CHAPTER 2

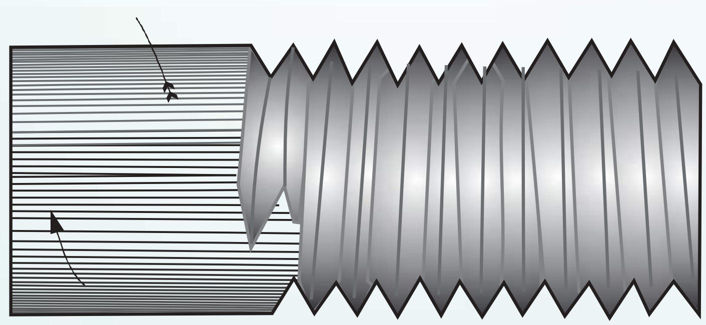
DRAWING OF MACHINE PARTS

2.1 INTRODUCTION

In our day to day life, we come across many objects where bolts and nuts are used to join two pieces together. For example we use wooden furnitures like desks, stools, tables etc. in school, showing bolts, nuts and screws. Such machine parts which are used to connect two pieces together are called as fasteners. There are two types of fasteners, viz, temporary fasteners and permanent fasteners. Threaded fasteners like bolt and nut are temporary fasteners. The process of joining different machine parts of machine or engineering products is called as fastening. Permanent fastening such as welding, riveting etc. join two parts together permanently and they cannot be separated without breaking the fastening, but in the case of temporary fastening, the parts are joined together temporarily and can be separated easily without breaking the fastening.

2.2 SCREW THREAD

A continuous helical groove cut along the outer circumference of a cylindrical surface is called a screw thread. A screw thread is an operating element of temporary fastening. Screw thread occurs on practically all engineering products. Fig. 2.1 shows a screw thread/helical groove on a cylindrical rod.



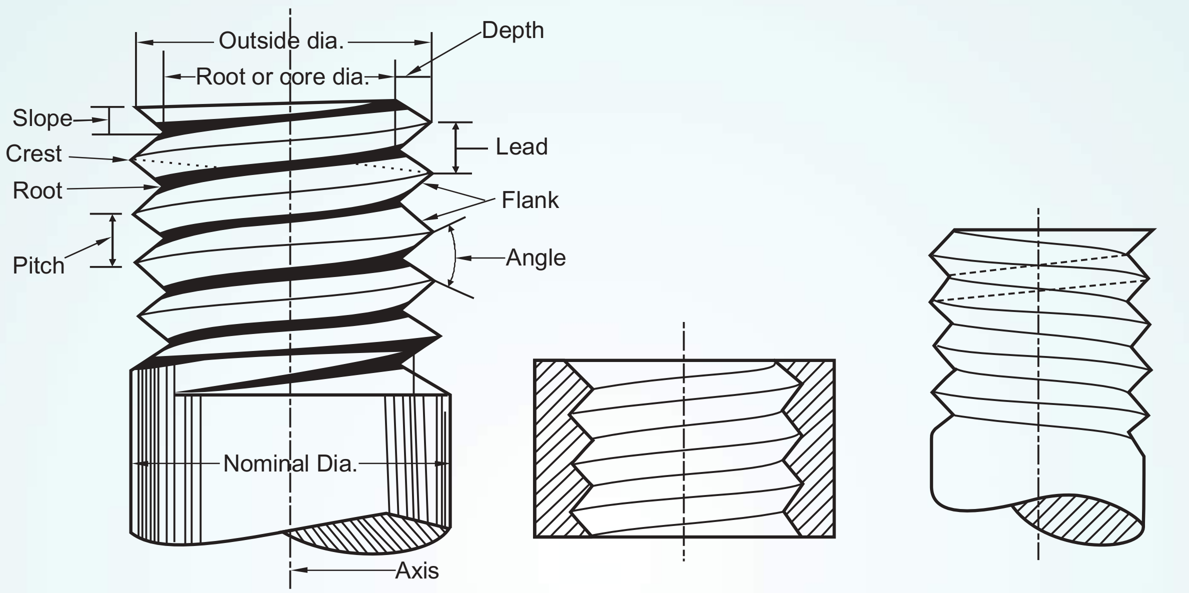
SCREW THREAD

Fig. 2.1

Screw threads are widely used for temporary fastening as well as for transmission of power from one machine part to another

2.3 TERMS USED IN THREADS / SCREW THREADS

The various terms in connection with screw threads are given below. Refer Fig.2.2



(A) EXTERNAL RIGHT HAND THREAD | (B) INTERNAL LEFT HAND THREAD | (C) EXTERNAL LEFT HAND THREAD

Fig.2.2

(i) EXTERNAL THREAD

It is a continuous helical groove or ridge cut along the external surface of the cylinder, e.g. threads on bolts, studs, screws etc. Fig. 2.2(a) shows an external thread.

(ii) INTERNAL THREAD

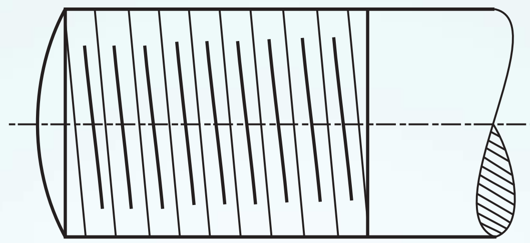
It is a thread on the internal surface of a hollow cylinder. Fig. 2.2(b) shows the internal threads, e.g. threads of a nut.

(iii) SCREW PAIR

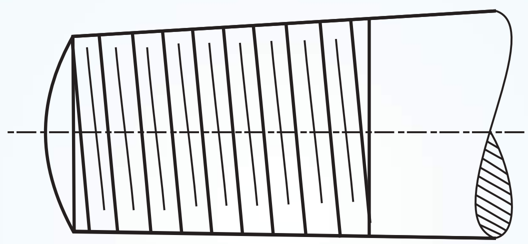
The bolt and nut together are called a screw pair. One or more such pairs are used to join two parts.

