHAPTER SEVEN

PROJECTION OF POINTS, LINES AND PLANES

Objectives:

At the end of the chapter, students should be able to:

- Discuss reference line, picture planes and views
- Classify lines based on direction, type etc.
- Explain the orthographic projection of points and lines (principal, vertical and inclined lines etc)
- Draw the true length of an oblique lines
- Explain how to draw a point view of a line
- Define principal planes
- List out the main difference between types of principal planes
- Explain the use of edge view and steps to draw an edge view of a plane
- Discuss the procedures how to draw true shape/size of oblique or inclined planes

7.1 Introduction

A major problem in technical drawing and design is the creation of projections for finding the true views of lines and planes. The following is a brief review of the principles of descriptive geometry involved in the solution of such problems. The designers working along with an engineering team can solve problems graphically with geometric elements. Structures that occupy space have three-dimensional forms made up of a combination of geometric elements.

The geometric solutions of three-dimensional forms require an understanding of the space relations that points, lines, and planes share in forming any given shape. Problems which many times require mathematical solutions can often be solved graphically with accuracy that will allow manufacturing and construction. Thus, basic *descriptive geometry* is one of the designer's methods of thinking through and solving problems.

All geometric shapes are composed of points and their

A point can be considered physically real and can be located by a small dot or a small cross. It is normally identified by two or more projections. In fig below, points A and B are located on all three-reference planes. Notice that the unfolding of the three planes forms a two-dimensional surface with the fold lines remaining. The fold lines are labeled as shown to indicate that F represents the *Front view,* T represents the *Top views,* and S represents the *Profile or Right side view.* The planes are replaced with reference lines HF and FP, which are placed in the same position as the fold lines.

7.2 Reference Planes

Unfolding of the reference planes forms a two-dimensional surface, which a drafter uses to construct and solve problems. The planes are labeled so that T represents the *top or horizontal reference plane,* F represents *the front or vertical reference plane,* S or P represents *the side (end) or profile reference plane.* Thus a point 1 on the part, line or plane would be identified as 1F on the top reference plane, and 1T on the top reference plane, and 1S on the profile reference plane. The folding lines shown on the box are required to as reference lines on the drawing. Other reference planes

7.3 Projection of Point

Since a point is a location in space and not a dimensional form, it must be located by measurements taken from established reference line. The two figures below show the glass box method of orthographic projection illustrated pictorially and orthographically. These two figures represent the projection of point 1 in the three principal planes, frontal (1F), horizontal (1H), and profile (1P). In glass box method, it is assumed that each mutually perpendicular plane is hinged so as to be revolved in to the planes of the paper. "*The intersection line of two successive (perpendicular) image planes is called* ***fold line/ reference line.***" All measurements are taken from fold lines to locate a point is space. A fold line/reference line can be visualized as the edge view of a reference plane.

A point can be located by means of verbal description by giving dimensions from fold/ reference lines. Point 1 is below the horizontal plane (D1), to the left of the profile plane (D2), and behind the frontal plane (D3). D1 establishes the elevation or height of the point in front and side view, D2 the right, left location or width in the front and top view, and D3 the distance behind the frontal plane (depth) in the top and side view.

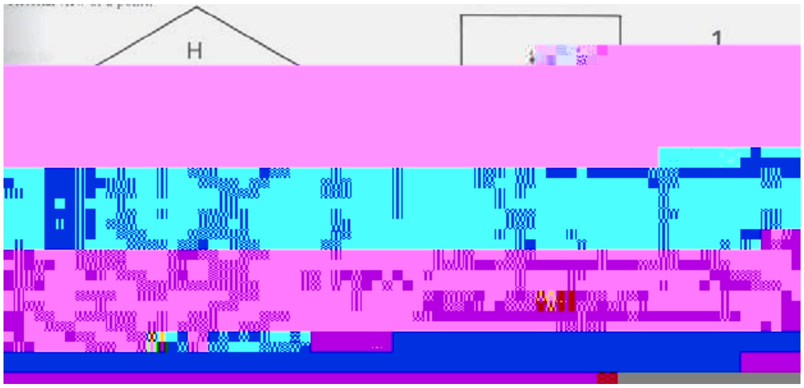


Figure 7.1 Projection of a point

7.4 Lines in Space

Lines can be thought as a series of points in space, having magnitude (length) but not width. It will be assumed that a line is straight unless otherwise stated. Though a line may be located by establishing its end points and may be of a definite specified length, all lines can be extended in order to solve a problem. Therefore a purely theoretical definition of a line could be: "*Lines are straight elements that have no width, but are infinite in length (magnitude); they can be located by two points which are not on the same spot but fall along the line.*"

When two lines lie in the same plane they will either be parallel or intersect. Lines can be used to establish surfaces, or solid shapes. In a majority of illustrations the view of a line and its locating points are labeled with a subscript corresponding to the plane of projection, as fig below where the end points of line 1-2 are denoted 1H and 2H in the horizontal views, 1F and 2F in the frontal view, and 1P and 2P in the profile plane.

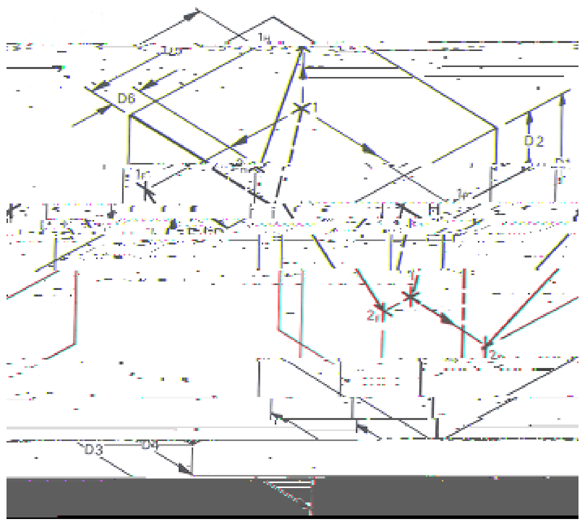


Figure 7.2 Projection of a line

7.4.1 Classification of Lines in Orthographic Projections

In orthographic projections lines can be classified based on their parallelism with the picture planes, type and direction.

A. Classification based on Parallelism

A line that is parallel to a principal plane is called a parallel. Since there are three principal planes of projection, there are three principal lines: *horizontal, frontal and profile.*

- ***A horizontal line***: is a principal line which is parallel to the horizontal plane and appears true length in the horizontal view.
- ***A frontal line***: is a principal line which is parallel to the frontal plane and appears true length in the frontal view.
- ***A profile line***: is a principal line which is parallel to the profile plane and appears true length in the profile view.

(a) Horizontal line ***(b) Frontal line*** ***(c) Profile line***

Figure 7.3 Types of pincipl lines

Besides the above definitions, the following terms are used describe lines according to the *direction* and *type*.

B. Classification Based ontion

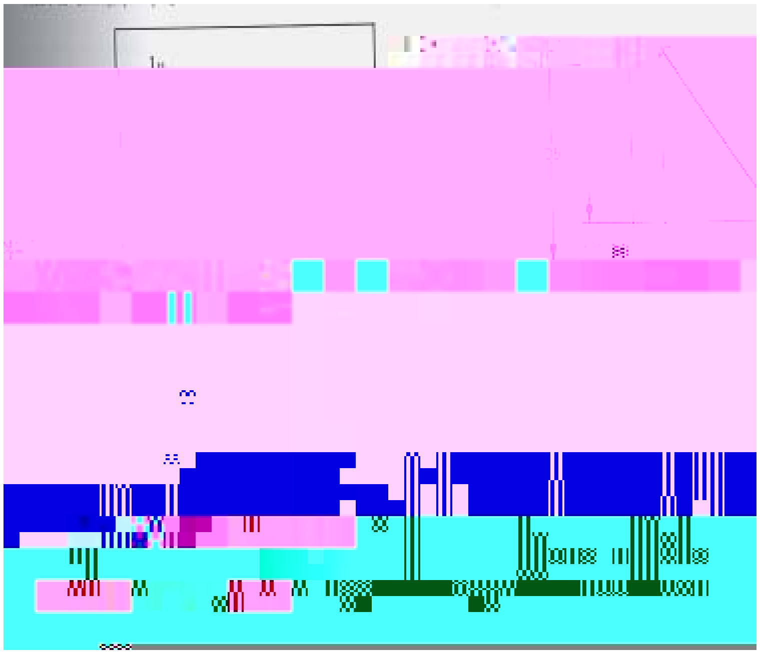
- ***Vertical line***: A vertical line is pedicula the horizontal plane, and appears true length in the frontal and profile views and as a point view in the horizontal views.

- ***Level line***: any line that is parallel to the horizontal plane is a level line. Level lines are horizontal lines.
- ***Inclined lines***: Inclined lines will be parallel to the frontal or profile planes and at angle to the horizontal plane and appears true length in the views where it is parallel to a principal plane.

C. Classification based on Type

- ***Oblique:*** oblique lines are inclined to all three principal planes and therefore will not appear true length in a principal view.
- ***Foreshortened***: lines that are not true length in a specific view appear shortened than their true length measurement.
- ***Point view***: a point view is a view of a line in which the line is perpendicular to the viewing plane (the line of sight is parallel to the line).
- ***True length***: a view in which a line can be measured true distance between its end points shows the line as true length and appears true length in any view where it is parallel to the plane of projection

7.4.2 Orthographic Pr

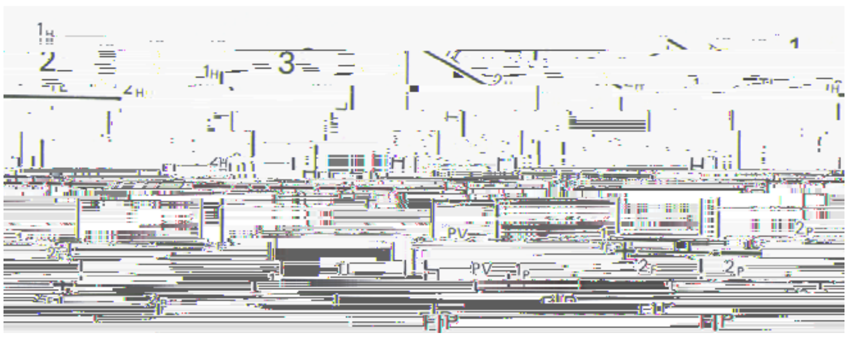


In figure above, each end points of line 1-2 is located from two fold lines in each view, using dimensions or projection lines that originate in a previous view. Dimensions D1 and D2 establish the elevation of the end points in the profile and frontal view, since these points are horizontally in line in these two views. D3 and D4 locate the end points in relation to the F/P fold line (to the left of the profile plane), in both the frontal and horizontal views, since these points are aligned vertically. D5 and D6 locate each point in relation to the H/F and the F/P fold line, since these dimensions are the distance behind the frontal plane and will show in both the horizontal and profile views.

A. Level and Vertical Lines

A line that is parallel to the horizontal projection plane is a “level” line and appears true length in the horizontal view. A level line is a horizontal line (principal line) since it is parallel to the horizontal projection plane. In figure below the three variations of level (horizontal) lines are illustrated. In example (1), line 1-2 is parallel to the horizontal plane and inclined to the frontal and profile planes. It appears true length in the horizontal view and foreshortened in the other two views. Example (2) shows level line line1-2 parallel to both the frontal and horizontal projection planes and is a point view in the profile view. Line 1-2 is true length in two principal views and is therefore both a horizontal line and a frontal line where as in example (3), line1-2 is parallel to both the profile and horizontal projection planes and appears as a point view in the frontal view, and true length in both other principal views. Hence, line 1-2 is a profile line, and a horizontal line.

Vertical lines are perpendicular to the horizontal plane (view)



B. Inclined Lines

Lines that appear true length in the frontal or profile view (but not both) are inclined

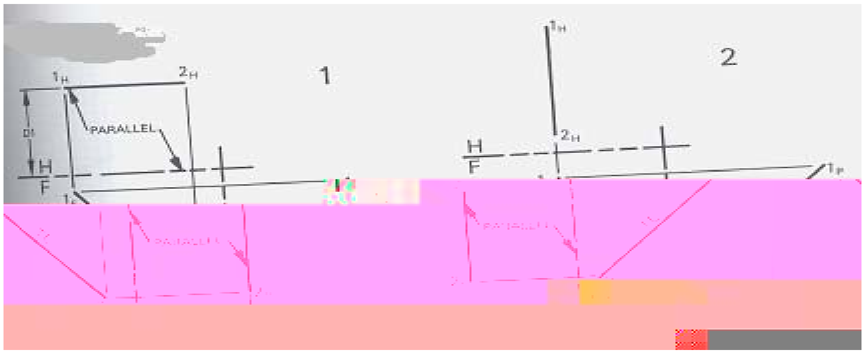


Figure 7.6 Inclined lines

Lines. Inclined lines will be parallel to the frontal plane, or parallel to the profile plane. Hence, inclined lines will appear foreshortened in two principal views and true length in the other principal view. In example (1), line 1-2 is true length in the frontal view i.e. parallel to the frontal projection plane and

C. Frontal Lines

*A line that is parallel to the frontal projection plane is a **frontal line***. Frontal lines are principal lines and always appear true length in the frontal view. A frontal line can be inclined, level, or vertical, but must be true length. A vertical frontal line appears as a point view in the horizontal view and true length in both the frontal and profile views, therefore a vertical line is both a frontal and profile line since it is true length in both of these views. If a level frontal line appeared as a point in the profile plane, it would be true length in the frontal and horizontal views and is therefore a horizontal as well as a frontal line.

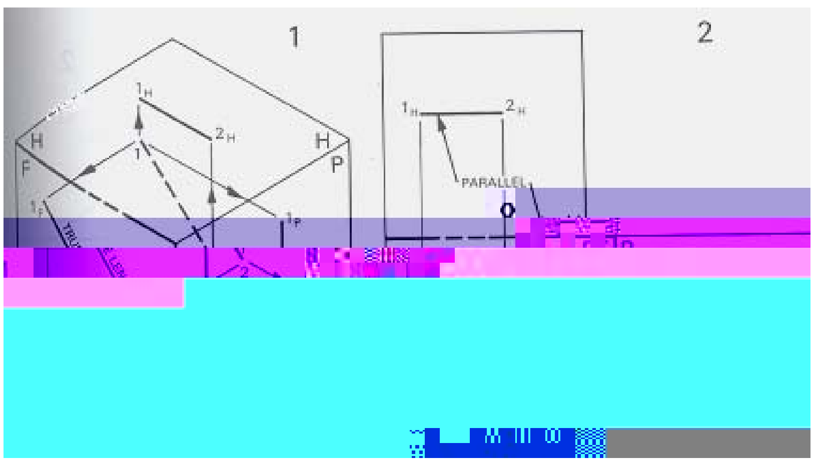


Figure 7.7 Frontal lines

Line 1-2 lies behind the frontal plane the same distance in the horizontal and profile views, dimensions D1.Note that it is not possible to tell if a line is a frontal line given the front view alone. Only in the profile and horizontal views can it be established that a line is a frontal line

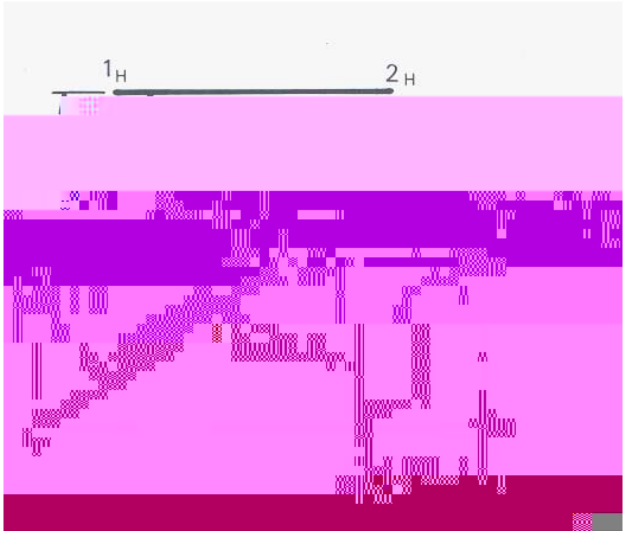


Figure 7.8 Orthographic projection of frontal lines

D. Horizontal Lines

*A line that is parallel to the horizontal projection plane is a **horizontal line.*** Horizontal lines appear true length in the horizontal view and are therefore principal lines. A horizontal line will always be level in the frontal and profile views. If a horizontal line is perpendicular to the frontal plane (and parallel to the profile view) it appears as a point views in the frontal view and true length in the profile view and is a combination horizontal and profile line. Likewise, if a horizontal line is parallel to the frontal plane it appears as a point view in the profile view and true length in the frontal view and thus is a combination horizontal and frontal line.

