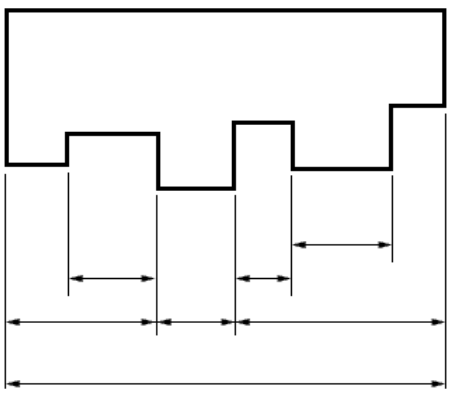
UNIT 4

DIMENSIONING



Combined Dimensioning

Learning Competencies:

Up on completion of this chapter you should be able to:

- ✓ **Know the importance of dimensioning;**
- ✓ **Identify the basic elements of dimensioning, such as dimension line; arrowheads extension line, leaders, notes, etc;**
- ✓ **Distinguish between the aligned system of dimensioning and the unidirectional system of dimensioning;**
- ✓ **Explain the theory of dimensioning;**
- ✓ **Differentiate between size dimensioning and location dimensioning;**
- ✓ **Understand the difference between datum dimensioning and chain dimensioning;**
- ✓ **Understand the rules of placement of dimensions on views.**

4.1 Introduction

What do you understand from the word Dimensioning?
How do you describe the size of your class room on drawing?

A Drawing of an object is prepared to define its shape and to specify its size. A complete drawing of an object gives its shape description and also a complete size description.

The shape description is based upon the theory of projection. The size description is based upon the theory of dimensioning. A dimension is the art by which the dimensions of an object are written on its drawing. The correct dimensioning requires a systematic way in which the dimensions are written on the drawing.

All the discussions throughout this text is supported by an illustration to explain the basic principle of dimensioning however those detail drawings not helpful for this explanation have been omitted.

4.2 Lines and Symbols

For a proper size description of an object, one must have basic knowledge and skill how to use the various symbols, forms and elements of dimensioning on its drawing. The basic symbols, forms and elements used in dimensioning are *dimension lines, extension lines, leaders, arrowheads, dimension (numerical values), symbols* explaining a feature's size and *notes.*

All these concepts are explained graphical on Fig 4.1.

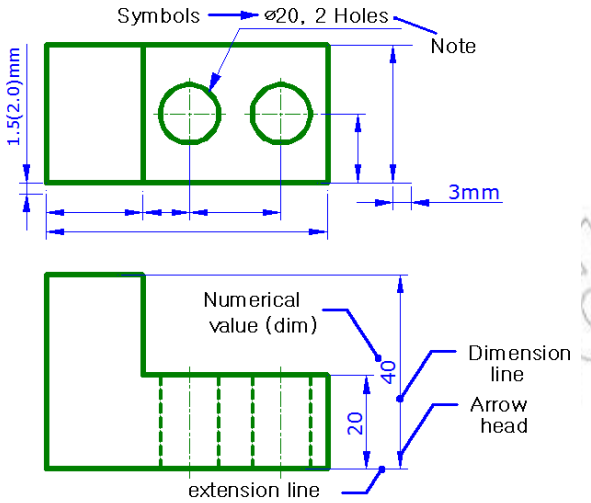


Fig.4.1 Notation of dimensioning

Forms of dimensioning

The two basic dimension forms while giving a size of a feature are a *dimension and a note* as shown on the above figure.

Dimension: refers to the numerical value used to give distance information between two specified points or size of a particular feature. It is placed centrally above or by breaking dimension line.

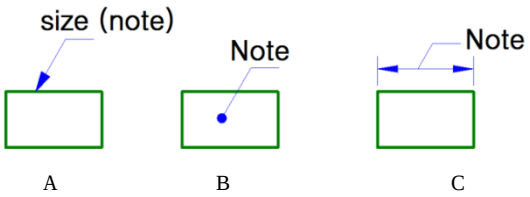
Note: Refers to the written word or Phrase used along with a dimension as explanatory information.

Leader: is a thin continuous line leading from a dimension value or an explanatory note to the feature on the drawing to which it applies. Leader lines start from a size or a note ends:

A) with an arrow head when it stops touching outline of view of a part and

B) with a dot when rests on a surface with in the outline of a part crossing its outline or

C) without any arrow and dot mark when rests on a dimension line as shown on figure below.



A) When touching outline of a part
B) When rests crossing nothing on a surface
C) When rest on a dimension line

Fig 4.2 Style of leader lines

Avoid the use of long leader line even if it means repeating features. Leaders should not cross each other rather one drawn parallel to the other.