(iv) PARALLEL AND TAPER THREAD

A thread formed on the surface of a cylinder is called as parallel or straight thread. Refer Fig 2.3(A)



(A) PARALLEL THREAD



(B) TAPER THREAD

Fig. 2.3

A thread formed on the surface of a cone called as taper thread. Refer Fig. 2.3(B)

(v) RIGHT HAND AND LEFT HAND THREADS

Consider any nut and bolt. Hold the bolt firmly in left hand and rotate the nut clockwise by the right hand, the nut will 'screw-on' the bolt, these threads are right handed (RH) threads. A nut with left hand screw thread when assembled with a stationary mating bolt, 'screw-off' the bolt for clockwise rotation. It is abbreviated as LH thread.

Observe that mostly the bolts and nuts that we use in daily life have RH thread. Also we can observe that all the jewellery mating pieces have LH thread.

(vi) PITCH, P

It is "the distance between the corresponding points on the adjacent thread surface, measured parallel to the axis". Refer Fig. 2.2 (A)

(vii) LEAD, L

It is "the distance moved by a nut or bolt in the axial direction in one complete rotation".

(viii) SINGLE START AND MULTI START THREADS

When only one helix, forming the thread runs on a cylinder, it is called as single start thread. If more then one helices run on a cylinder, it is called as multi start threads.

i.e. L=P in the case of single start

L=2P in the case of double start

L=3P for triple start and so on.

(ix) CREST

It is the edge of the thread surface farthest from the axis, in case of external thread and nearest to the axis, in case of internal thread

(x) ROOT

It is the edge of the thread surface nearest to the axis in case of external thread and farthest from the axis, in case of internal thread.

(xi) FLANK

The surface connecting crest and root is called as flank.

(xii) THREAD ANGLE

It is "the angle between the flanks measured in an axial plane".

(xiii) MAJOR DIAMETER OR OUTSIDE DIAMETER

It is the diameter of an imaginary coaxial cylinder just touching the crest of external threads or roots of internal threads. It is the largest diameter of a screw thread.

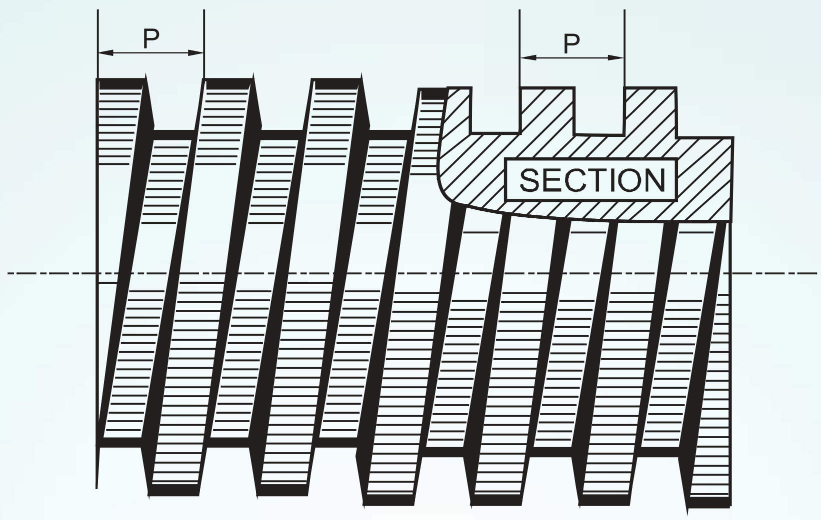
(xiv) MINOR DIAMETER OR ROOT DIAMETER OR CORE DIAMETER

It is the diameter of an imaginary co-axial cylinder just touching the roots of external threads or crest of internal threads.

(xv) NOMINAL DIAMETER

It is the diameter of the cylinder from which external threads are cut out. The screw/bolt is specified by this diameter.

(xvi) FORM / PROFILE OF SCREW THREAD



PROFILE OF SCREW THREAD

Fig. 2.4

The section of a thread cut by a plane containing the axis is known as the form of the screw thread. It is also called the profile of the thread. Refer Fig. 2.4

2.4 STANDARD PROFILE / FORM OF SCREW THREADS

There are two basic screw thread profiles. viz.

(a) Triangular or 'V' thread

(b) Square thread.

(a) TRIANGULAR OR 'V' THREAD

When the thread has a triangular or V-cross section, it is called as V-threads. All types of V-threads have inclined flanks making an angle between them. In the practical use of the threads, a clearance must be provided between the external and internal threads. V-threads are used "to tighten two parts together" as in bolts and nuts, studs and nuts, screws etc.

For interchangeability between the screws and nuts of the same nominal diameter and form, various countries have standardized V-thread profiles. A few such standard thread forms are given in our syllabus namely

(i) B.S.W. thread

(ii) Metric thread

(b) **SQUARE THREAD**

When the thread has square cross section it is called as square thread. Flanks of square threads are vertical and parallel to each other. "Square threads are used for power transmission" on feed mechanism of machine tools, screw jacks etc, as they offer less frictional resistance. In our syllabus we are going to study about the standard profile/ form of a few square threads viz.