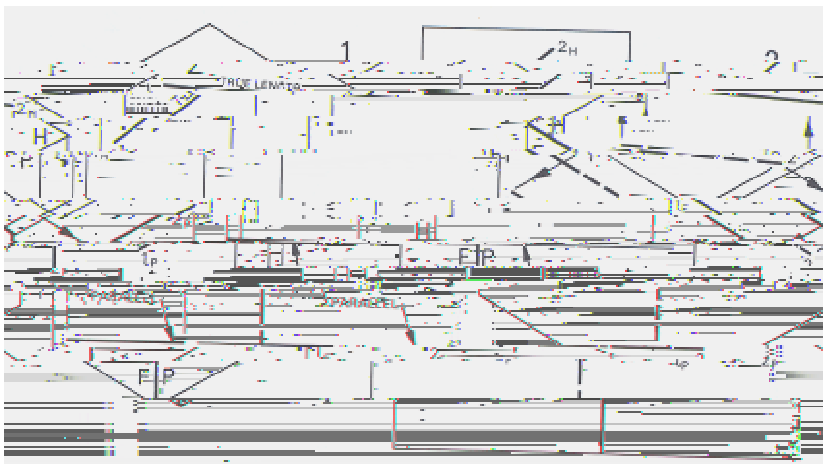


Figure 7.9 Horizontal lines

In order to tell if a line is in or parallel to the horizontal plane, it is necessary to have either the frontal or profile views of the line. Only the frontal and profile views show the line as a point view or parallel to the horizontal plane.

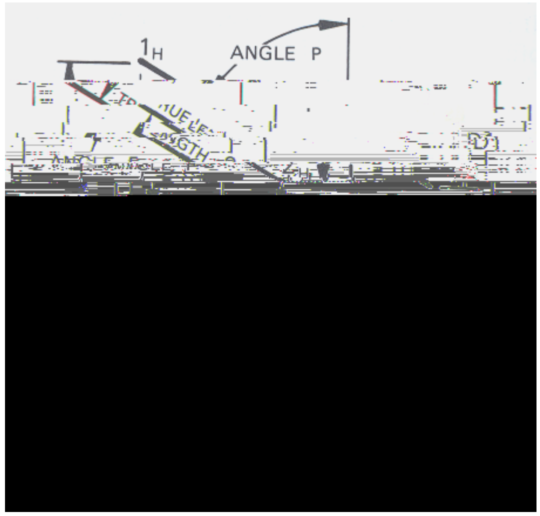


Figure 7.10 Orthographic projection of horizontal lines

E. Profile Lines

A profile line is parallel to the profile plane and shows as true length in the profile view. The frontal and horizontal view of a profile line always shows the line as a point view or foreshortened, in either case the line is parallel to the profile plane. Vertical lines are both profile and frontal lines since they appear true length in the frontal and profile views and as a point in the horizontal view. Where a profile line appears as a point in the front view, the line is both a frontal and profile line.

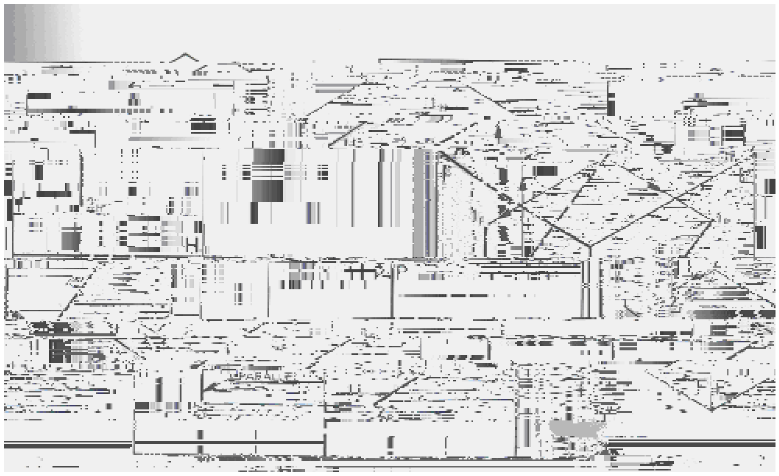


Figure 7.11 Profile lines

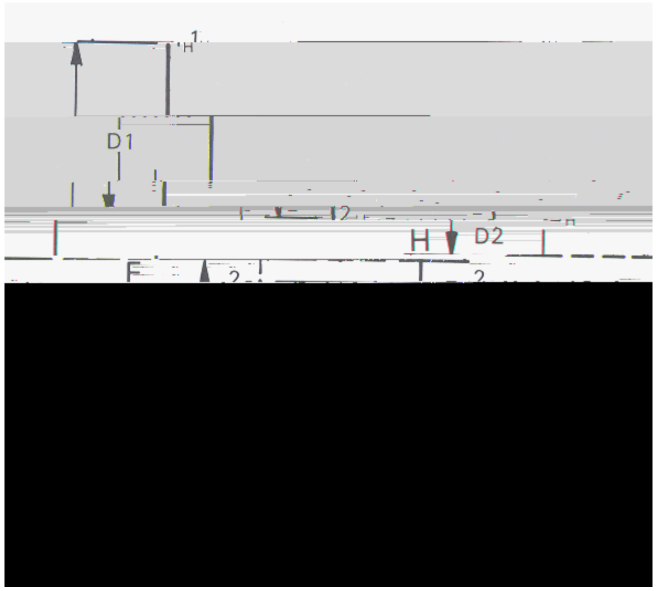


Figure 7.12 Orthographic projection of profile lines

F. Oblique Lines

Oblique lines are inclined to all three principal planes: horizontal, frontal, and profile. An oblique line is not vertical,

and thehhe does not ap-.000. ar true length in th.000. frontal, horizontal, or profile views. All three principal views of an oblique line appear foreshortened.

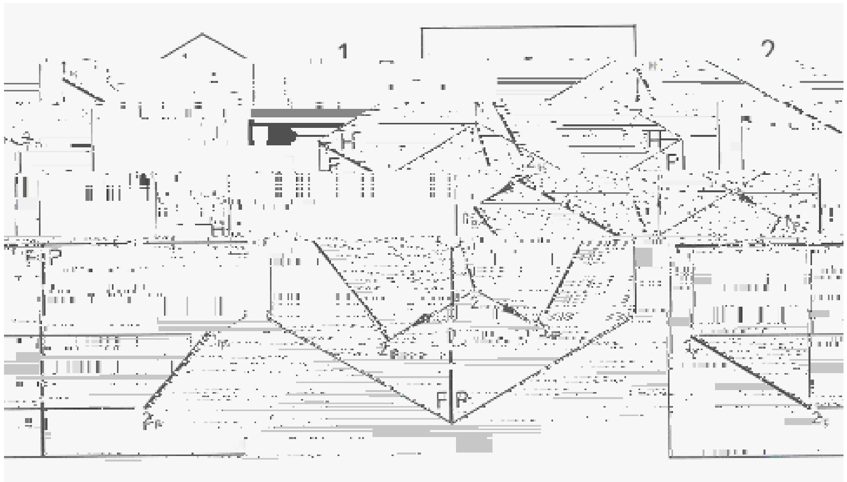
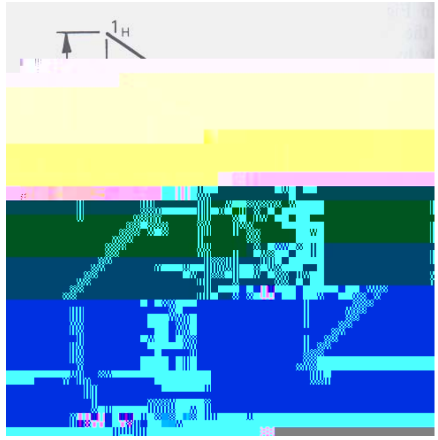


Figure 7.13 Oblique lines

In order to solve for true length of an oblique line, an auxiliary view with a line of sight perpendicular to a view of the oblique line must be projected from any existing view. The fold line between these two views will be parallel to the oblique line.

Line 1-2 is an oblique line since it is not parallel to any principal planes of projection and appears foreshortened in every view. In order to locate an oblique in space, dimensions must be taken from fold lines and projection lines extended from an existing view. Dimension D1 and D2 locate the end points of line 1-2 from the H/F and F/P fold line and represent the distance line1-2 behind the frontal plane.



describe the procedure for drawing a true length projection of an oblique line from the frontal view,

1. Establish a line of sight perpendicular to oblique line 1-2 in the frontal view.
2. Draws fold line F/A perpendicular to the line of sight and parallel to the oblique line 1_F-2_F

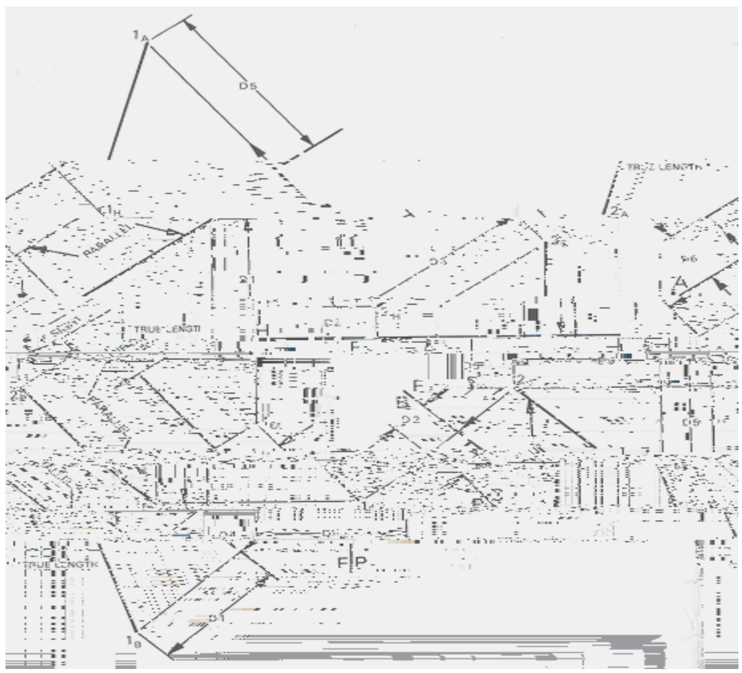


Figure 7.15 True lengths of oblique lines

3. Extend projection lines from point 1_F and 2_F perpendicular to the fold line and parallel to the line of sight.

4. Transfer dimensions D1 and D2 from the horizontal view to locate point 1_A and 2_A along the projection lines in auxiliary view A.
5. Connect points 1_A and 2_A. This is the true length of line1-2.

The true length of an oblique line can also be projected from the horizontal views and profile views using the same basic steps as described above.

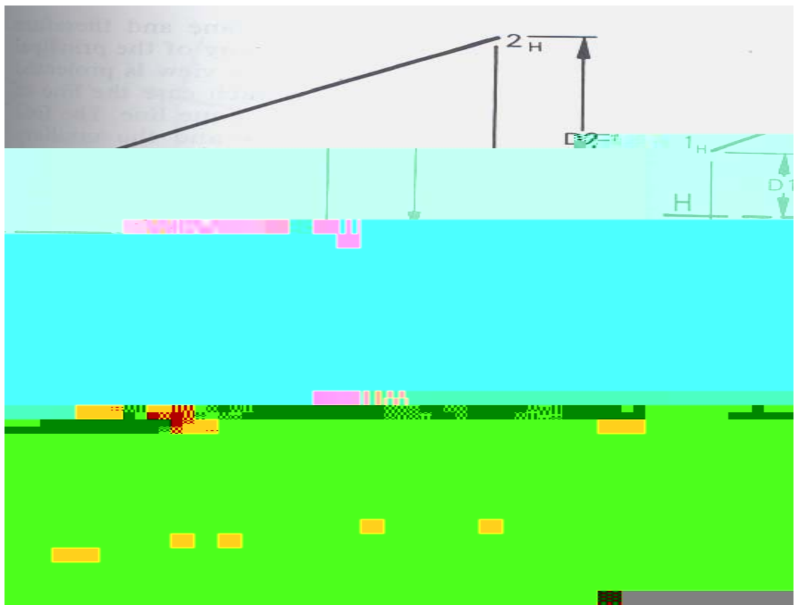


Figure 7.16 True lengths of oblique lines for all principal planes

G. Point View of a Line

A line will project as a point view when the line of sight is parallel to a true length view of the line; in other words the point view is projected on a projection plane that is perpendicular to the true length. Finding the true length and the point view of a line will be required for many situations involving the application of descriptive geometry to engineering problems. The first requirement for a point view is that the line be projected as a true length.

The point view of a principal line is established by the use of a primary auxiliary view as shown below. The steps are:

Step 1: Establish a line of sight parallel to the true length line 1_H-2_H.

Step 2: Draw the fold line perpendicular to the line of sight (H/A or H/B). Note that the fold line is also perpendicular to the true length line.

Step 3: Draw a projection line from line 1_H-2_H perpendicular to the fold line and therefore parallel to the line of sight.

Step 4: Transfer dimension D1 from the front view to locate both points along the projection line, in either auxiliary view A or B.

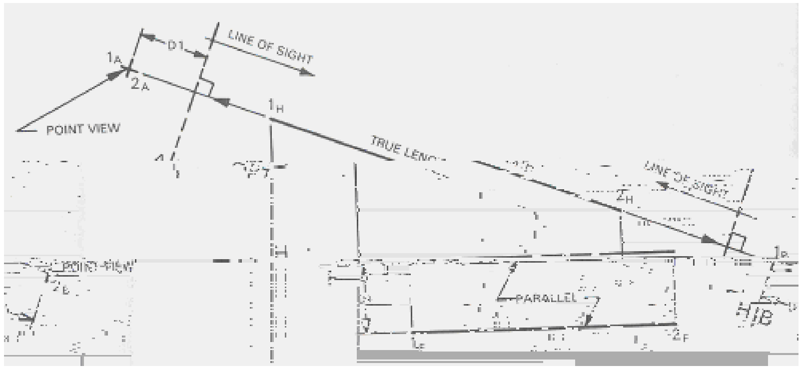


Figure 7.17 Point view of a line

Line 1-2 is projected as true length in two separate primary auxiliary views, A and C. To establish the point view, a secondary auxiliary view (B or D) is projected perpendicular to the true length line. For auxiliary view B transfer the distance between H/A and line 1_H-2_H along the projection line from fold line A/B to locate point view 1_B-2_B. For auxiliary view D, transfer the distance between F/C and line 1_F-2_F along the projection line from fold line C/D to locate the point view of line 1_D-2_D.