Dimension line: is a thin continues line terminating commonly with an arrow head in a machine drawing and oblique stroke/ dot in architectural and structural drawing to indicate direction and extension of dimension.

Extension line/projection line: is a thin continuous line that extends from a point on a drawing to which a dimension refers to and providing a boundary for the dimension line.

It is usually drawn perpendicular to the outline and dimension line and there should be a gap of about 1.5 (2.0) mm from the outline of the object and 2mm extension beyond the dimension line.

Arrowheads: are terminators of dimension lines where they stop touching extension lines or features lines. They should be uniform in size and style throughout the drawing. The length of arrow head should be three times its width.

There are basically two styles of arrow heads namely *open* and *closed*; as shown in Fig 4.3. In fact there are very different styles of arrow head terminators.

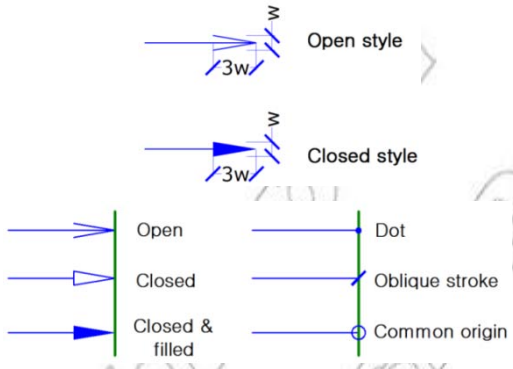


Fig.4.3 Style of arrow heads

Most often the closed filled in type is used for general purpose and oblique stroke for architectural and structural drawings.

4.3 Reading Direction of Figures

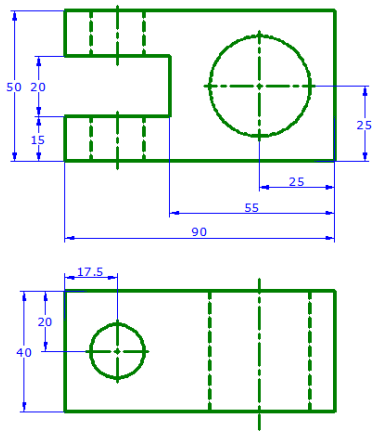
There are two systems of placing dimension based on the reading direction of figures.

Unidirectional dimension

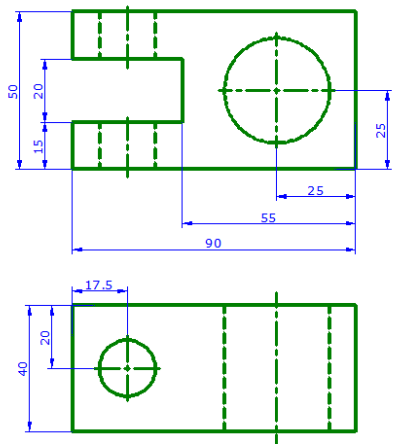
Here dimension and notes should be placed to be read from the bottom of the drawing. This system in majority cases used for engineering drawing as show in Fig 4.4 (a) below.

Aligned dimension

In this system, all the dimensions are so placed that they may be read from the bottom or right hand edge of the drawing. All the dimension should stand normal to the dimension line as shown below on Fig.4.4 (b). Mostly this system of dimen-sion is used for architectural and structural drawings.



A) Unidirectional dimensioning



b) Aligned dimensioning

Fig 4.4 Unidirectional and Aligned dimensioning

Checkpoint 4.1

Redraw the given views of an object twice and then dimension them using aligned and unidirectional system of dimensioning.

4.4 Theory of Dimensioning

All objects are composed of one or more of the following different basic geometric shapes such as prism, cylinder, cone, pyramid and sphere.

So dimensioning an object becomes relatively easy if you first break it down into its component geometric shapes as shown on Fig.4.5.

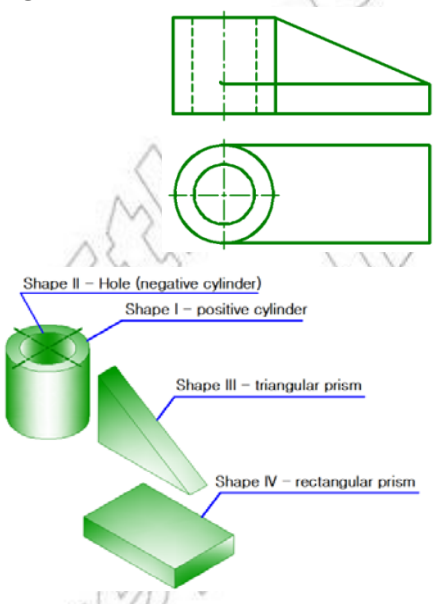


Fig. 4.5 An object broken down into its component parts

The object is said to be fully dimension when the two types of dimensions i.e. size dimension and location dimension are included.