(i) Square thread

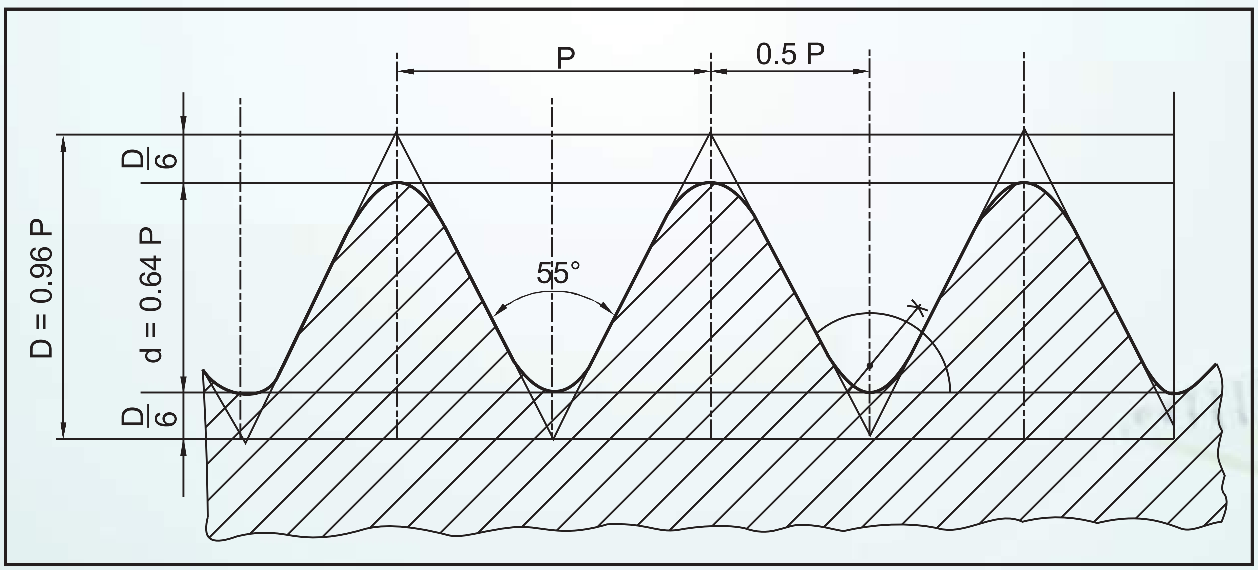
(ii) Knuckle thread

2.4.1 PROFILE OF B.S.W. THREAD

British standard whitworth (B.S.W.) thread is the most widely used form in British practice. Let us now learn to draw the standard profile of B.S.W. thread.

Example 1: Draw to scale 1:1, standard profile of B.S.W. thread, taking pitch = 40 mm. Give standard dimensions.

Solution



P	D	d	D/6
40	38.4	25.6	6.5

BRITISH STANDARD WHITWORTH THREAD (B.S.W. THREAD)

Fig. 2.5

Steps Involved

(i) Draw vertical centre lines separated by the distance of P/2, (P/2=20 mm).

(ii) Draw two horizontal lines separated by a distance of major diameter D=0.96P.

(iii) One sixth of 'D' is cut off parallel to the axis of the screw at top and bottom, to draw the horizontals for minor diameter, d= 0.64P.

(iv) Draw the basic or fundamental triangles within the D lines, such that the angle between the flanks is 55°.

(v) Draw arcs at crest and roots, to make it round by any suitable method. The method is shown clearly in Fig. 2.5, or radius of the arc can be taken as r= 0.137P.

(vi) Complete the profile and hatching is done as shown in Fig. 2.5, to represent the external thread.

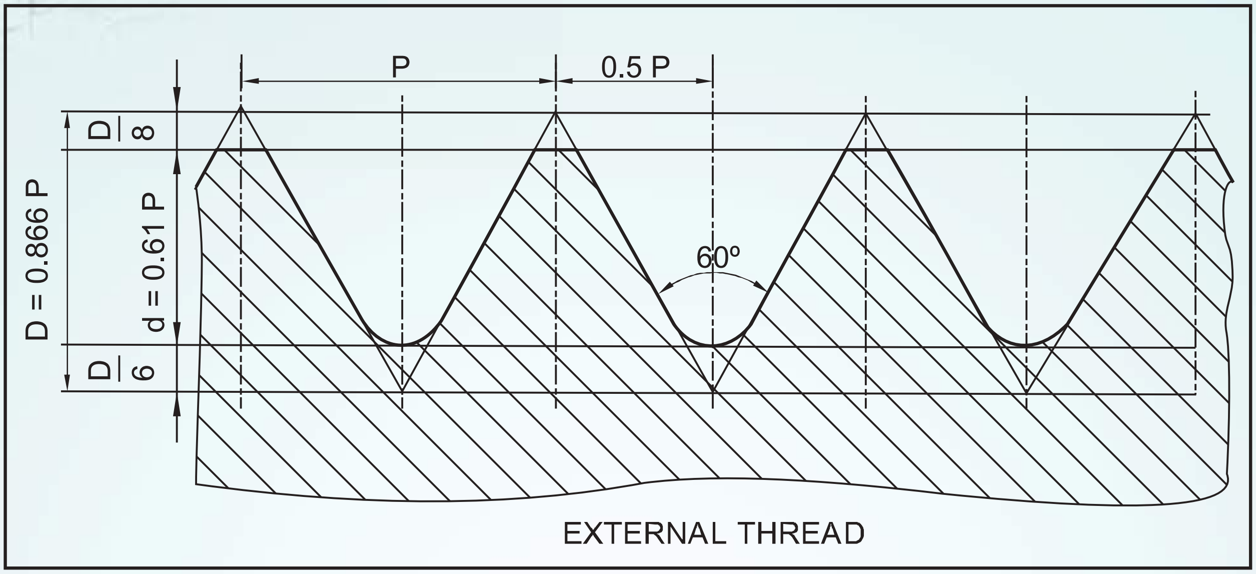
(vii) Standard dimensions are to be done as shown in the above figure.

2.4.2 METRIC THREAD

The Bureau of Indian standards (BIS) has recommended the adoption of ISO (INTERNATIONAL ORGANISATION FOR STANDARDISATION) profile with the metric screw thread system. In metric thread, the external and internal thread vary in shape. It can also be called as unified thread. In general, this ISO-metric thread will be specified using the basic designation.

The basic designation consist of the letter M followed by the nominal size (major diameter in mm) and followed by the pitch in mm. For example M20 x 1.5 means the major diameter of the metric thread is 20mm and the pitch is 1.5mm. Let us now draw the standard profiles of metric screw thread.

Example 2: Draw to scale 1:1, the standard profile of metric screw thread (external) taking enlarged pitch as 50mm. Give standard dimensions.



P	0.86P	0.61P	D/8	D/6
50	43	30.5	5.4	4.2

METRIC SCREW THREAD PROFILE

Fig. 2.6

Solution:

(i) Draw vertical centre lines P/2 apart i.e. 50/2=25mm apart.

(ii) Draw horizontals to indicate D, (D=0.866), apart.

(iii) Cut off one eighth of D at the top and one sixth of D at the bottom or draw horizontals to indicate d=0.61P.

(iv) Draw the slanting lines representing the sides of the thread. Here the angle between the flanks is 60°.