Figure 7.18 Point view of an oblique line

Planes

*A **plane** can be defined as a flat surface that is not curved or warped. And a plane can be fixed in space by locating any three points that lie in its surface and are not in a straight line. A line and a point, two intersecting lines, or two parallel lines also define a plane.*

Classification of Planes

When a plane is parallel to a principal projection plane, it is a ***principal plane***. A principal plane can be a horizontal plane, a frontal plane, or a profile plane depending on its relation ship to a principal projection plane. All lines in a horizontal plane, frontal plane, or profile plane are true length lines; therefore principal planes are made up of principal lines. Principal planes can be classified as:

A. Principal Lines

- ***A horizontal plane***: it is parallel to the projection plane. It is true size or shape in the horizontal view since all of its lines are principal lines, therefore they project true length. The frontal and profile views of a horizontal plane always show the plane as *edge view.*

- ***A frontal plane***: it lies parallel to the frontal projection plane where it shows as true size. In the horizontal and profile views the plane appears as an edge view. All lines show true length in the frontal view, since they are principal lines (frontal lines).

- ***A profile plane***: it is true size in the profile view and appears as an edge in the frontal and horizontal views. Every line in the plane is true length in the profile view since they are profile lines. Profile planes are perpendicular to the frontal and horizontal projection planes.

Figure 7.19 Types of principal planes

B. VERTICAL PLANES

Vertical planes are perpendicular to the horizontal projection plane. The horizontal view of all vertical planes shows the plane as an edge view. The following figures show the three basic positions for a vertical plane.

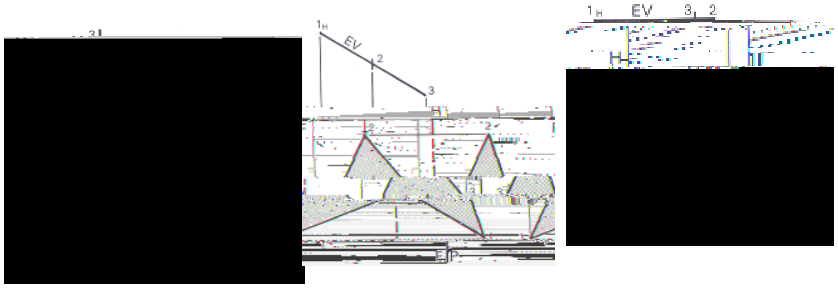
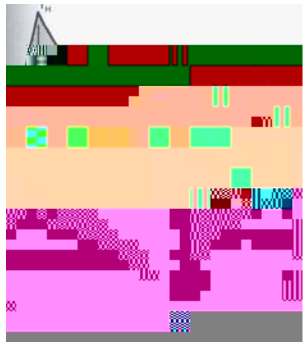


Figure 7.20 Vertical Planes

C. OBLIQUE AND INCLINED PLANES

The classification of planes is determined by their relationship to the three principal projection planes: frontal, horizontal, and profile. Principal planes appear as a true size in one of the three principal projections and as edges in the other two. *Oblique planes* and inclined planes do not appear true size in any of the three principal views. Oblique and inclined planes are not vertical or horizontal (level), and will not be parallel to a principal projection plane.

- ***Oblique plane***: An oblique plane is inclined to all



Edge View of a Plane

An edge view of a plane is seen in a view where the line of sight is parallel to the plane. The line of sight is parallel to the plane when it is parallel to a true length line that lies on the plane. Since a projection plane is always perpendicular to the line of sight, it follows that a view drawn perpendicular to a plane (perpendicular to a true length line that lies in the plane) shows the plane as an edge. This can be seen in a vertical plane, which appears, as an edge in the horizontal view, since it is perpendicular to the horizontal projection plane. A horizontal plane is perpendicular to the frontal and profile projection planes and thus appears as an edge in these two views.

When the given plane is oblique, an auxiliary (secondary projection plane) plane is needed. In order to establish a line of sight parallel to the plane, a true length line needs to be drawn which lies on the plane. An auxiliary view where the line appears as a point view shows the plane as an edge. So the following are the genera steps that are required to create an edge view. In figure below, plane 1-2-3 is given and an edge view is required.

Step 1: Draw line 1_H-2_H on plane 1_H-2_H-3_H, parallel to the H/F, and complete the frontal view by projection. Line 1_F-4_F is true length.

Step 2: Project auxiliary view a perpendicular to plane 1_F-2_F-3_F. The line of sight for this projection is parallel to the plane and parallel to the true length line 1_F-4_F. Draw F/A perpendicular to 1_F-4_F and complete auxiliary view A by projection.

Step 3: Auxiliary view a shows the line 1_A-4_A as a point view and therefore plane 1_A-2_A-3_A appears as an edge view.

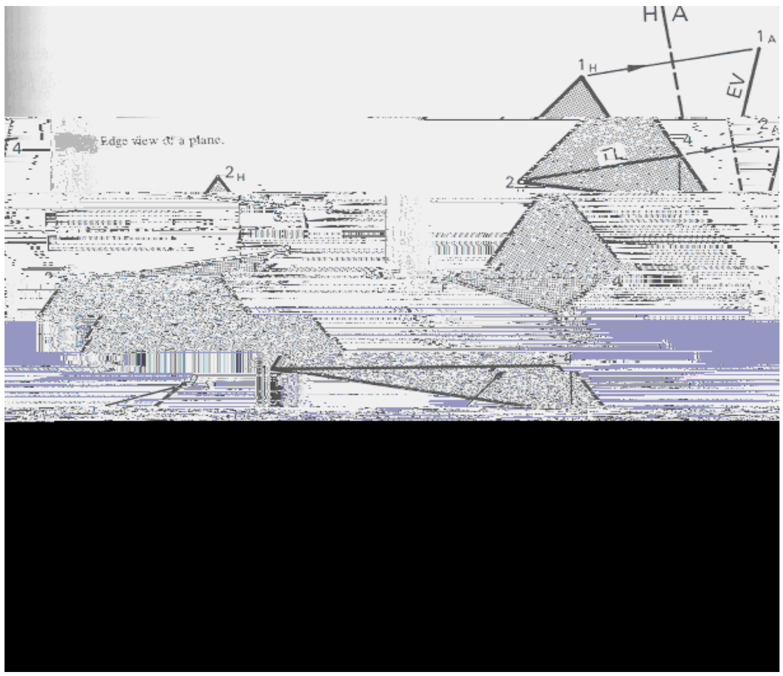


Figure 7.23 Edge view of a plane

7.4.3 True Size (Shape) Of an Oblique Plane

When the line of sight is perpendicular to the edge view of a plane, it projects as true size (shape). The true size view is projected parallel to the edge view of the plane. Therefore the fold line between the views is drawn parallel to the edge view. An oblique plane does not appear as true size in any of the principal projection planes. Therefore a primary and secondary auxiliary view is needed to solve for the true shape of an oblique plane.

In figure 8.6, oblique plane 1-2-3 is given and its true shape is required.

Step 1: Draw a horizontal line 1_F-4_F parallel to the H/F and show it as true length in the horizontal view.

Step 2: Draw H/A perpendicular to line 1_H-4_H and complete auxiliary view B. Line 1_A-4_A is a point view and plane 1_A-2_A-3_A an edge.

Step 3: Project secondary auxiliary view B parallel to the edge view of plane 1_A-2_A-3_A. Draw A/B parallel to the edge view.

Step 4:

Figure 7.24 True shape of an oblique plane

Review questions

1. Describe the difference among reference line, picture planes and views.
2. Explain the orthographic projections of points and lines (principal, vertical and inclined lines etc)
3. Discuss the procedure how to draw the true shape/ size of oblique or inclined planes.
4. Enumerate the use of edge view and steps to draw edge of a plane.

CHAPTER EIGHT

DIMENSIONING

Objectives:

At the end of this chapter, the students should be able to:

- Discuss the purposes of dimensioning
- Explain the differences between dimension line, extension line, leaders etc.
- Draw the dimension of technical drawings as per the standard

8.1 Introduction

The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines.

1. Accuracy: correct values must be given.
2. Clearness: dimensions must be placed in appropriate positions.
3. Completeness: nothing must be left out, and nothing duplicated.
4. Readability: the appropriate line quality must be used for legibility.

8.2 Definitions

- **Dimension line** is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (figure 8.1).

Figure 8.1 Dimensioning Drawing

- An **arrowhead** is approximately 3 mm long and 1 mm wide. That is, the length is roughly three times the width.
- An **extension line** extends a line on the object to the dimension line. The first dimension line should be

approximately 12 mm (0.6 in) from the object. Extension lines begin 1.5 mm from the object and extend 3 mm from the last dimension line.

- ♦ A leader is a thin line used to connect a dimension with a particular area (figure 8.2).

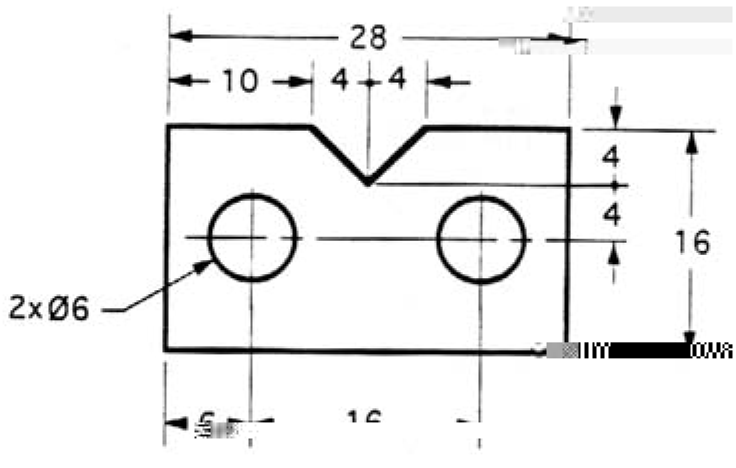


Figure 8.2 Example drawing with a leader

A leader may also be used to indicate a note or comment about a specific area. When there is limited space, a heavy black dot may be substituted for the arrows, as in figure 8.1. Also in this drawing, two holes are identical, allowing the "2x" notation to be used and the dimension to point to only one of the circles.

8.3 Steps in Dimensioning

There are two basic steps in dimensioning objects, regardless of the type of object.

STEP 1: Apply the size dimensions. These are dimensions, which indicate the overall sizes of the object and the various features, which make up the object.

STEP 2: Apply the location dimensions. Location dimensions are dimensions, which locate various features of an object from some specified datum or surface.

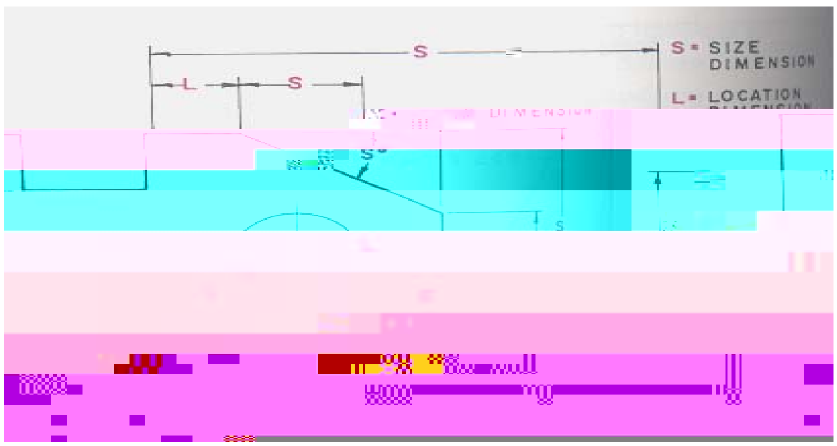


Figure 8.3 Dimensioning

8.4 Where to Put Dimensions

The dimensions should be placed on the face that describes the feature most clearly. Examples of appropriate and inappropriate placing of dimensions are shown in figure 9.4.

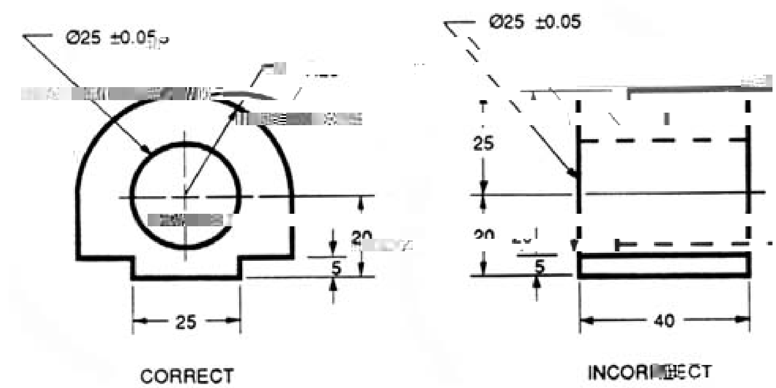


Figure 8.4 Example of appropriate and inappropriate dimensioning

In order to get the feel of what dimensioning is all about, we can start with a simple rectangular block. With this simple object, only three dimensions are needed to describe it completely (figure 8.5). There is little choice on where to put its dimensions.

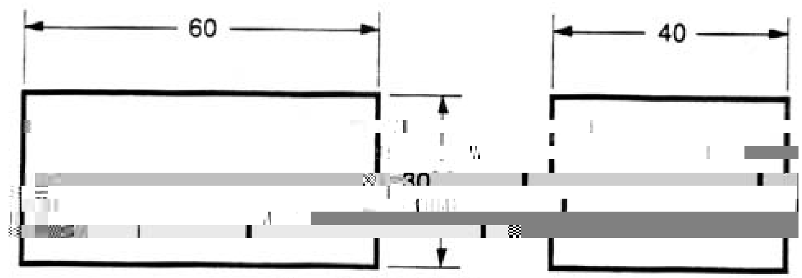


Figure 8.5 Simple object

We have to make some choices when we dimension a block with a notch or cutout (figure 9.6). It is usually best to dimension from a common line or surface. This can be called *the datum line of surface*. This eliminates the addition of measurement or machining inaccuracies that would come from "chain" or "series" dimensioning. Notice how the dimensions originate on the datum surfaces. We chose one datum surface in figure 9.6, and another in figure 9.7. As long as we are consistent, it makes no difference. (We are just showing the top view).

Figure 8.6 Surface datum example

Figure 8.7 Surface datum examples

In figure 9.8 we have shown a hole that we have chosen to dimension on the left side of the object. The Ø stands for "diameter".

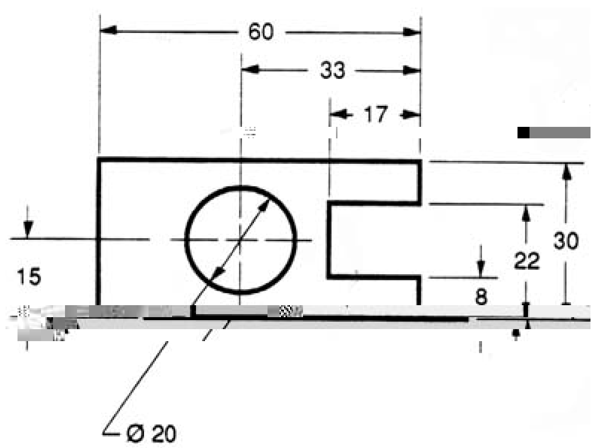


Figure 8.8 Examples of a dimensioned hole

When the left side of the block is "radiuses" as in figure 9.9, we break our rule that we should not duplicate dimensions. The total length is known because the radius of the curve on the left side is given. Then, for clarity, we add the overall length of 60 and we note that it is a reference (REF) dimension. This means that it is not really required.