4.4.1 Size Dimensioning

It is used to describe size of an object such as height, width, depth, thickness, length, radius, diameter etc, with regard to its form and other features like holes and slots.

4.4.2 Location Dimensioning

It is a type of dimension used to locate the various features like hole, slot etc, of an object relative to each other from center of one feature to centerline of another similar/ different feature or to a reference edge. It can be given in all width, height and depth direction.

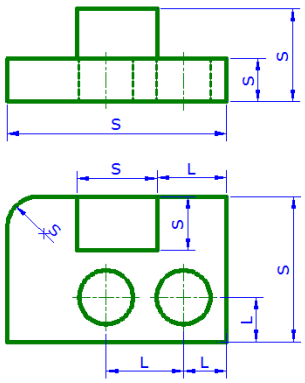


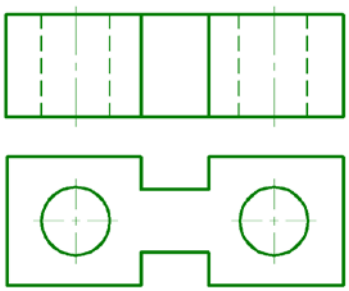
Fig.4.6 Size and location dimensions

Activity 4.1

- What is the difference between size and location?

Checkpoint 4.2

Show the size and location dimension of the object whose views are given below.



4.4.3 Selection of Dimension

When dimensioning an object, the dimensions to be given should be selected in such a way that they are convenient for the workmen to use during manufacturing. The following points should be noted during selection of dimensions:

- Dimensions of mating parts should be selected so as to ensure proper functioning.
- Dimension should not be duplicated or minimum number of dimensions should be used (Fig.4.7 (c) and (d)).
- Dimensions should be selected so that it will not be necessary to calculate, scale, or assume a dimension during manufacturing.
- Selection of location dimension require more attention than size dimensioning.
  - A hole dimension is given using diameter than radius on its circular view (Fig.4.7 (a) and (b)).

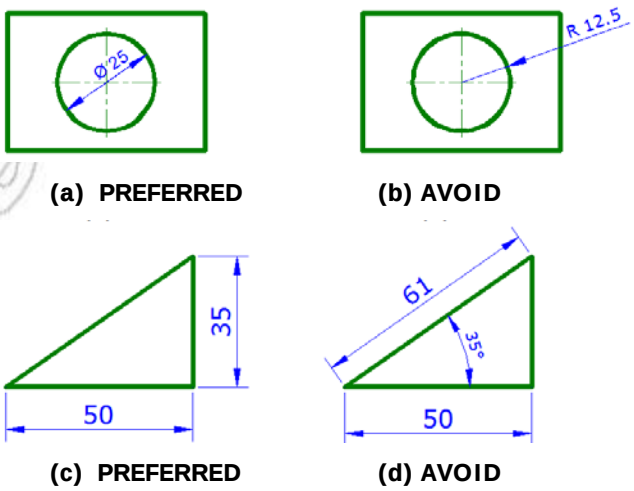


Fig. 4.7 Selection of dimension

Scale of a drawing

Scale is a means by which we determine the graphical size of an actual object on paper with equal, reduced and enlarged size. Regardless of the scale used, the dimension figures shown on the drawing always represent the actual size of the object.

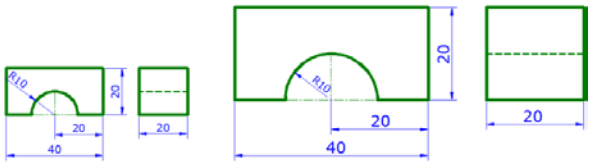


Fig.4.8 Relationship between scale of the drawing and dimensioning

The term also refers to the ratio between the size of a drawing and the actual object. A scale drawing can be larger, smaller or the same size as the object. Object should be drawn full size whenever possible. For example, a scale of 1:2 implies that one unit on a drawing represents two units of corresponding actual size of an object.

4.5 Methods of Dimensioning

There are different methods of dimensions to be used depending on the characteristic feature of an object dimensioned. However, at this level of technical drawing course only two of the commonly used methods are discussed and these are namely:

A) Chain or point to point dimensioning and
B) Datum or base line dimensioning

4.5.1 Chain Dimensioning

It is a method of dimensioning used when a series of dimensions is given on a point to point basis. The disadvantage of this method is it may result in an undesirable accumulation of tolerance error between individual features (the term tolerance will be discussed and understood at a higher level of education). So this method is not preferred for a product or part requiring high accuracy. This method may be adequate for describing simple parts, as shown on Fig.4.9.