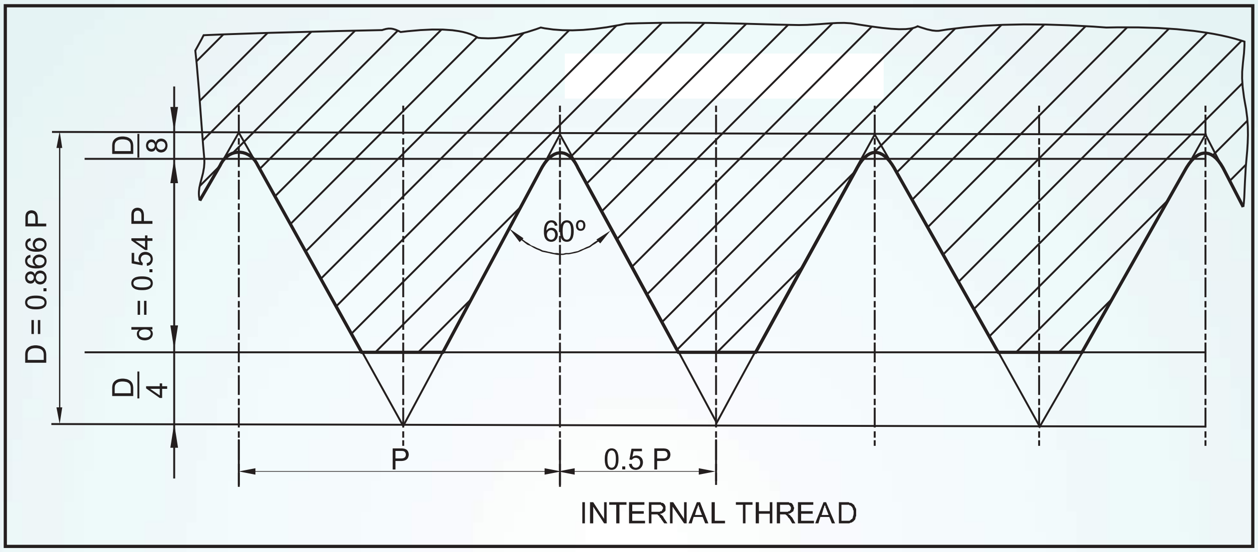
(v) Make the crest flat and roots round. Roots are made round by any suitable method.

(vi) Hatching is done as shown in Fig. 2.6. This lower hatched profile shows the basic form of the bolt.

(vii) Dimensioning is done as shown is Fig. 2.6

Example 3 : Draw to scale 1:1, the standard profile of metric screw thread (internal) taking enlarged pitch as 50mm. Give standard dimensions.

Solution : Refer Fig 2.7



P	D=0.86P	d=0.54P	D/8	D/4
50	43	27	5.4	10.8

METRIC SCREW THREAD PROFILE

Fig. 2.7

Steps involved are similar to the previous example. Here the upper hatched profile shows the basic form of nut.

2.4.3 SQUARE THREAD

Mechanisms of machine tools, valves, spindles, vice screws etc. are generally provided with square threads. A square thread (SQ) is specified by nominal diameter and pitch. For example a square thread of nominal diameter = 40 mm and pitch = 4mm is designated as SQ 40 X 4.

Let us now learn to draw the standard profile of a square thread, taking enlarged pitch as 60mm.

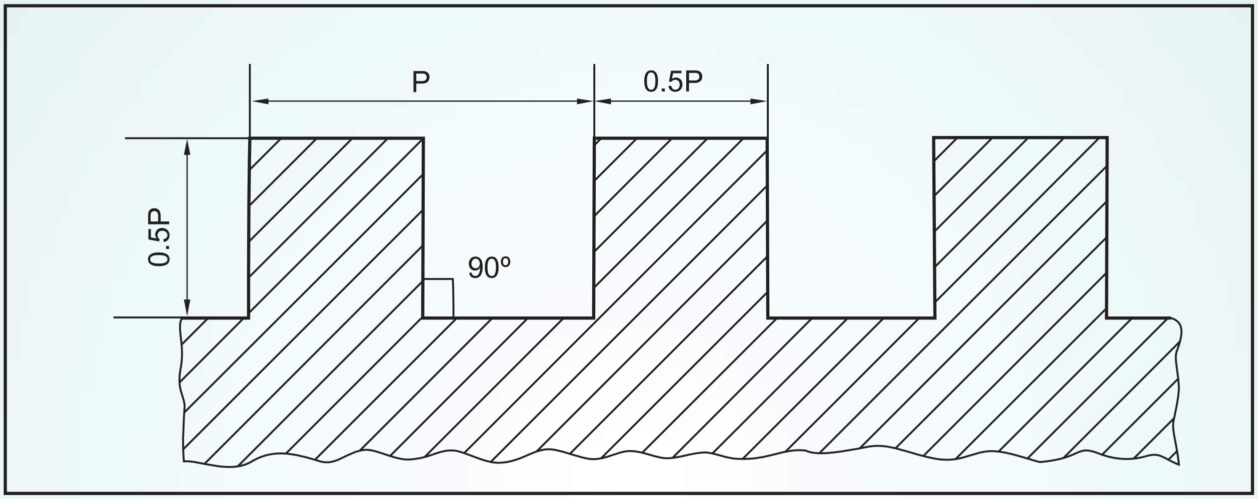
Solution : Refer Fig. 2.8

Steps Involved

(i) Draw two horizontals, P/2 apart i.e. 60/2= 30mm apart.

(ii) Draw a number of perpendiculars, 30mm apart so as to have a row of squares.

(iii) Hatching and dimensioning is done as shown in Fig. 2.8



P	0.5P	ANGLE
60	30	90°

PROFILE OF SQUARE SCREW THREAD

Fig. 2.8

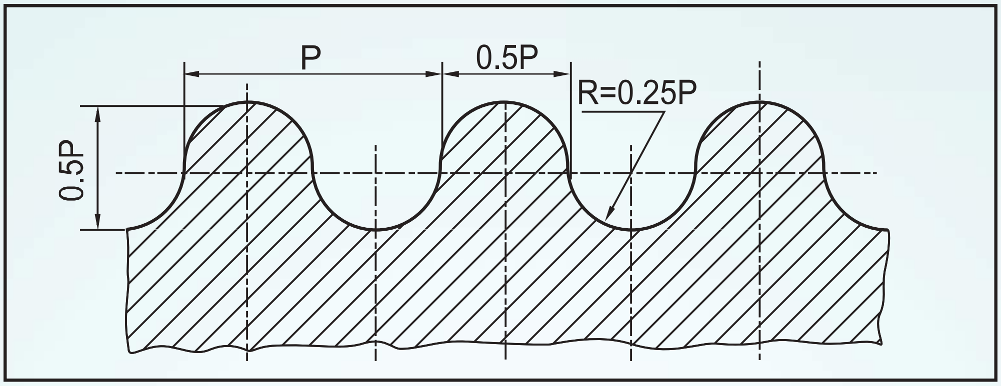
2.4.4 KNUCKLE THREAD

Knuckle thread is a modified form of square thread. Knuckle thread is a special purpose thread. It is used in railway carriage coupling screws and on the neck of glass bottles.