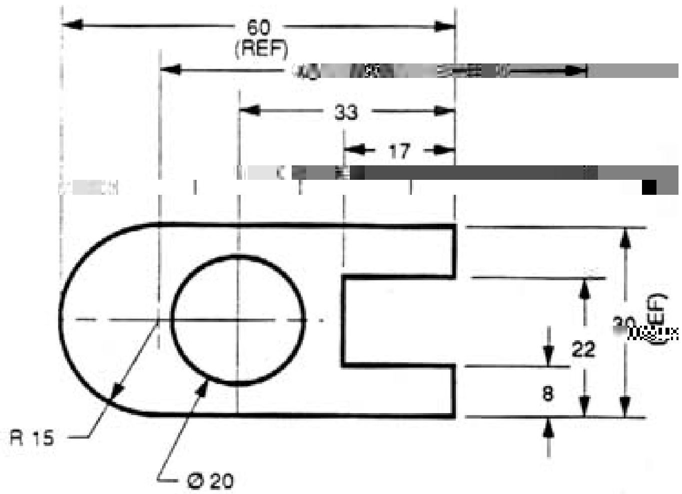


Figure 8.9 Examples of a directly dimensioned hole

Somewhere on the paper, usually the bottom there should be placed information on what measuring system is being used (e.g. inches and millimeters) and also the scale of the drawing.

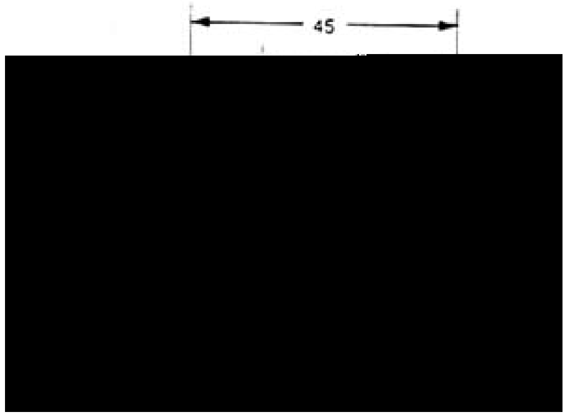


Figure 8.10 Example of a directly dimensioned hole

This drawing is symmetric about the horizontal centerline. Centerlines (chain-dotted) are used for symmetric objects, and also for the center of circles and holes. We can dimension directly to the centerline, as in figure 9.10. In some cases this method can be clearer than just dimensioning between surfaces.

158**line and leaders 2. Discuss the purpose of dimensi**

9.3 Purpose

Map shows information of the locality that is quantifiable; for example:

- Used to show or indicate the exact size or location of a pace.
- Used to measure distances between two places with out the need of actual measurement.
- Used to indicate the direction of places.
-

9.4 Classification of maps

The types of map depend on the size of the map and the purpose of the map. The size of the amp on the other hand, depends on the amount of information that the map maker wants to show. Depending on this, maps are divided in to three categories.

1. **On The Basis Of Scale**:- maps are divided in to three groups. These are:-
    A. Large scale map
    B. Medium scale map
    C. Small scale map

- ***Large scale maps*:-** are maps with the scale of > 1:50,000 (one to fifty thousand). Such maps can cover small area but they show very detailed information.
- ***Medium scale maps***:- are maps with a scale between 1:50,000 and 1:250,000 (One to fifty thousand and one to two hundred and fifty thousand). Here the area to be covered is larger while the amount of information shown is smaller than the large scale map. These maps can't cover large areas.
- ***Small scale maps***:- are maps with a scale of <1=250,000 (one to two hundred and fifty thousand). Such maps can cover large areas but the information

is highly summarized. Therefore, they are suitable for drawing the map of a country, continent, world, etc.

2. On The Basis Of Their Uses

Maps are divided in to two major groups on the basis of their uses. These are:-

- ***Topographic maps:-*** are maps that are used to show all man made and natural features of a given place in one map. E.g relief features, human activities, soil type, population distribution etc. They are some times known as general reference maps.

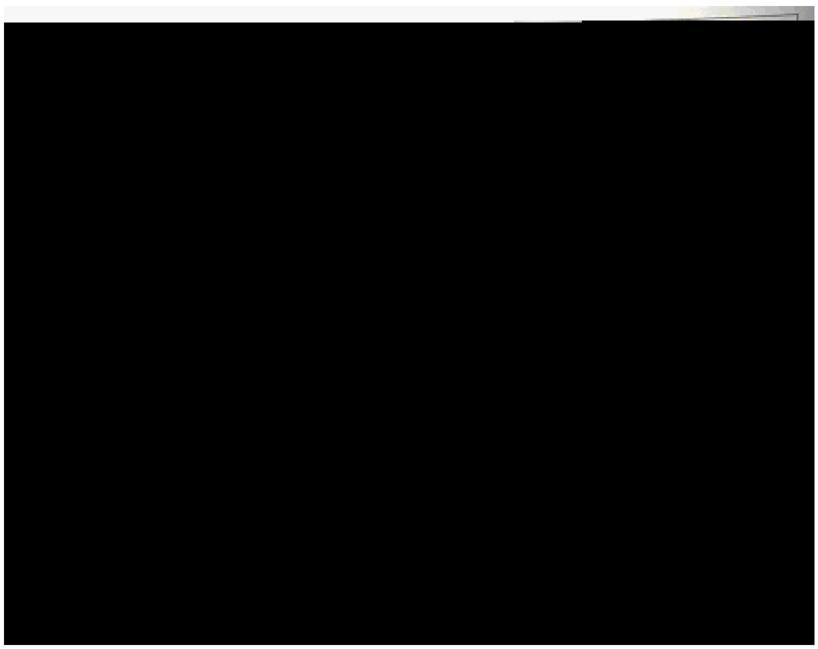


Figure 9.1 Topographic maps

- ***Topical maps***:- are maps that are used to show one particular feature of a given place. Eg. Climate map, population density map, vegetation map, etc. the best examples of topical maps are the followings:
    a. Mobility maps- are the maps that are used to show the pattern of roads, railways, ship routes, airlines, etc.
    b. Inventory maps – like thematic maps they consider specific feature. But in this case the maps are used to show the exact or precise location of an object.
    c. Thematic maps – are the maps that show the distribution of one particular object in a given place. Eg. The distribution of population in a certain locality.

Figure 9.2   Topical Maps

3. One The Bases Of How The Maps Are Drawn:

- Scaled maps
- Air photographed maps
- Sketch maps
- Block maps

For small jobs traditional methods and manual drawing still may be employed. From an educational stand point, one can not under estimate the value of the experience of manually plotting a map as it leads to a much- enhanced ability to use and evaluate properly the main features found in maps.

Sketch map is one that may be utilized in small public health projects and would serve its purpose.

It is a map which can be performed with in short period of time when compared to other maps. As a result this manual focused only on a sketch map.

9.5 Sketch Map

Definition:- a sketch is a free hand drawing of a map or picture of an area or route of travel. It shows enough detail of a locality. Sketches are useful when maps are not available or the existing maps are not adequate.

Sketches may vary from hasty to complete and detailed, depending up on their purpose and the degree of accuracy required. For e.g. a sketch of a large minefield will require more accuracy than a sketch map of .12 757all publv6.5ag

- **The North line (direction)**: It should be drawn close to and parallel with the upper right hand edge of the map sheet.
- **Symbols:** Are conventional signs or assigned symbols, which represent both natural and man made features on the map.

Figure 9.3 Symbols

- **Legend (key):** indicates the meaning of all the mapping symbols used. It appears in the lower right hand corner of the map sheet.

- **Details:** such as the total population, number of houses, highest and lowest elevation are also shown if any. This appears on the top right hand corner of the sketch map sheet.
- **Natural and cultural (man made) features:** Including all water sources (rivers, wells, springs, swamps, lakes and reservoirs) with their name and appropriate direction of flow; markets, schools, police stations, post offices, telephone offices, hospitals, health stations, roads, bridges, mountains, etc. should be shown.
- **Boundaries:** The locality boundaries should be indicated in their correct relative position with the neighboring areas (kebeles, ketena, etc.) N.B – A locality is a small geographical unit with defined boundaries.
- **Scale:** The scale used to convert actual ground measurement in to paper size.
- **Name of the drawer and the person checking the sketch map:** The name of a person (s) who drew the sketch map and the person checking it should be indicated.
- **Boarder line:** are lines drawn all around the sheet leaving a margin of 10mm. A margin of 25 or 30 mm is left on the left hand side so as to facilitate filing. Title block is drawn on the right hand side or right

hand side bottom corner. The remaining space is utilized for making drawings.

N.B: Some of the most common conventional symbols are:


Wreck (hull above low water)
Wreck (depth unknown)
Sunken wreck (dangerous to surface navigation)
Life-saving station (in general)
L.S.S.
Life-saving station (Coast Guard)
Lighthouse
Producing Oil Well
Small Oil Well
Oil and gas symbols. These are used
on contour and relief maps.

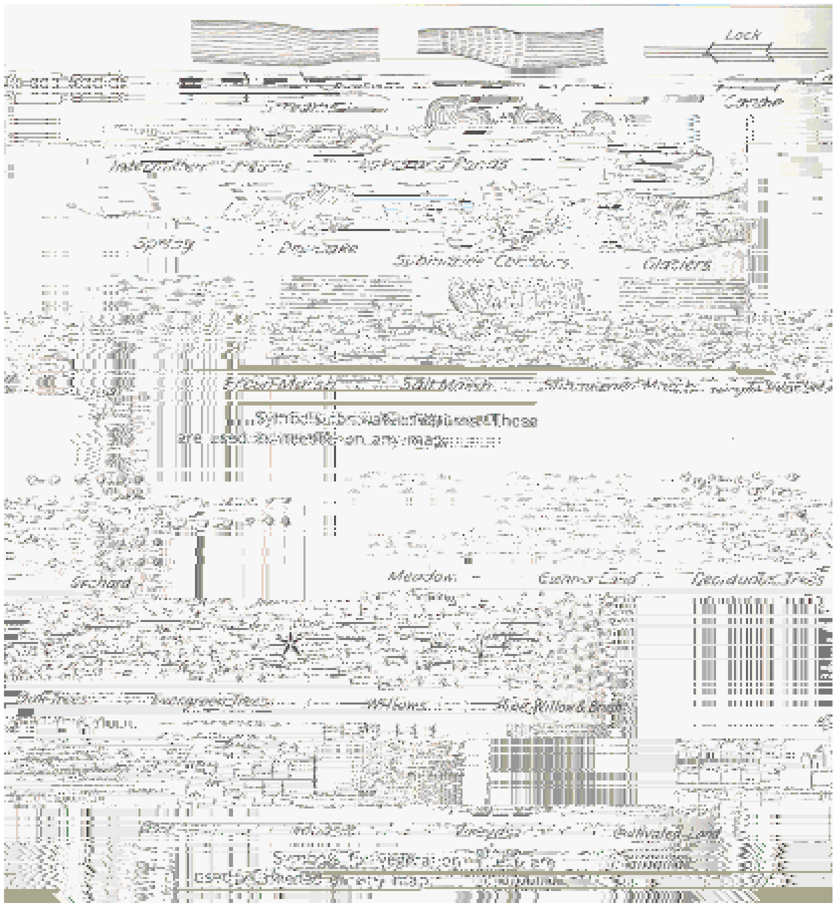


Figure 9.4 Conventional Symbols

9.6. Materials used in a sketch mapping for field or office use

- Map board (Portable drawing board) 42x45 cm.
- Magnetic compass
- Ruler of 40 cm length
- Appropriate size of drawing paper
- Pencil (HB soft) with eraser
- Pencil sharpener (pocket size)
- Thumb-tacks or scotch tape
- Paper clips
- Altimeter 0-3000 meters if possible.
- A clip board
- A haver sac (bag)

9.7 Procedures for making a sketch map

1. Make a survey of the specific location to be drawn. Observe the area from a high point to see lay out of the location (eg. From top if a hill, building, etc.)
2. Select land marks, reference point or bench mark of the location: Land marks a location are prominent and permanent features which are expected to be there incase somebody wished to return to the place at a later dates. Examples of landmarks are: rivers, bridges, lakes,

mountains, market places, schools, police stations, health centers, etc.

3. Proceed sketching: Locate such details as the location of each households, churches, mosques, shops, stores, factories etc. with their proper orientation and compass direction to each other. Draw the actual shapes of the buildings as of their top plan.

Limitation of Sketches Maps

Maps are never identical with the whole or parts of the earth's surface they represent. They do not truly represent the actual

House numbers could be marked on houses using deferent ways:

- Tagged metals
- Number written on pieces of metal sheets
- Paints on doors, windows, on frames or walls.
- Using markers
- Using chalks

N.B: Nevertheless, it is important that the number marks are permanent or long-lasting.

The step of numbering house should be in such a way that it will lead from one house hold or group of house holds to the next minimized walking.

For a systematic is completed (in the office after the field work is over). This helps to organization the assignment of numbers of houses should be planned after the sketch map plan blocks, zones or clusters of houses for ease of tracing.

Review questions

1. Explain the difference between maps and sketches
2. Classify maps based on scales used and method of drawings
3. Mention the procedures and materials used in making sketches

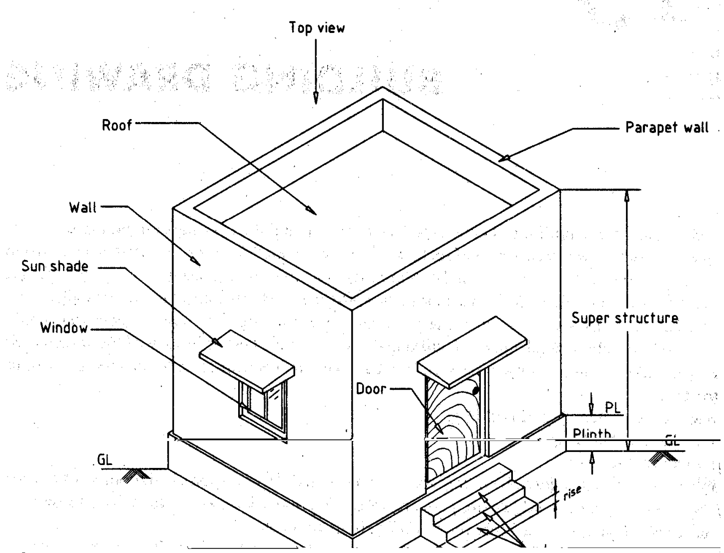
CHAPTER TEN

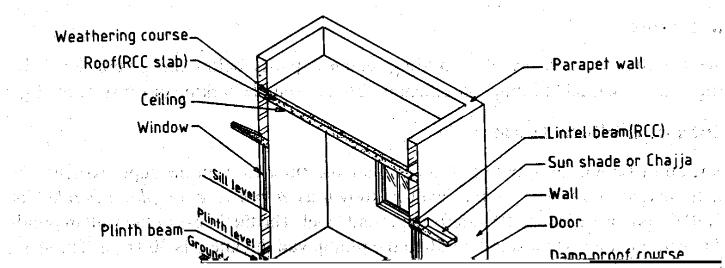
BUILDING DRAWING PLANNING

of the room sizes and components of a building. Building drawings are prepared with great care, much before the construction of any buildings is to be implemented. It shows the location and sizes of various rooms in a building. It is a basic requirement of all sanitarians to know about the details in a building drawing, for the best utilization of the spaces in that building.