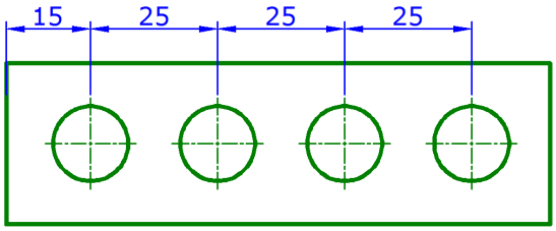
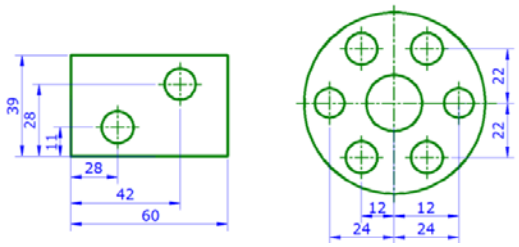


Fig 4.9 Chain dimensioning

4.5.2 Datum or Base Line Dimensioning

Points, lines or edges and surfaces of an object from which the locations of other features of the object are established is known as *datum*s. For example the left side and bottom surfaces of the object, as shown in Fig.4.10 (A) are the datum surfaces and similarly the centerlines of the largest holes are used as datum lines for the other object as shown in Fig.4.10 (B).This dimension may be necessary if a part with more than one critical dimension must mate with another part as shown in fig 4.10 (A) and (B).



(a) (b)

Fig. 4.10 (A) and (B) datum dimensioning

4.5.3 Combined Dimension

These are the result of simultaneous use of chain and parallel dimension as shown in Fig.4.11.

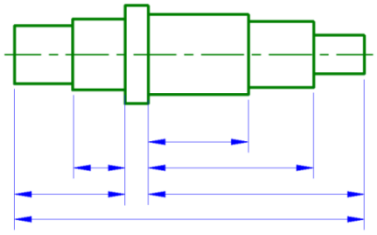


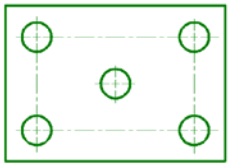
Fig. 4.11 Combined dimensioning.

Activity 4.2

1. From the basic terms of dimensioning listed earlier suggest a good positioning of dimension line, dimension text, extension line with example.
2. What do you understand with the difference b/n the words chain, datum and combined?

Checkpoint 4.3

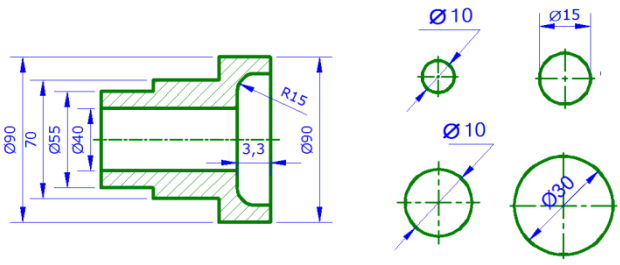
Redraw the given views of an object and then dimension them using chain and parallel method of dimensioning.



4.5.3 Standard features Dimensioning

Circular Feature

Diameter: should be dimensioned on the most appropriate view to ensure clarity. Circle is dimensioned by diameter. The dimension (numerical value) is preceded by ϕ symbol.



(a) (b)

Fig. 4.12 Dimensioning of diameters

Arcs: are dimensioned by giving the radius on the view that shows the true shape of the arc. The dimension line for the radius of arc should always be drawn at 30°, 45°, 60° but not vertical and horizontal. The dimension of chords, arcs and angles are shown in Fig.4.13

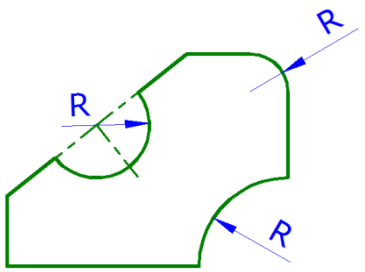


Fig.4.13. Dimensioning of arcs, cords and angles.

Curves: non-circular curves can be dimensioned by datum dimensioning method.

The more the number of points used on the curve, the better the curve is dimensioned.