Let us now draw the standard profile of Knuckle thread.

Example 5 : Draw to scale, 1:1, the standard profile of a Knuckle thread, taking enlarged pitch as 40mm

Solution : Refer Fig.2.9



P	0.5P	0.25P
40	20	10

PROFILE OF A KNUCKLE SCREW THREAD

Fig. 2.9

Steps Involved

(i) Draw a thin centre line.

(ii) On either side of the centre line draw a row of tangential semi circles as shown clearly in Fig. 2.9 Care should be taken in free flowing of semi circles into one another.

(iii) Hatching and dimensioning is done as shown in Fig. 2.9.

Exercises

1. Draw to scale 1:1, the standard profile of BSW thread, taking enlarged pitch as 30mm. Give standard dimensions.

2. Draw to scale 1:1, the standard profile of metric thread (external) taking enlarged pitch as 60mm. Give standard dimensions.

3. Draw to scale 1:1, the standard profile of metric thread (internal) taking enlarged pitch as 60mm. Give standard dimensions.

4. Draw to scale 1:1, the standard profile of square thread, taking enlarged pitch as 40mm. Give standard dimensions.

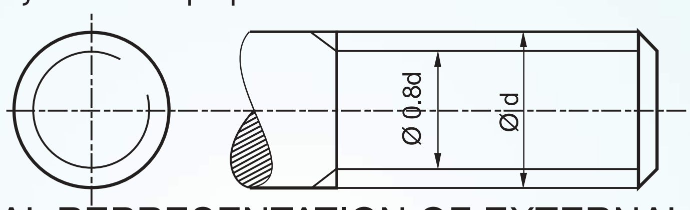
5. Draw to scale 1:1, the standard profile of knuckle thread, taking enlarged pitch as 60mm. Give standard dimensions.

2.5 CONVENTIONAL REPRESENTATION OF THREADS

In actual projection, the edges of threads would be represented by helical curves. It takes a lot of time to draw them. So, for convenience sake threads are generally shown by conventional methods as recommended by B.I.S

2.5.1 CONVENTIONAL REPRESENTATION OF EXTERNAL THREADS

The Bureau of Indian standards has recommended a very simple method of representing V-threads. Fig 2.9 shows the simplified representation of external V-threads. According to this convention, two continuous thick lines and two continuous thin lines are drawn to represent crest and roots of the thread respectively. The limit of useful length of the thread is indicated by a thick line perpendicular to the axis.

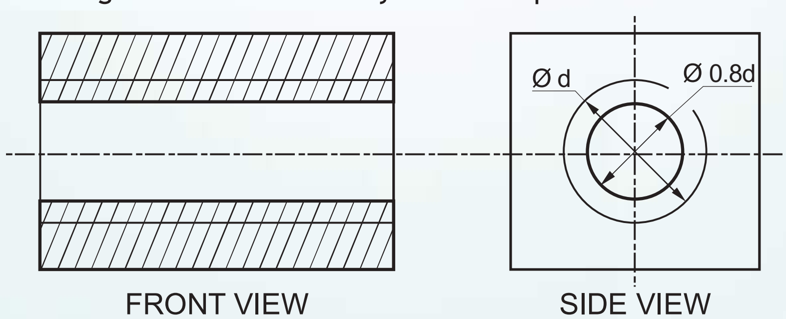


CONVENTIONAL REPRESENTATION OF EXTERNAL THREADS

Fig. 2.9

2.5.2 CONVENTIONAL REPRESETATION OF INTERNAL THREADS

Fig. 2.10 shows the representation of internal V-threads. It shows the sectional view of a threaded hole in the front view. Thick line indicates the crest and thin line indicates the root. Section (hatching) lines are extended up to thick lines. The side view shows a thick circle representing the crest and roots by thin incomplete circle



CONVENTIONAL REPRESENTATION OF INTERNAL THREADS

Fig. 2.10

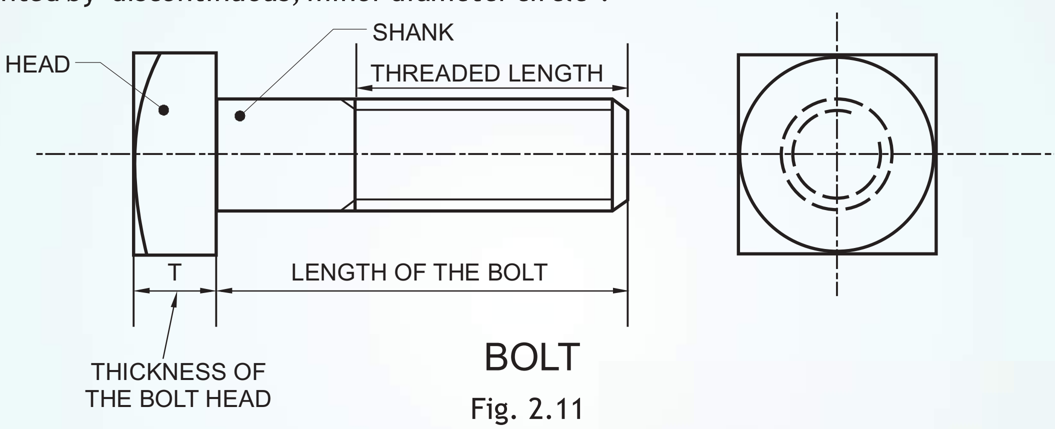
Exercise

1. Sketch freehand the conventional representation of internal and external threads, given d = 30 mm.

2.6 BOLTS

In day to day life, we can observe many machine parts joined by bolt and nut. Now, let us study about the bolts.