10.2 IMPORATNT TERMS USED IN BUILDING DRAWING

Consider a small building having one room, it is cut vertically


Top view
Roof
Parapet wall
Wall
Sun shade
Window
Super structure
Door
PL
Plinth
GL
GL
rise


Weathering course
Roof(RCC slab)
Ceiling
Window
Sill level
Plinth level
Plinth beam
Parapet wall
Lintel beam(RCC)
Sun shade or Chajja
Wall
Door

- Foundation (Substructure):the portion of the building below the ground level which is in direct contact with the ground and used to transmit the loads of the building to the ground.
- Super structure: The portion of the building above the ground level or substructure.
- Basement: it is the lower storey of a building which is partly below the ground level.
- Plinth and Plinth level: the portion of the building between the ground and floor level in the super structure is called *Plinth.* Its height above the ground level is known as *Plinth level or Plinth height*. Its height is usually 450mm, 600-750mm from ground level.
- Wall: the thickness of the super structure which carries the load of the roof , usually 200mm thickness
- Parapet: the wall built above the flat roof, which provides safety to the people, whin9nd leCpty to the people, whb7 TD-.0003 Tcthe C/G3

- Plinth area: the area covered by a building at the plinth level. It is obtained by measuring the outside dimensions of a building at the plinth level.
- Floor area: the area of a building, excluding the area occupied by the wall. It is obtained by deducting the area occupied by walls, from plinth area. In building, the floor area will be 80% to 90% of the plinth area.
- Carpet area: the area of a building which is useful or livable. It is obtained by deducting the area occupied by Verandah, corridors, kitchen, toilet, bath rooms etc. from the floor area.

10.3 PRINCIPLES OF ARCHITECTURE

A house, as far as possible, must satisfy the day to day needs of it occupants. It should provide a comfortable living and protection from weather and seasons. The following principles of architecture are followed to achieve this.

1. Functional planning
2. Structural durability
3. Essential service
4. Outward appearance i.e. aesthetic value
5. Economy

5. Economy

A building is always planned and designed as an economical structure. To ascertain this

- This area is provided near the main entrance with a verandah
- It is directly connected to the bed, bath rooms and W.C by passages
- It is near the dinning room or dining area may be a part of this area
- It is spacious so that furniture can be properly placed leaving some area for circulation
- It has sufficient windows so that surrounding landscape can be fully viewed and enjoyed

***2*. Sleeping Area**

This area is provided for sleeping and relaxing. Bed rooms of all types come under this area. These rooms have attached bath and W.C's. Area of these rooms varies from 10 to 20 m^2. These rooms are large enough so as to allow space for beds, cup boards, writing table and chair. Sometimes space is provided for dressing and make up. Windows are placed on North-West or south west directions. These rooms are placed on North or south-West directions so as to receive in direct sun-light.

3. Service Area

This area is used for daily services like cooking, eating, cleaning, bathing etc. kitchens, dining room, bath rooms, W.C's and toilets from this area. Spaces provided for boilers, washing and drying machines, air conditioning are also covered by service areas.

- ***Kitchen*:** It is the area where cooking is done. It preferably has Eastern or North-Eastern location. Windows are so placed that a house wife can see the main entrance and also supervise the playing children. Standing working areas in kitchen are preferred. Working shelves, washing sink and cooking ranges are placed at 700 to 800 mm. high from floor level. Walls, shelves and skirting are provided with a glazed finish.
- ***Dinning***: It has kitchen on one side and living area on the other. Kitchen activities should not be visible from this area. This area is made ventilated and airy. It is

these areas. For free circulation in the building these are placed. Prayer room study or hobby room, garage and a storage place can also be covered under these areas. A public man, a lawyer, a doctor, a professor needs a separate room in his residential place for carrying out his professional obligations.

The placing of these areas with respect to their utility and functionality is termed as *planning*. The over all placing of rooms, position of rooms, and position of windows, ventilators and doors with respect to north line is called *orientation*.

10.5 PRINCIPLES OF PLANNING OF RESIDENTIAL BULIDINGS

Before planning a residential building, the site is visited, local building by- laws are studied and a line plan is prepared.

7. elegance

cross ventilation. Small sized windows are normally used in areas where hot and dry weather remains most of the time.

6. ***Flexibility*:** It is a provision which allows the same space to be used for some other purposes. Dining space attached to the drawing room and an additional verandah with large windows can allow these areas to be converted into a hall. Even a good terrace on a compact combination on of different rooms can allow such congregations.

7. ***Elegance***: The out ward appealing look which allows the building to diffuse into the adjoining environment is termed *elegance*. Balconies, Verandahs, Sunshades, porches etc. can enhance elegance if properly placed and planned. Circular or arched openings spanning the verandah, doors and window openings have again come in to use they add to the elegance and break the monotony of present day stereo- typed buildings.

8**.** ***Land scaping***: The space around the building may be suitably covered with greenery and plants. Green foliage and shrubs provide a hygienic and healthy atmosphere in addition to keeping the place cool and refreshing.

9**.** ***Economy***: The cost of the building should be with in the economical reach of the builder. All spaces of activities are grouped together by means of passage, lobby, staircase etc. These areas should be minimum but purposely and well ventilated. Planning is only an art not a science and hence it needs proper utilization of many facilities of building. The basic criteria of *Form Follows Function* be adhered too.

10.6 SPECIFICATIONS USED TO DRAW THE BUILDING DRAWING

The specifications of the building components which are commonly followed in small residential and office building construction are given below:

MINIMUM SIZES

S.No	*Description*	*Minimum Sizes*
1.	Drawing room or living room	$16m^2$

10. Stair case- residential buildings

Width of steps = 1.00m

Width of landing = 1.20m

Rise = 180mm

Tread = 250mm

Public buildings

Width of steps =1.50m

Width of landing = 1.20m

Rise = 150mm

Tread = 300mm from street level

Light area of staircase = 1.5m^2 per floor height.

Height of Plinth = 450mm

SIZES OF DOORS AND WINDOWS

- ♦ Parapet: brick work of 200mm thick and 600mm height above the roof slab.
- ♦ Window: top is in level with doors

W_1-900mm X 1200mm

W_2-1200mm X 1200mm

Placed at 900mm above floor level.

i. Plan – scale 1:50
ii. Elevation- scale 1:50
iii. Section – scale 1:50
iv. Detail – scale 1:20 or 1:10
v. Site plan- scale 1:200
vi. Enlarged views of important details
vii. Reference tables, legends showing area covered, sizes of doors and windows etc

i. ***Plan:*** The single line plan is developed in to a double line or solid plan. Length and width of rooms are shown in the plan. Plan is drawn by assuming the structure to be cut at a height of 1.5m from the ground level. Thickness of walls, width of doors, windows, sunshades, steps etc. are shown in the plan. The parts of the structure above the cutting plane are shown by dotted lines. Plinth projection is also shown in the plan.

ii. ***Elevation****:*

plinth height etc. Section also shows type of materials used for construction. The following table show the conventional symbols used for different types of building materials.

[illegible]	[illegible]
Earth or Sand filling	[illegible]
[illegible]	[illegible]

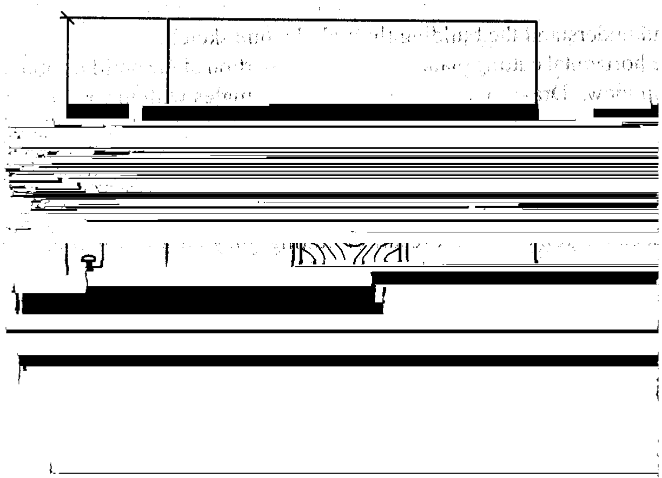
10.8 TIPS TO DRAW BUILDING DRAWING

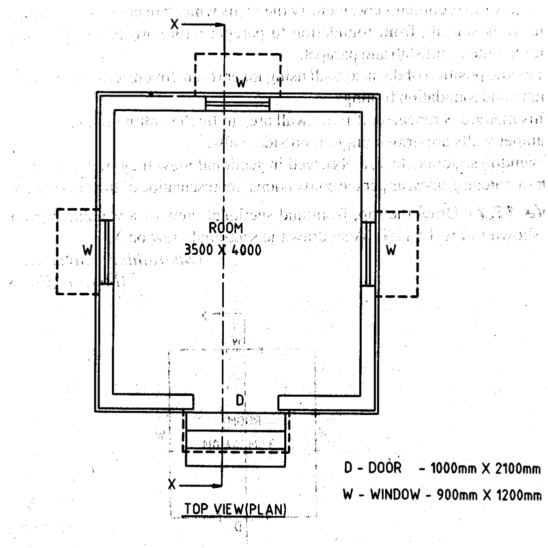
♦

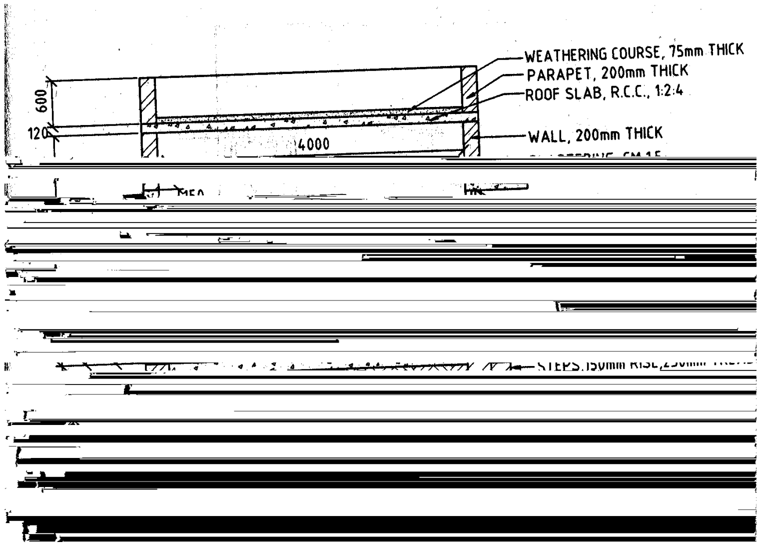
- To draw the sectional view, identify the walls which are cut by cutting plane. Draw one of the walls