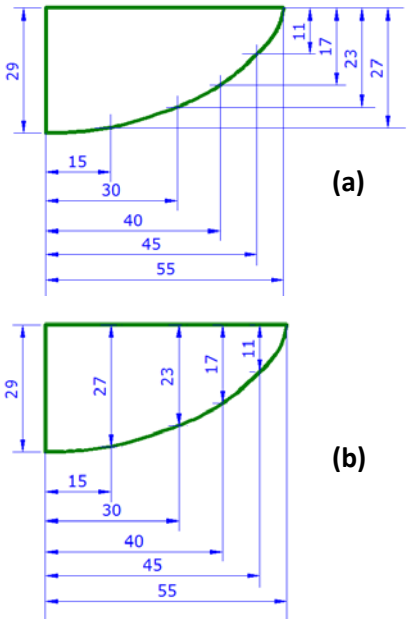


Fig. 4.14 Dimensioning of non circular curves.

Chamfers

Chamfers are normally dimensioned by giving their angles and linear lengths. When the chamfer is 45°, it may be specified as a note.

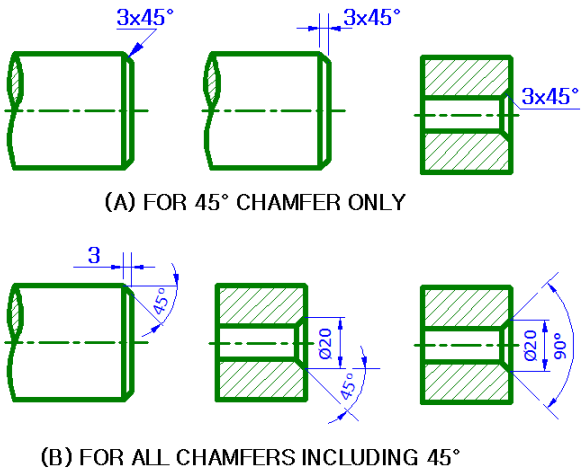


Fig. 4.15 dimensioning of chamfers.

Angles

When dimensioning an angle the dimension line will be an arc centered at the vertex of the angle

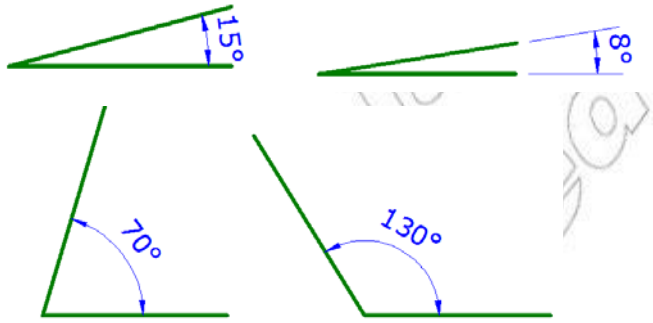
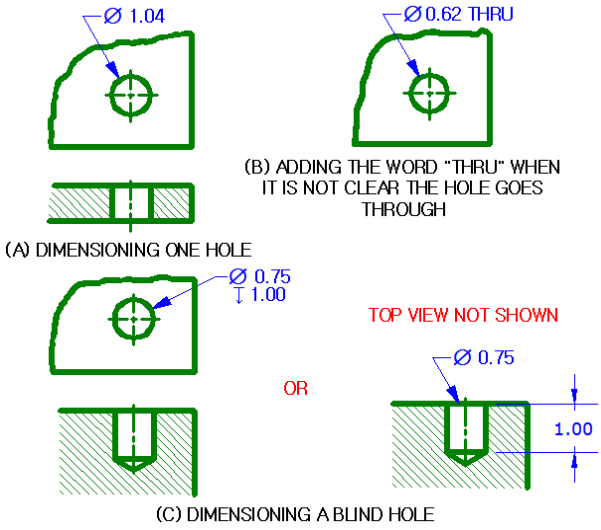
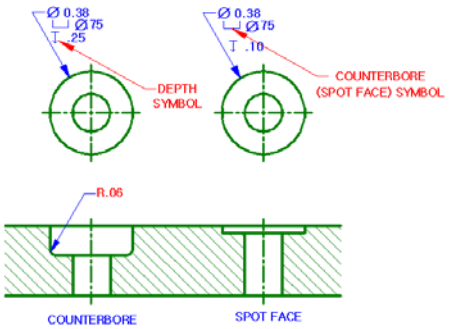


Fig 4.16 Dimensioning of angles

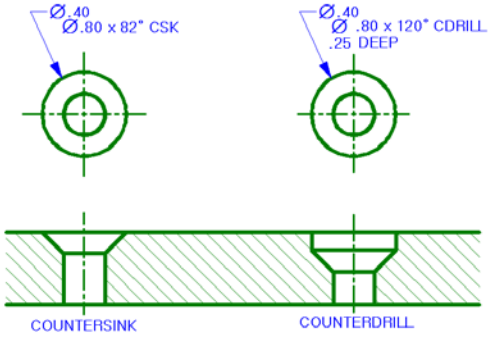
Holes

Plain and round holes are dimensioned in various ways depending upon the design and manufacturing requirements. However the leader is the method most commonly used as shown on Fig.4.12.