A bolt consists of a cylindrical body with one end threaded and the other end converted into a head. It is passed through clearance holes (diameter slightly more than nominal diameter of bolt) in two or more aligned parts. A nut is screwed on the threaded end of the bolt to tighten the parts together. Different types of bolts are used for different purposes. The shape of the head also depends upon the purpose for which the bolt is used. The length of a bolt is its total length, *"excluding the height or thickness of bolt head"*. Bolt has external thread. An external thread is represented by *"discontinuous, minor diameter circle"*.



BOLT

Fig. 2.11

We are going to study about the following types of bolts

- (i) Hexagonal headed bolt
- (ii) Square headed bolt
- (iii) Tee headed bolt
- (iv) Hook bolt

2.6.1 HEXAGONAL HEADED BOLT

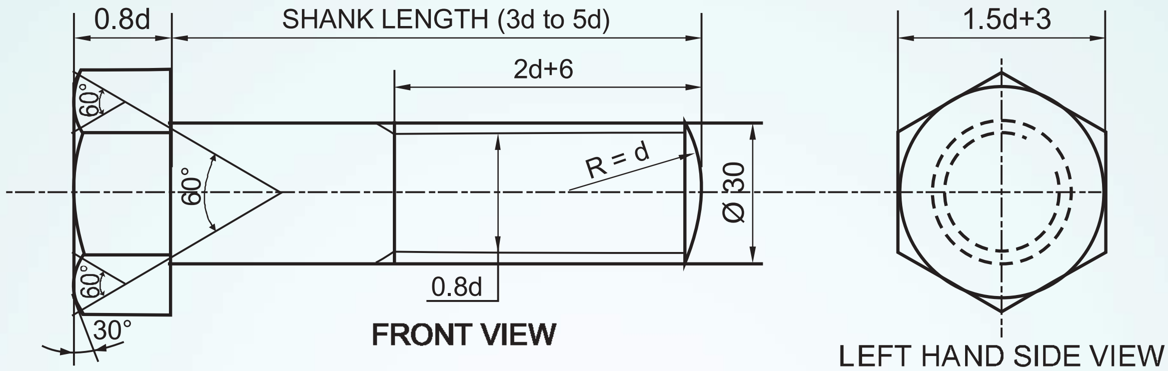
It is the most commonly used form of bolt. The head of a hexagonal bolt is a hexagonal prism with a conical chamfer rounded off at an angle of 30° on the outer end face. Chamfering is done to remove sharp corners to ensure the safety of the user. The approximate height/thickness of the bolt head is 0.8d (d is the diameter of the bolt). A little portion (about 3 mm) of the threaded end should remain outside the nut.

Let us now learn to draw the views of a hexagonal headed bolt.

Fig. 2.12

EXAMPLE 6: Draw to scale 1:1, the front view and side view of a hexagonal headed bolt of diameter 30mm, keeping the axis parallel to H.P and V.P.

Solution: Refer Fig. 2.13a



d	0.8d	1.5d+3	2d+6
30	24	48	66

HEXAGONAL BOLT

Fig. 2.13a

Steps Involved

(i) "Start with the view where circles are seen". Here the side view shows the circles representing the shank. So, start with the side view.

(ii) Draw a circle of given diameter, d= 30mm

(iii) Draw another circle of diameter 0.8d (24mm), which is shown as broken/discontinuous circle. (Broken part is shown in first quadrant) 'This inner broken circle indicates that the thread on the bolt is an external thread'.

(iv) Draw another circle of diameter 1.5d+3 mm (48 mm) to indicate the chamfering circle.

(v) Circumscribe hexagon around the chamfering circle as in Fig. 2.13b using 30° – 60° degree set square and minidrafter.

(vi) After completing the side view, the front view will be drawn by taking projections. Project the shank diameter (d= 30 mm) from the side view. Draw a rectangle for the shank.

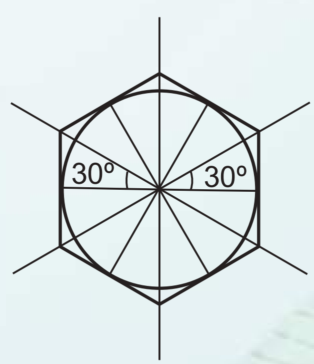


Fig. 2.13 b

(vii) The end of the bolt is rounded and is done with the radius equal to the diameter of the bolt. (R = d = 30mm)

(viii) Indicate the threaded portion (by projecting the 0.8d = 24mm circle with "thin continuous lines") at the end of the shank for the length of 2d+6 mm =66mm

(ix) Draw the head of the bolt in the front view, by projecting the hexagon from the side view. Size A/C (across corners) will be projected to get the width of the head. Height of the head is taken as 0.8d= 24mm.

(x) The three faces of the hexagonal head with chamfering arcs is drawn by any of the appropriate method.

(xi) The centers of chamfering arcs for the three faces may be located as shown in the Fig. 2.13a

Keep in your mind that, in the front view, showing "three faces" of the hexagonal head, show the upper corners of the head chamfered. In the front view showing "two faces" of the hexagonal head, show the upper corners square.

2.6.2 SQUARE HEADED BOLT

It is also the common form of the bolt and is generally used where the head of the bolt is to be accommodated in a recess. The recess itself is in the form of square in which the head rests having a little clearance. The square recess prevents the head from rotating when the nut is screwed on or off.

Let us now learn how to draw the views of a square headed bolt.

Fig. 2.14

Example 7 : Draw to scale 1:1 the Elevation and Plan of a square head bolt when it axis is perpendicular to H.P. Take the diameter of the bolt as 24mm, and length as 110 mm.

Solution : Refer Fig 2.15

Steps Involved

(i) Since the circles are seen in the top view, start with the top view. Draw a circle of diameter, d= 24 mm.

(ii) Within the 'd' circle, draw an another discontinuous/broken circle of diameter = 0.8d say 19.2 mm to the bolt.

(iii) Draw the chamfering circle of diameter =1.5d+3 mm, say 39 mm.