Examples of Detailed Drawings

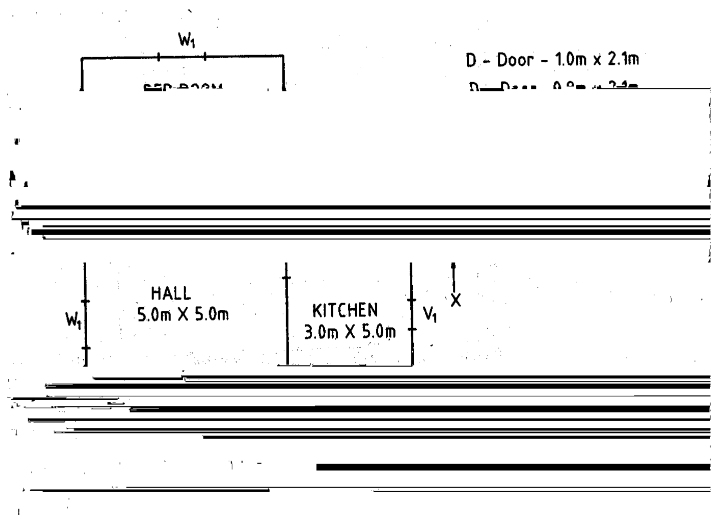
EXAMPLE-1

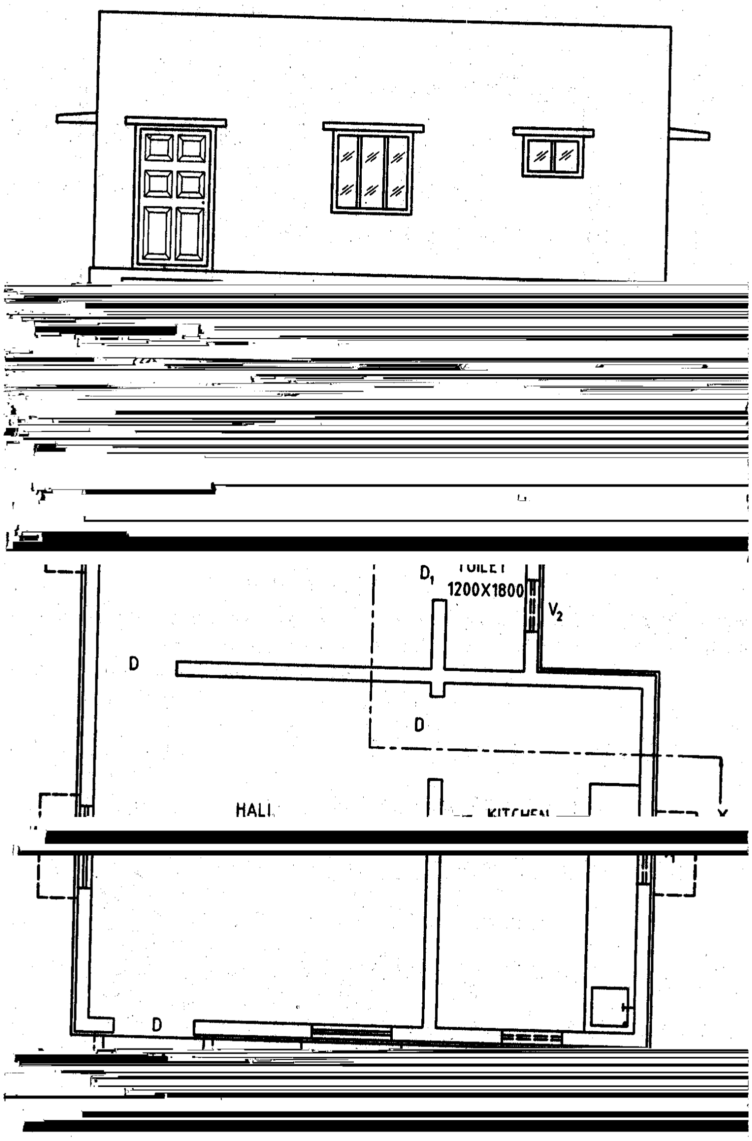




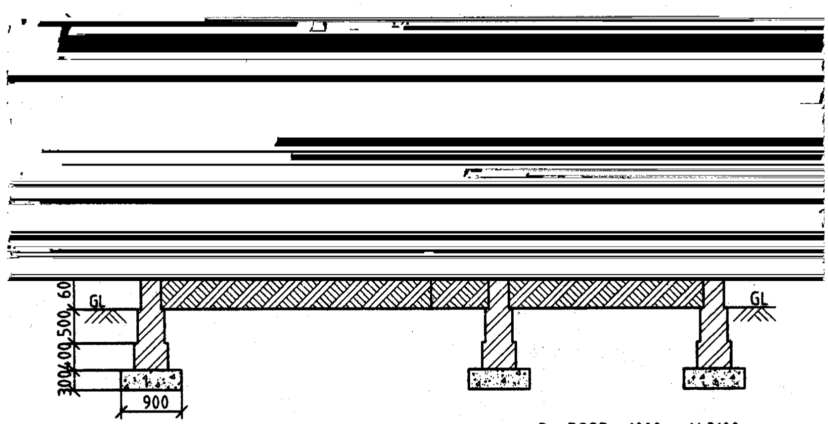

WEATHERING COURSE, 75mm THICK
PARAPET, 200mm THICK
ROOF SLAB, R.C.C., 1:2:4
WALL, 200mm THICK
600
120
4000

EXAMPLE-2


W1
D - Door - 1.0m x 2.1m
HALL
5.0m X 5.0m
KITCHEN
3.0m X 5.0m
W1
V1
X



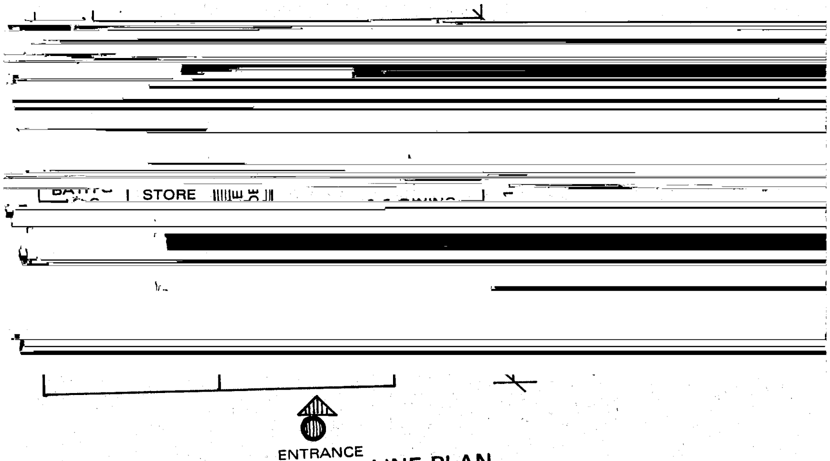
D1
1200X1800
V2
D
D
D



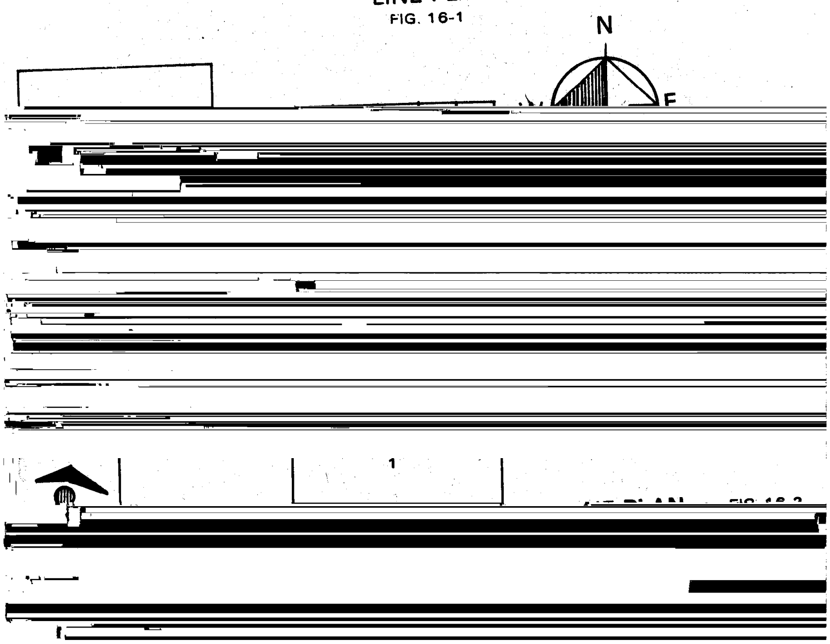
SECTION ON XX

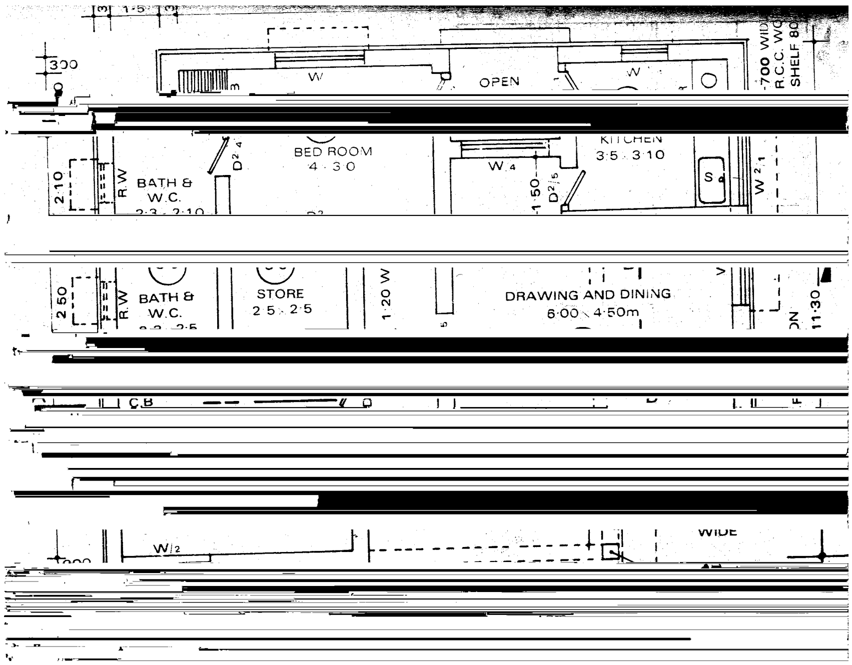
D - DOOR - 1000mm X 2100mm
D_1 - DOOR - 800mm X 2100mm
W - WINDOW - 1200mm X 1200mm
V_1 - VENTILATOR - 900mm X 600mm
V_2 - VENTILATOR - 600mm X 600mm

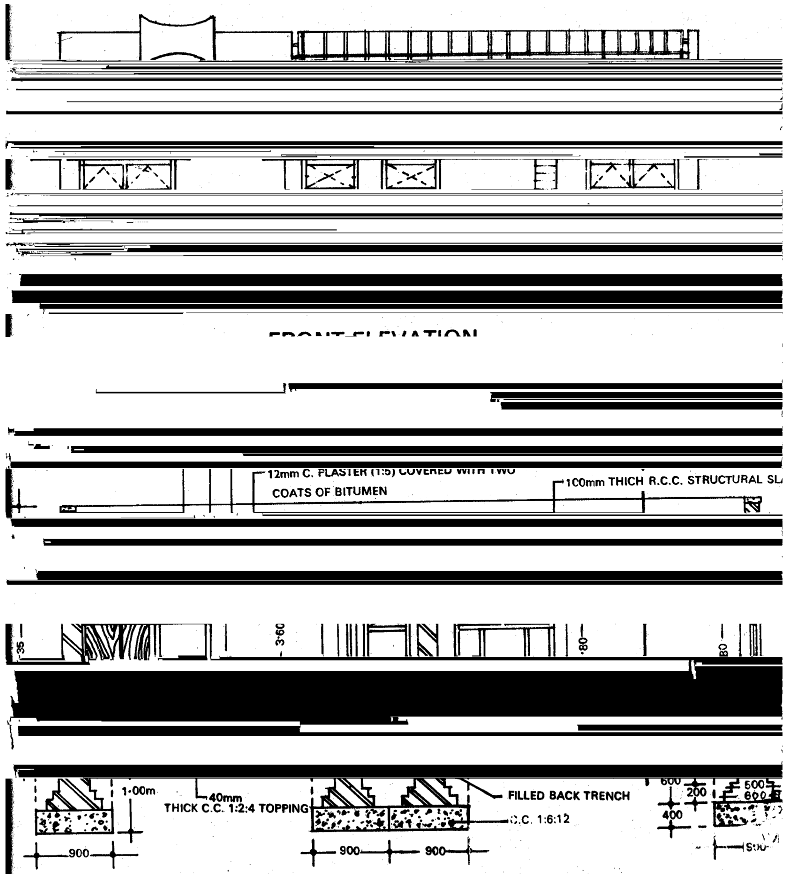
EXAMPLE-3



LINE PLAN
FIG. 16-1




300
OPEN
BED ROOM
4·30
KITCHEN
3·5 3·10
BATH &
W.C.
R.W
2·10
STORE
2·5 2·5
DRAWING AND DINING
6·00 4·50m
1·20 W
2·50
11·30
C.B
WIDE
700 WIDE
R.C.C. WO
SHELF 80



SECTION AT ABBC
SCALE 1:75

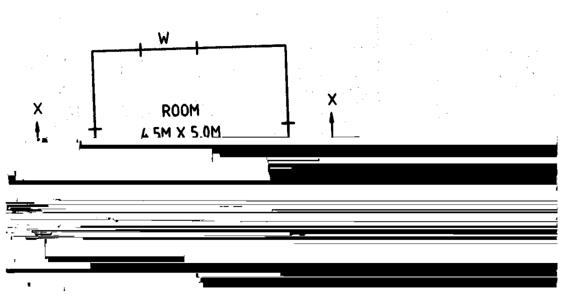
REVIEW QUESTIONS

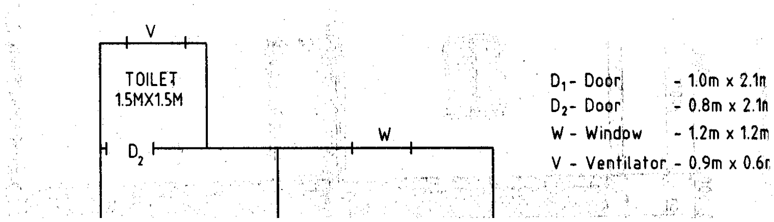
1. Mention the basic elements of planning residential building?

2. Elaborate the major principles of planning residential building?

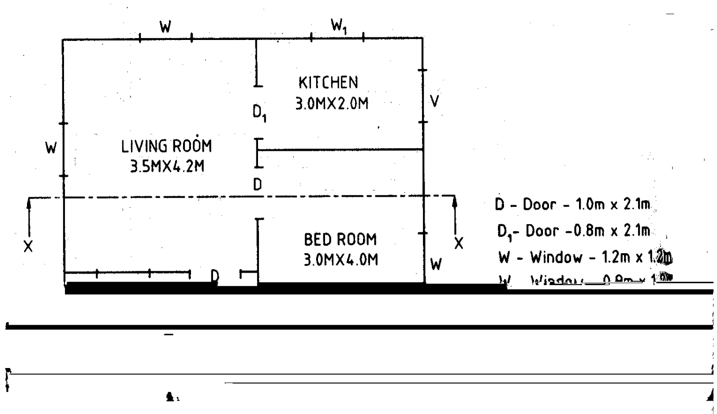
3. Describe the procedure for making line and detailed drawings.

4. Enumerate the important points to be considered while




V
TOILET
1.5MX1.5M
D2
W
D1 - Door - 1.0m x 2.1m
D2 - Door - 0.8m x 2.1m
W - Window - 1.2m x 1.2m
V - Ventilator - 0.9m x 0.6m

4. Residential building with Verandah



CHAPTER ELEVEN

APPLICATION OF ENGINEERING

This chapter deals with typical existing water supply and sanitation project design and drawing, and the design parameters with these projects. It is a basic requirement of all designers/environmental health experts to know about the details in an environmental health project drawings, for the best orientation of the sanitary facilities.

A. SANITATION PROJECT

1. Drains: the collection and disposal of sewage (wastewater that usually includes excreta and that is, will be, or has been carried in a sewer) is done through drains and sewers. surface drains are made in different shaped sections for easy flow of sewerage. Drains are provided with a normal gradient to create a smooth gravitational flow. The following shaped drains are commonly used, for detail sections of these drains see figure 11.1-11.2. drains are normally laid close to the boundary of a building or side edges of a street or road, thus forming on stable edge for the drain.

Figure 11.1: Semi circular types of drains sections

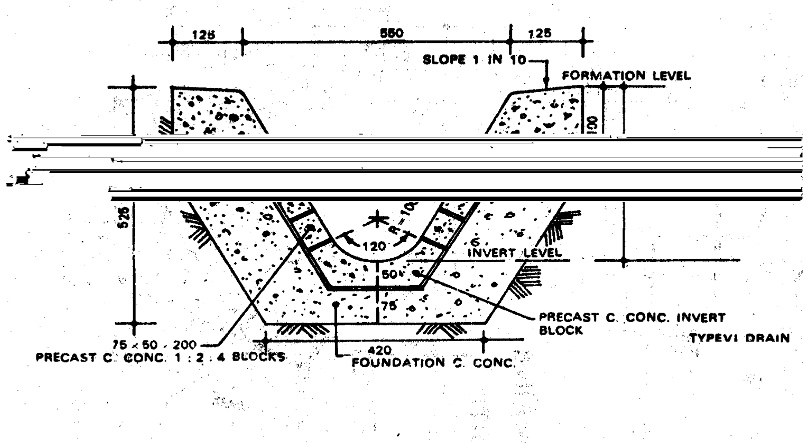


Figure 11.2: V - types of drain sections

2. **Sewers:** the under ground pipes, of any material, used for collecting and carrying the sewerage to the disposal points are called sewers. These get discharge from kitchens, bath rooms, toilets, water closets, urinals and rain. A sewer should be smooth, strong and durable so as to withstand the acidic effects of sewerage. The joint properly laid so as to avoid leakage. These sewers are circular in section. For detail sections of these sewers see figure 11.3-4.

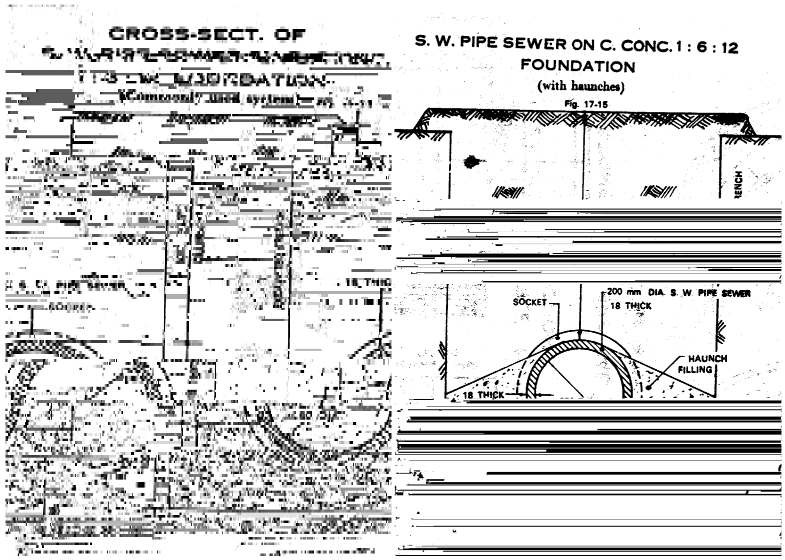


Figure 11.3: Different types of sewers sections

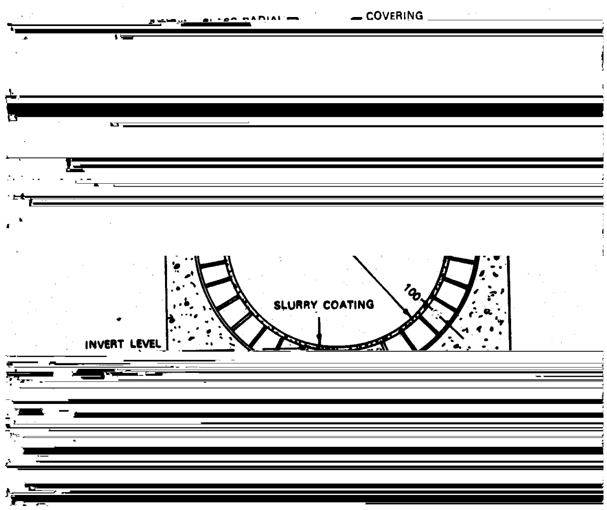


Figure 11.4: Circular brick masonry sewer sections

3. **Manholes**: it is a masonry chamber built in a sewer, of such a size, that a man can enter in it or leave it for carrying out inspection, repair, cleaning, testing, or joining of other sewers. It also gets connections from soil wastes, liquid wastes, and ventilating shafts.