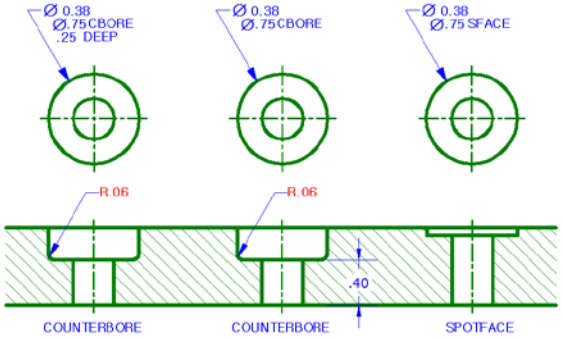


(a) Using symbols

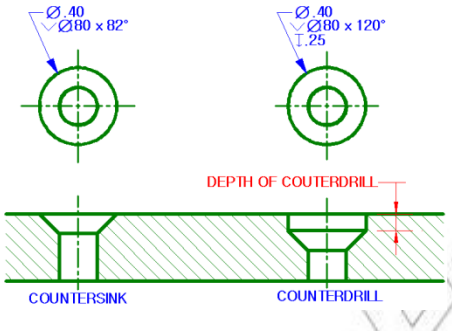


(b) Using words

Fig 4.17 Dimensioning of holes.



(b) Using words



(a) Using symbols

Screw thread

Screw threads are always specified with proper designation i.e. the nominal diameter is preceded by the letter M. The useful length of the threaded portion only should be dimensioned when dimensioning the internal thread, where the length of the drilled hole should also be dimensioned.

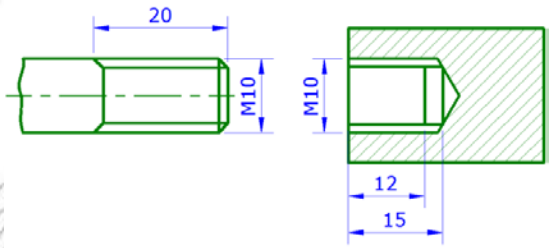


Fig. 4.18 Dimensioning of screw threads

Repetitive features

They are specified on a drawing by the use of an X mark in conjunction with the numeral to indicate the “Number of times” or “places” they are required.

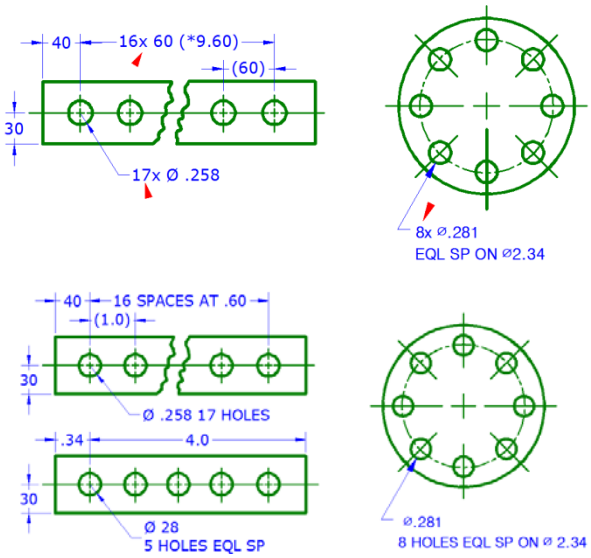


Fig. 4. 19 Dimensioning of repeated features

Note: EQL SP is to mean equal space.

Slopes and tapers

A slope is the slant of a line representing an inclined surface. It is expressed as a ratio of the difference in the heights at right angles to the base line at specified distance apart. A taper is the ratio of the difference in the diameter of two section perpendicular to the axis of a cone to the distance between these sections.

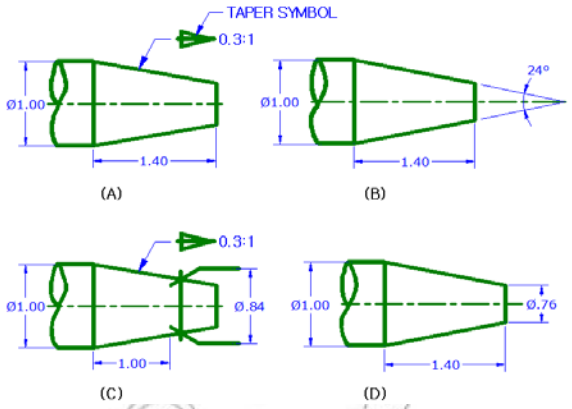


Fig. 4.20 dimensioning of slopes and tapers

4.6. Placement of Dimension

Dimension should be placed on the following elements so that reading of them will be easy and comfortable.