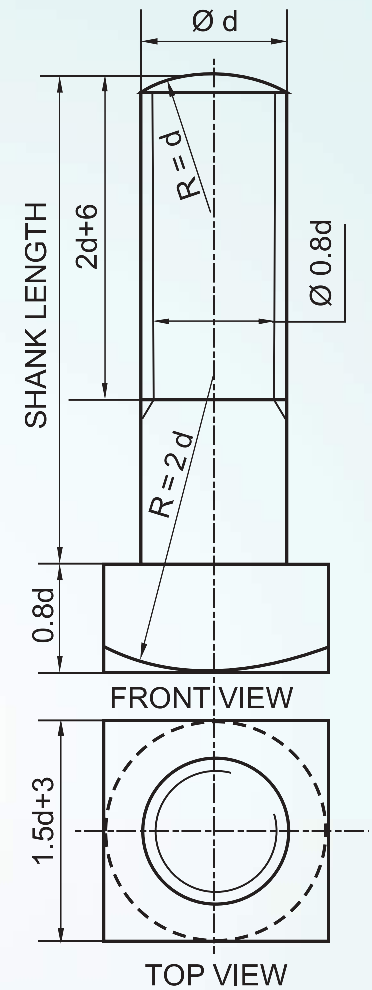
(iv) Circumscribe square around the chamfering circle.

(v) Project the Front view from the top view. Construct a rectangle of size Ød x length of the bolt, 24x110mm. The end of the bolt is rounded and is done with the radius equal to the diameter of the bolt. (R = d = 24 mm) Indicate the threaded portion at the end of the shank for the length of 2d+6 mm = 54 mm.

(vi) Bolt head is drawn by projecting the front view. Construct a rectangle of (1.5d+3)x0.8d say 39x19.2 mm.

(vii) Chamfering arc is drawn with radius of R = 2d = 48 mm.

(viii) All the standard dimensions are given as shown in the Fig. 2.14



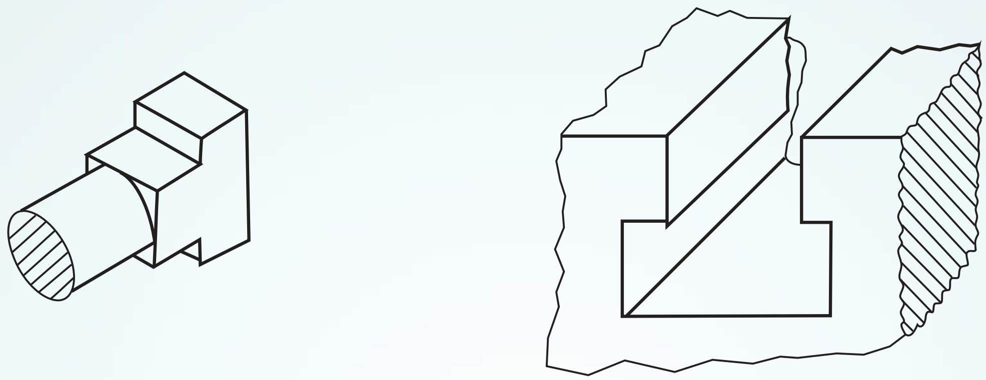
d	0.8d	1.5d+3	2d+6	2d
24	19.2	39	54	48

SQUARE BOLT

Fig. 2.14

2.6.3 T-BOLT

The head of this bolt is just like the English alphabet 'T' Fig 2.16(I). It is "used in machine tool tables". Corresponding T-slots are cut into the table [see Fig 2.16 (II)] to accommodate the T-head of the bolt. A square neck is usually provided with the head.

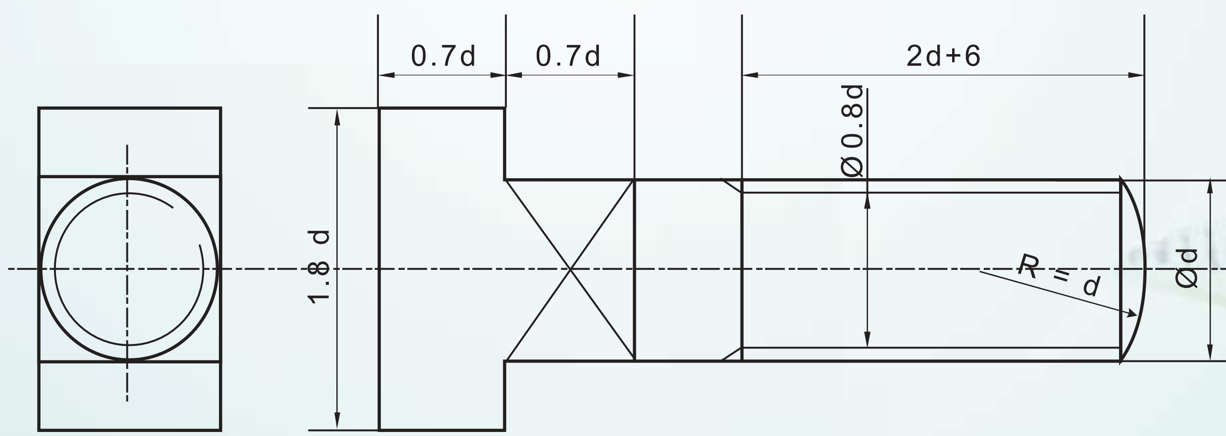


(I) T-BOLT (II) T-SLOT

Fig. 2.16

Example 8 : Draw to scale 1:1, the front view and side view of a T-Headed bolt of diameter 20mm. Keep the axis parallel to V.P and H.P.

Solution: Refer Fig. 2.17



SIDE VIEW FRONT VIEW

d	0.7d	0.85d	1.8d
20	14	17	36

T-HEADED BOLT

Fig. 2.17

Steps Involved

(i) Start with the side view where circles are seen. Draw outer and inner circle of diameter, d= 25 mm and 0.8d= 20 mm respectively, with inner circle discontinuous or broken.

(ii) Then the front view is drawn with the shank and bolt head as shown clearly in the Fig. 2.17.