It can be square, rectangular or circular in shapes. For detail sections of these manholes see figure 11.5. Its depth goes on increasing along with the falling gradient of the sewer.

4. **Septic tank**: it is a watertight chamber for the retention, partial treatment, and discharge for further treatment, of sewage.

It is a rectangular tank built of masonry below the ground surface (for detail section of this see figure 11.6) for anaerobic bacterial action.

The guiding principles in designing a septic tank are:

- To provide sufficient retention time for the sewage in the tank to allow separation of solids and stabilization of liquids;
- To provide stable quiescent hydraulic conditions for efficient settlement and flotation of solids;
- To ensure that the tank is large enough to store accumulated sludge and scum;
- To ensure that no blockages are likely to occur and that there is adequate ventilation of gases.

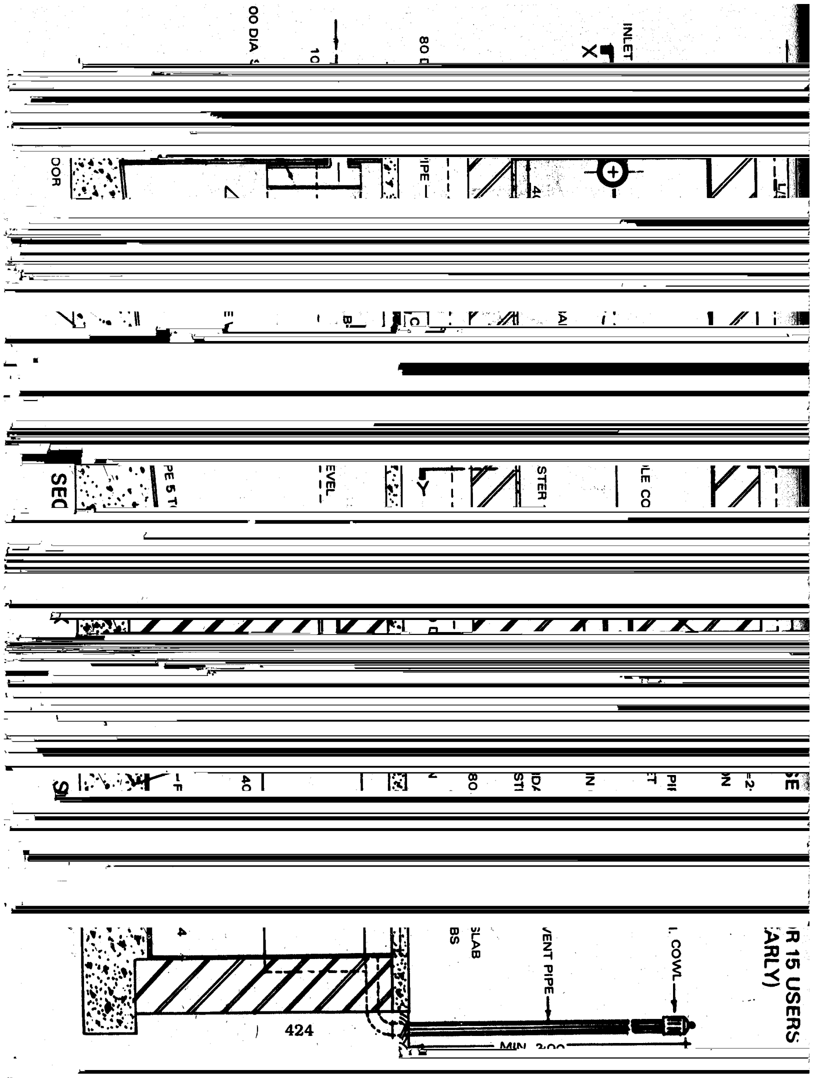
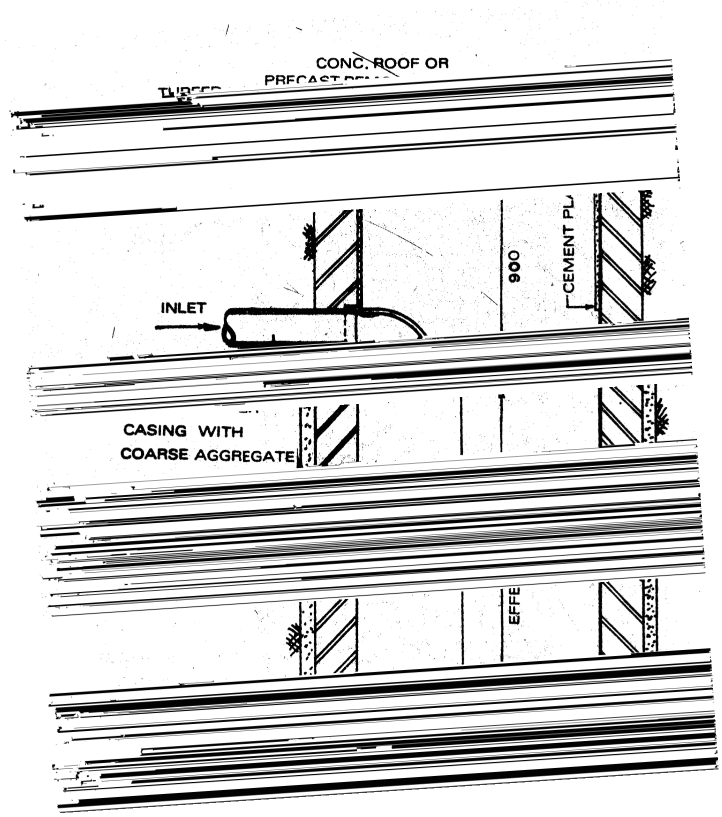


Figure 11.6: septic tank sections

5. **Secondary treatment and disposal of the septic tank effluent:** the effluent from the septic tank is disposal off by one of the following methods:

   (a) Soak pits or seepage pits: pits used to dispose of effluent from septic tanks are commonly 2-5 mcnQ346m6



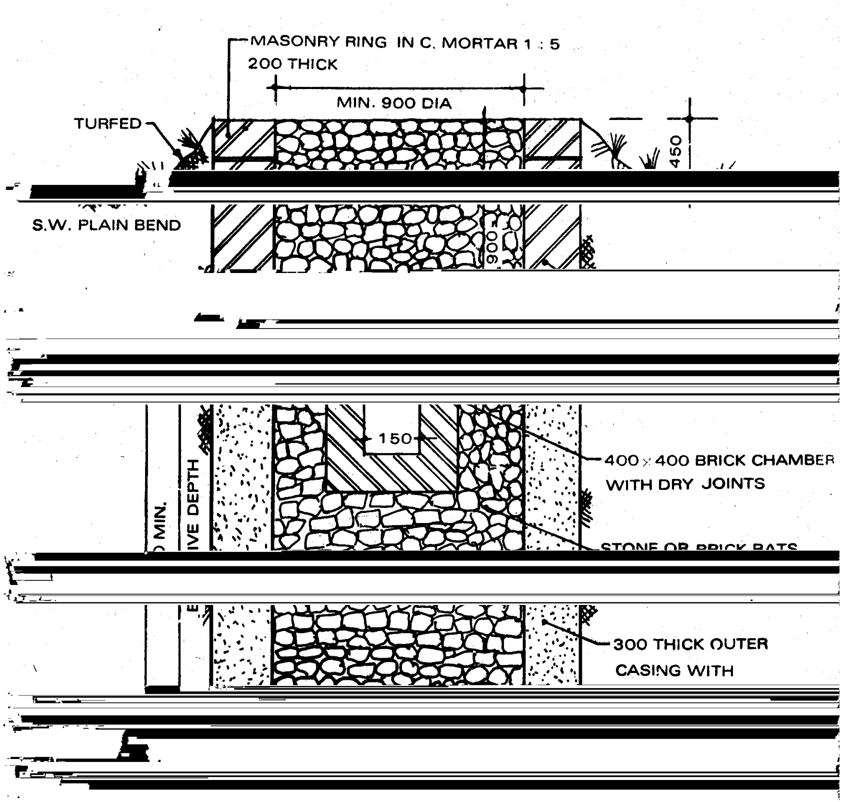


Figure 11.8: field in seepage pit sections

(b) Drainage trenches: the disposal of the large quantity of effluent from septic tanks is often effected in trenches, which disperse the flow over a large area, reducing the risk of overloading at one place. The effluent is carried in pipes, which are normally 100 mm in diameter with a gap of about 10 mm between each pipe. For detail section of this see figure 11.9.

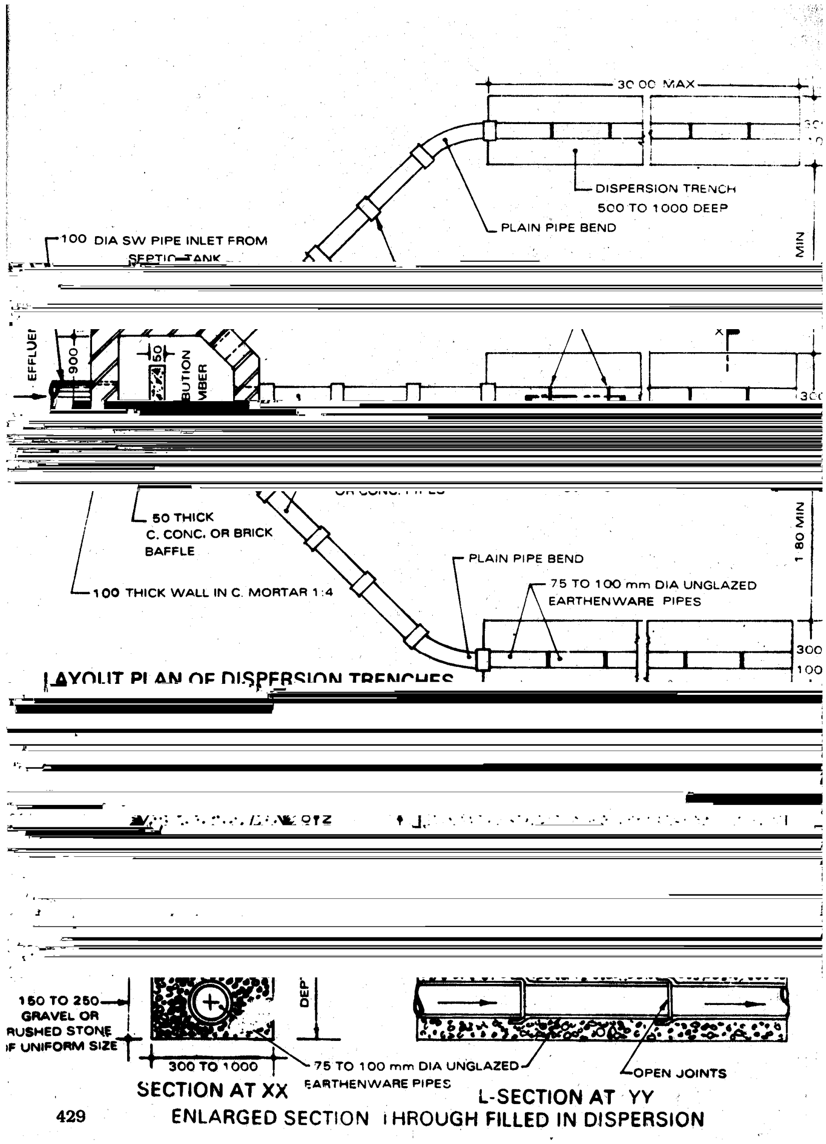
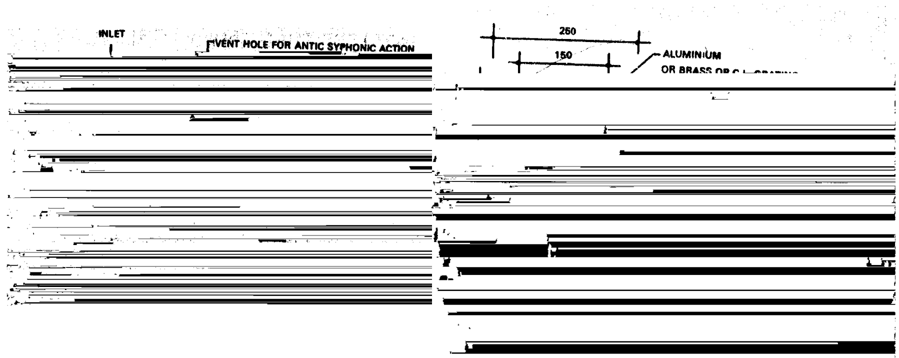


Figure 11.9: layout plan and sections of effluent disposal


INLET
VENT HOLE FOR ANTIC SYPHONIC ACTION
260
150
ALUMINIUM

7. **Simple Pit latrines:** The simple pit latrine consists of hole in the ground covered by a squatting slab or seat where the user defecates. The superstructure design is irrelevant to the operation of the latrine but crucial to the acceptability of the latrine to the user. The cover slab should be raised at least 150 mm above the surrounding ground to divert surface water away from the pit. For detail section of this see figure 11.11

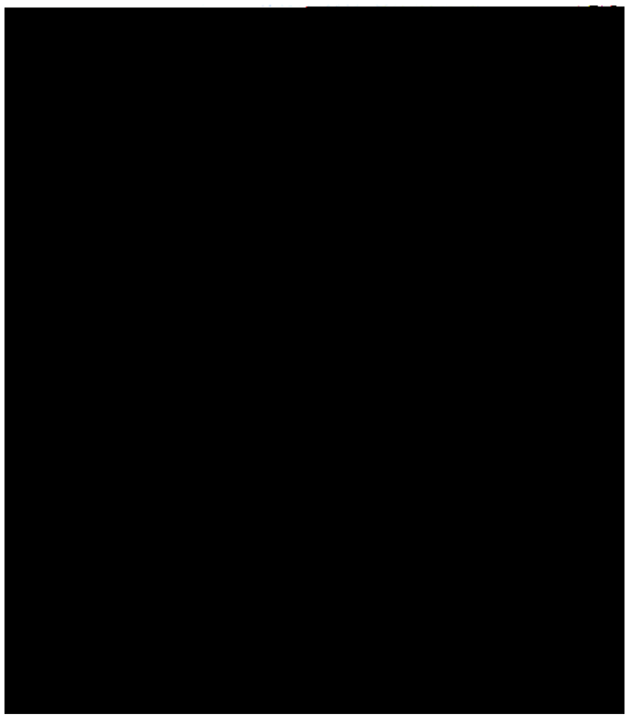


Figure 11.11: simple pit latrine section

8. **Ventilated improved pit (VIP) latrine**: VIP-latrine; pit latrine with a screened vent pipe and a partially dark interior to the superstructure. For detail section of this see figure 11.12