4.6.1 Dimensioning of Views

Dimensions should be selected carefully and placed on a view that shows the contour of the feature to which they apply.

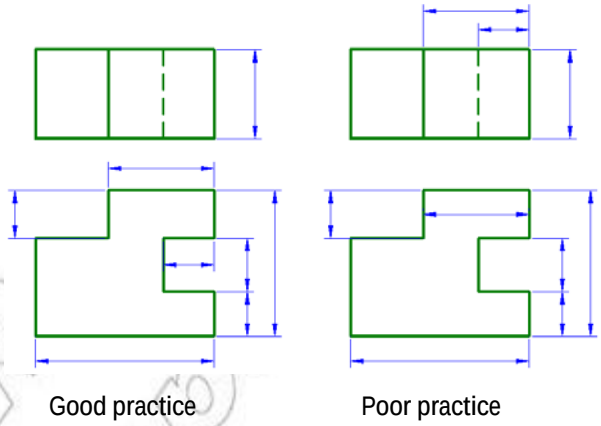


Fig. 4.21 Dimensioning of views.

Placement rules of dimensions on view

1. Dimension should be placed between views whenever possible unless required elsewhere.
2. Dimension should be placed outside the views of an object unless and otherwise placing them inside is required for clarity and ease of reading especially for large views.
3. Dimension given on one view should not be repeated on another view. A redundant dimension may be given when required

for reference dimension by placing it in a bracket.

4. Dimension should be taken from visible outline than the invisible (hidden) line.
5. Use only one system of dimension either aligned or unidirectional on one or more views of an object.
6. Use the same unit of measurement and dimension line terminator (arrowhead) on a single view.
7. Dimension should be placed on a view that shows the true length edge of an inclined surface.
8. Dimension the view that best shows the characteristic contour or shape of the object.

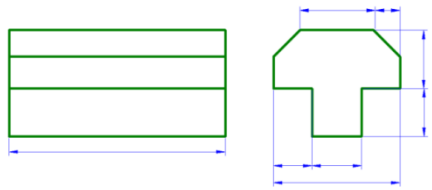


Fig. 4.22 Dimension a view showing characteristic shape of an object.

9. In a parallel method of dimensioning the shortest and longest dimension lines should be placed closest and farthest from the outline of the view respectively.
10. Dimension figures should be placed midway between arrowheads of a dimension line unless staggered as in the case of parallel dimension to improve clarity and reading of dimensions.
11. Avoid using centerline and outline of a view of an object as dimension line, however centerline may be used as extension line.
12. Avoid crossing of two dimension lines and extension line.
13. When an overall dimension is given at outermost, one of the intermediate dimension should be omitted to avoid redundant dimensioning as in parallel dimensioning.
14. Avoid any dimension line which passes through a dimension figure.
15. The distance from the outline of a view to the first dimension line and between parallel dimension lines varies from 5-10 mm. Use a single uniform distance between dimension lines.

4.6.2 Dimension on Limited Space

When the space between the extension lines is too small to permit placing of the dimension line and the dimension, an alternate method of placing them is shown on Fig.4.23.

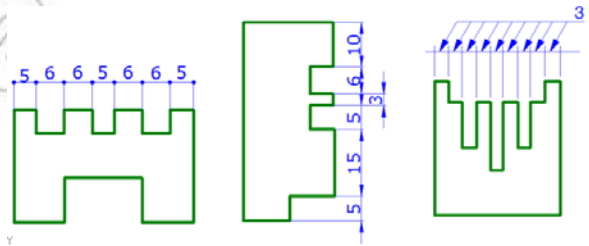


Fig. 4.23 Dimensioning in limited space.

4.6.3 Pictorial Drawing Dimensioning

Activity 4.3

1. Do you remember any exercises given on orthographic projection?
2. How can you dimension those exercises?

Some time when the need arises to give dimensioning on the pictorial representation of an object the following few basic principle of pictorial drawing dimensioning should be noticed.

Dimension line and extension lines should be drawn parallel to the isometric axes. It is better to use aligned system of dimensioning to dimension arcs and curves in pictorial drawing. Leaders and associated notes should be placed in a plane parallel to the face on which the dimension applies as shown in Fig.4.24.

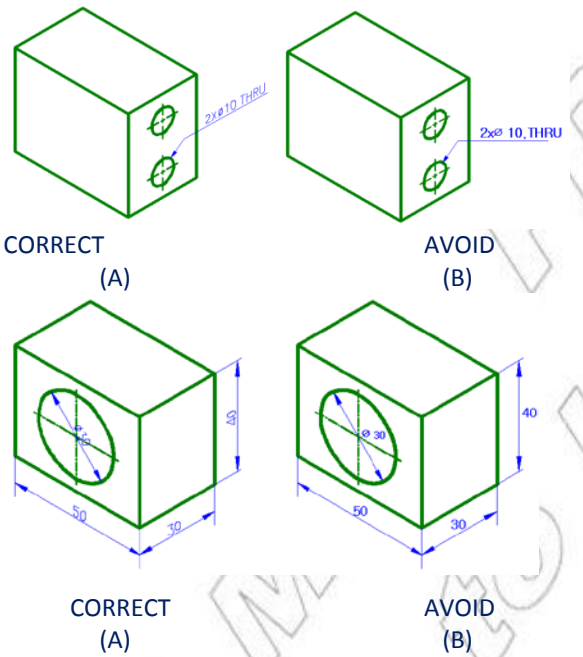


Fig. 4.24. Pictorial dimensioning

Key terms

- ***Datum***: is a point, line, or surface from which all measurements are taken.
- ***Leader lines***: are thin continuous lines that point to features on an engineering drawing with an arrowhead. They are accompanied by a dimension or local note that specifically describes circular feature.
- ***Tolerance***: is the allowed deviation for a specified dimension. How much deviation is acceptable is different for each type of job. The deviation or error is displayed as ± measurement.

Unit Summary

A detailed drawing must indicate not just the shape, but the size of the object. Additional information such as surface finish, welding techniques, material lists and tolerances may also be included. Dimensioning includes both size and location dimensions.

Dimensions should be placed outside the object for clarity. Try not to repeat dimensions on drawings. Extension lines must be light and do not start in contact with the outline of the object. Arrow heads are also usually three times the length compared with the width.

The following are a few basic rules that summarize what might well be a list of hundreds of very specific rules that apply to dimensioning. Review the list carefully. Make each of these items a part of your dimensioning practices.

- Each dimension should be clearly shown and stated so that it can be interpreted in only one way.
- Dimensions should be placed in the view where the best shape and true form are shown.
- Place a dimension between views, especially if it applies to both views and will improve clarity.
- Do not assume that a part is symmetrical. Dimension both sides of a symmetrically shaped part or use the centre line symbol or note to avoid confusion.
- Spacing between dimensions should be consistent within a drawing.
- Line up dimensions horizontally or vertically where possible.
- Avoid crossing dimension lines or leaders where possible.
- Cylinders should be dimensioned in their rectangular view.
- When using chain dimensioning don't complete the chain. Instead dimension all but one part of the chain and do an overall dimension.
- Dimension circles by their diameter and arcs by their radius.
- Use dimensioning symbols where appropriate.

Exercise

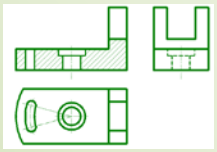
EXERCISE I

1. How are concentric circles best dimensioned?
2. Sketch the symbols for: diameter, radius, depth, counter bore, countersink, and square.
3. Where are the symbols listed in question 2 placed with respect to their numerical values?
4. When is a small cross required at the center of a radius?
5. When the depth of a blind hole is given, to what does the depth dimension refer?
6. When should extension lines be broken?
7. How is a reference dimension identified?
8. How can you tell if a dimension is out of scale (without measuring the drawing)?
9. Write a note that would show that a 10mm deep 20mm diameter hole is to be repeated six times.
10. How can you tell if an arc is to be dimensioned as a diameter or as a radius?
11. What is the proper proportion of width to length of arrowheads?
12. Compare the thickness of dimension lines to object lines.
13. Compare the thickness of dimension lines to extension lines.
14. If two dimensioning guidelines appear to conflict, which guideline should be followed?

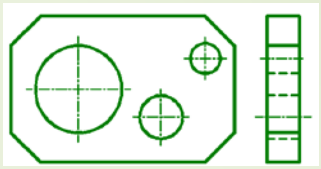
EXERCISE II

The orthographic views of some objects are given below, redraw the views and dimension them using aligned system and convenient method of dimensioning.

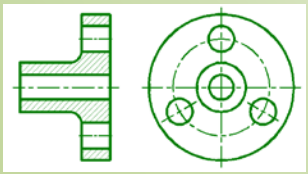
(a)



(b)



(c)



(d)

Exercise II

Make pictorial dimensioning and then draw the required number of view of each pictorial drawing and dimension them using unidirectional system and convent method of dimensioning.