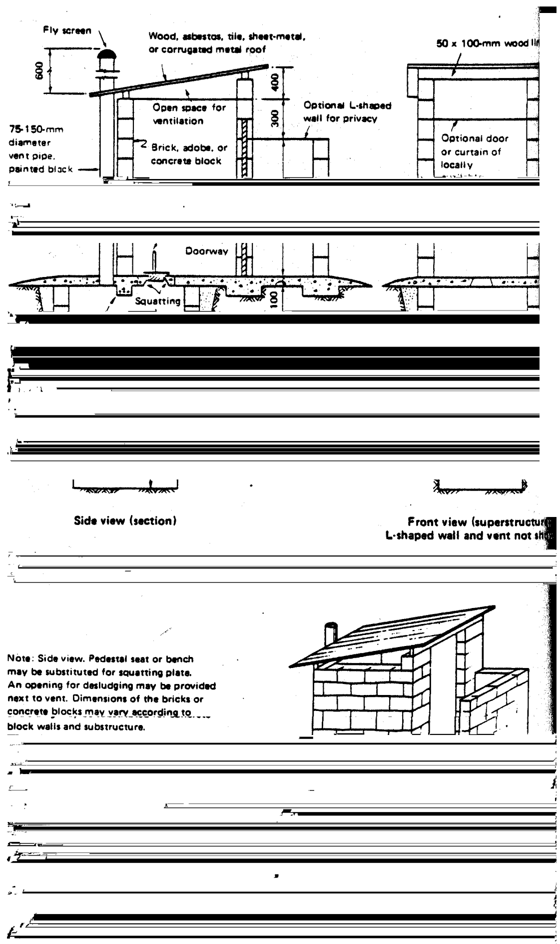


Figure 11.12: VIP latrine sections and view

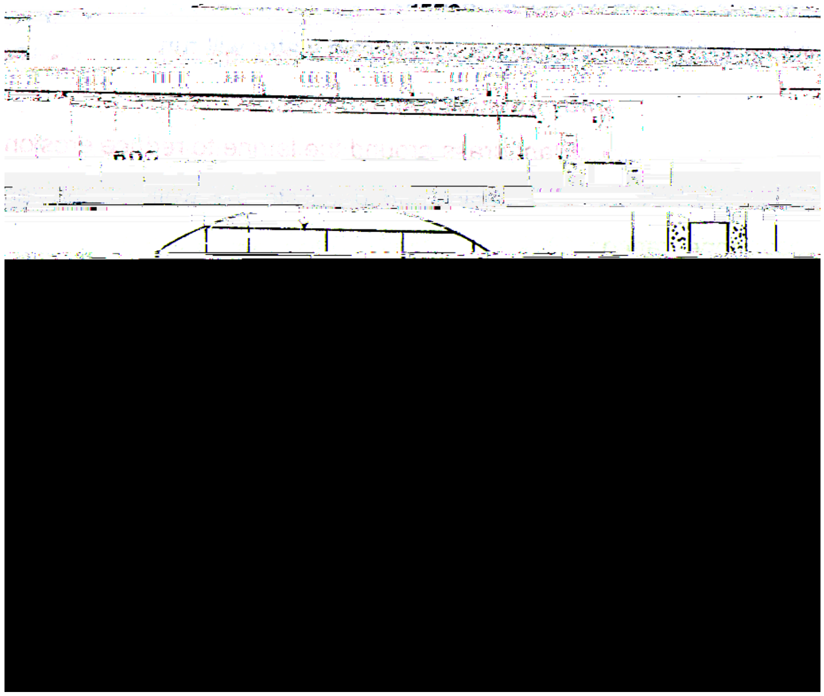
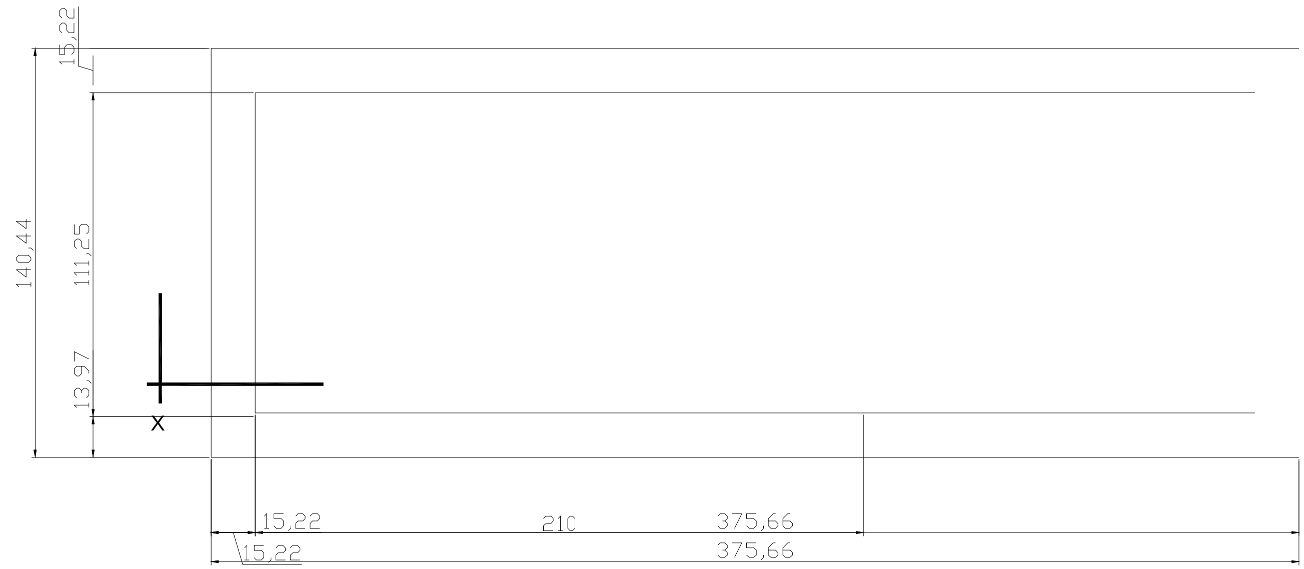


Figure 11.13: VIP latrine plan



A typical design of a double-compartment septic tank
Plan

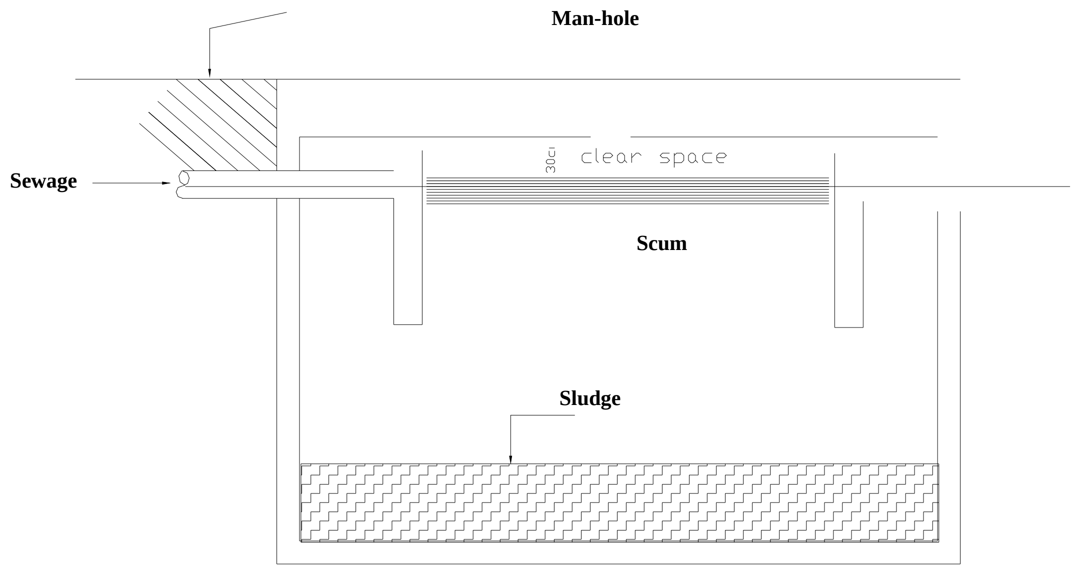


Figure: Cross-section of a typical household septic tank

9. **Incineration**: it is a process of burning the combustible components of garbage and refuse. Disposal of solid waste by incineration can be effectively carried out on a small scale in food service establishments as well as in institutions such as school, hospitals, etc. single chamber on-site incinerator is one of the common means of disposing combustible solid wastes/refuses. A typical design consists of the following dimensions: width = 110 cm; length = 110 cm; height in front = 135 cm; height at the back = 150 cm. concrete base (chamber) = 60 cm by 75 cm by 10 cm; top fueling door = 60 cm by 60 cm square, with thickness 5 cm. for detail section of this see figure 11.14

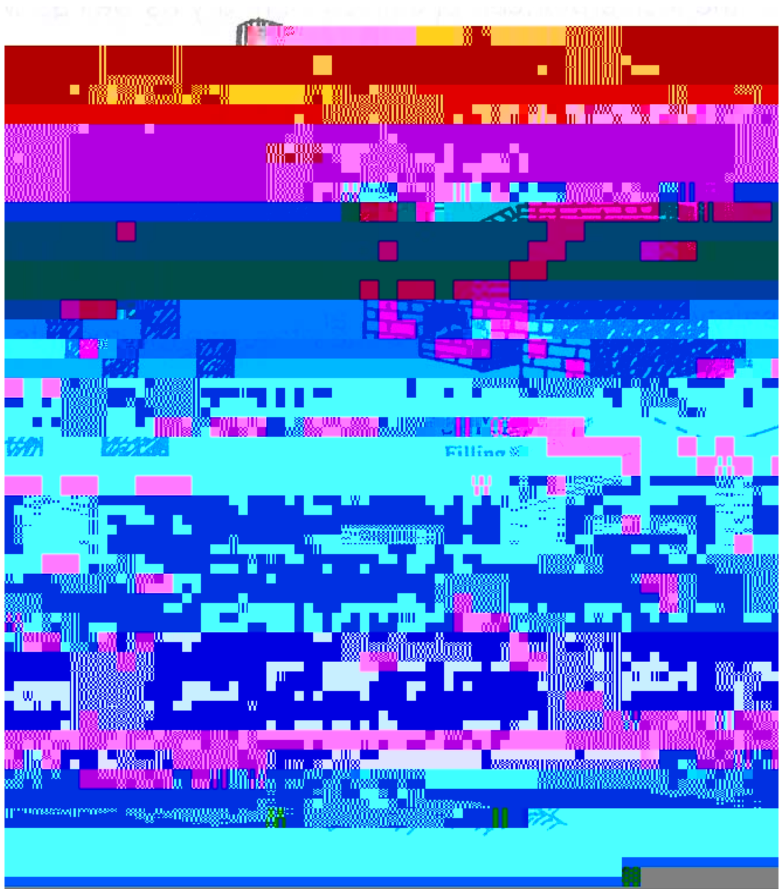


Figure 11.14: on site incinerator section

B. WATER PROJECTS

1. Domestic rainwater harvesting system

A domestic rainwater harvesting system can consist of a collection surface, a storage tank, and guttering or channels to transport the water from one to the other. Other peripheral equipment is sometimes incorporated, such as a first-flush system to divert the initial dirty water that contains roof debris built up during prolonged dry periods; filtration equipment; and settling chambers to remove debris and contaminants before the water enters the storage tank or cistern. For detail section of this see figure 11.15.

Figure 11.15: rainwater harvesting sections

2. Spring water: are occurrences of groundwater naturally

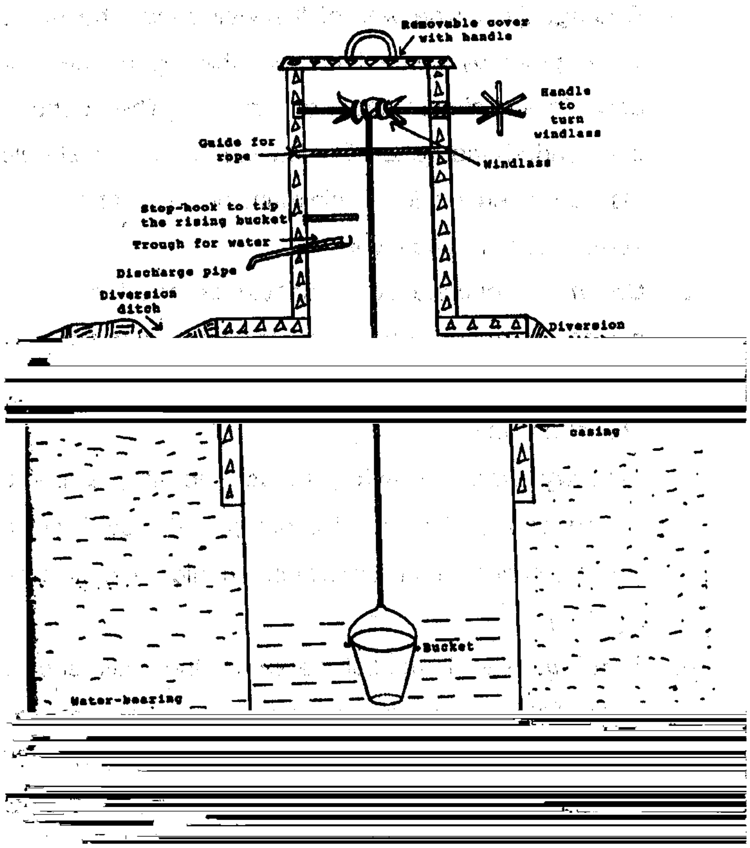


Figure 11.17: Hand dug water section

Review question

1. Draw a model pit latrine (plan, sections, and isometric view) with the following assumed dimensions:

    Pit – 2m x 1.5 m x 3m

    Casing – 3 m deep, 0.4m thick

    Slab – 0.1m thick, has similar dim. With pit

    Superstructure – walling: 2.5m x 2m x 2.5m,

    Black walling

    Roofing-CIS, flat roof

2. Draw a small-scale septic tank (plan, sections, and isometric view) based on the following information:

    Pit – 3m x 1.5m x 3m,

    Floor slab – 0.2 m thickness

    Cover slab thickness = 0.15m

3. Draw a spring (plan, sections, and isometric view) based on the dimensions given:

    Protection box- 1m x 1.5m x 1m, wall thickness = 0.12m

    Floor slab thickness = 0.2m

    Cover slab thickness = 0.1m

    Manhole cover size = 0.6 x 0.6 x 0.6m

    Collection box- 2m x 1.5 x 2m, wall thickness = 0.12m

    Floor slab thickness = 0.2m

    Cover slab thickness = 0.1m

    Manhole cover size = 0.6 x 0.6 x 0.6m

Bibliography

1. Jenson,Cecil Howard,Engineering drawing and design,1925,4th ed.,Macmillan/McGram-Hill
2. Louis Gary Lamit, Descriptive Geometry,1981,1st ed.,Prentice-Hall
3. Frederick E.,Technical Drawing,1958,4th ed.,The Macmillan Company
4. David L.Goetsch et al, Technical drawing,1994,3rd ed., Delmar Publishers Inc.
5. A text book of engineering drawing, B.Gupta. Nasaka Pashakar publisher
6. V.B. Sikka ,A course in civil engineering drawing ,1998,4th ed.
7. T. Jeyapoovan, Engineering Drawing with autocad 2000, Vikas publishing