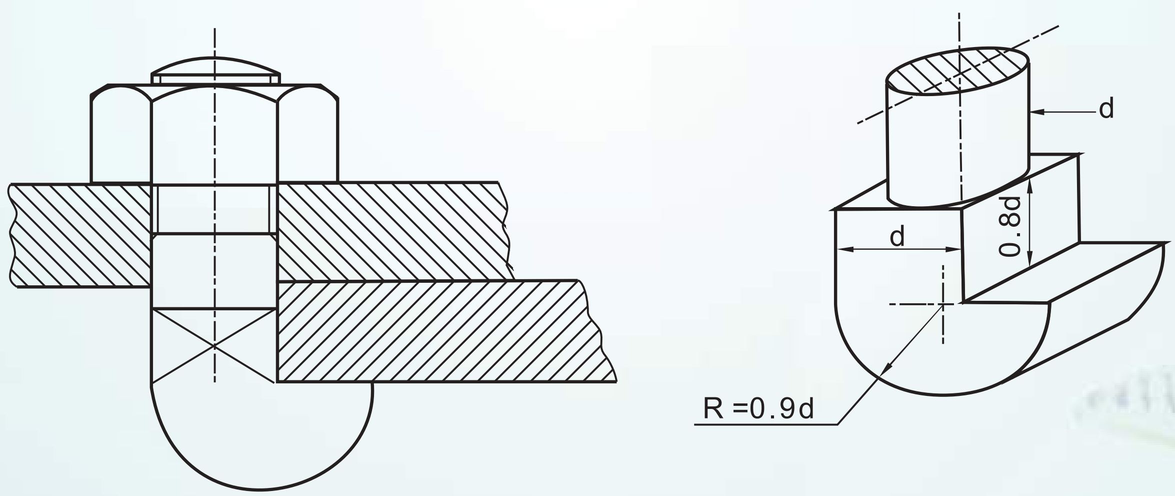
Observe that the square cross section is shown by drawing thin cross lines.

(iii) Then complete the side view by projecting the T-head.

(iv) Dimensioning is done as shown in the Fig. 2.17.

2.6.4 HOOK BOLT/J-BOLT

Fig 2.18(b) shows the pictorial view of a Hook bolt. The head is in the form of a hook (J-shape) which projects only in the side of the shank. The shank of the bolt passes through a hole in one part only. The other part to be joined comes under the head of the bolt. A hook bolt is usually provided with a square neck to prevent its rotation while tightening.



(a) J-BOLT IN POSITION

(b) PICTORIAL VIEW OF A J BOLT

HOOK BOLT / J-BOLT

Fig. 2.18

Example 9 : Draw to scale 1:1, the front view and plan of hook bolt with diameter 20 mm, keeping the axis vertical. Give standard dimensions.

Solution : Refer Fig. 2.19

Steps Involved

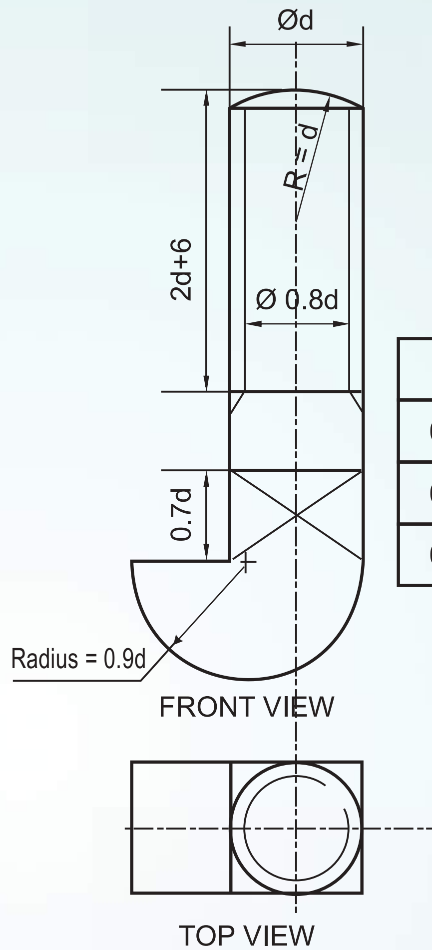
(i) Start with the view having circles. Here start with the top view. Draw centre lines and draw outer and inner circle of diameter d= 20mm and 0.8d= 16mm respectively. To indicate the external thread of the bolt, 0.8d circle is drawn broken.

(ii) Complete the shank portion of the front view as shown clearly in the Fig. 2.19

(iii) Head portion of the front view is complete and the square cross section is shown as thin cross lines.

(iv) Complete the hook portion of the top view by projecting the front view.

(v) Dimensioning is done as shown in the Fig. 2.19



d	20
0.7d	14
0.8d	16
0.9d	18

HOOK BOLT / J-BOLT

Fig. 2.19

Exercises

1. Draw to scale 1:1, the Front view and side view of a hexagonal head bolt of diameter 30 mm, keeping the axis parallel to H.P and V.P. The two opposite sides of the hexagonal head is parallel to V.P. The length of the bolt is 120 mm.

2. Draw to scale 1:1, the Front view and top view of a hexagonal headed bolt of diameter 20mm, keeping the axis perpendicular to V.P. Give standard dimensions.

3. Draw to scale 1:1, the Front view and Side view of a hexagonal headed bolt of diameter 24mm, keeping the axis parallel to V.P and H.P. Two opposite sides of the hexagonal head is perpendicular to V.P. Take the following dimensions.

   Length of the bolt = 120mm

   Threaded length of the bolt = 80mm

4. Draw to scale full size, the Front view and Side view of a square head bolt of diameter 24mm, keeping its axis horizontal.

5. Draw to scale 1:1, the Elevation and Plan of a square head bolt of diameter 30mm, when its axis is perpendicular to H.P. Give standard dimensions.

6. Draw to scale 1:1, the Front elevation and Plan of a tee head bolt of diameter 24mm, keeping the axis perpendicular to H.P.

7. Draw to scale 1:1, the Front view, Side view of a hook bolt with diameter 25mm, when its axis parallel to V.P and H.P. Give standard dimensions.

2.7 NUTS

A nut is a machine element having a threaded hole that engages with the threaded end of the bolt. There are different types of nuts in use. In our syllabus, we are going to study about hexagonal nut and square nut.

2.7.1 HEXAGONAL NUT

Refer Fig. 2.20

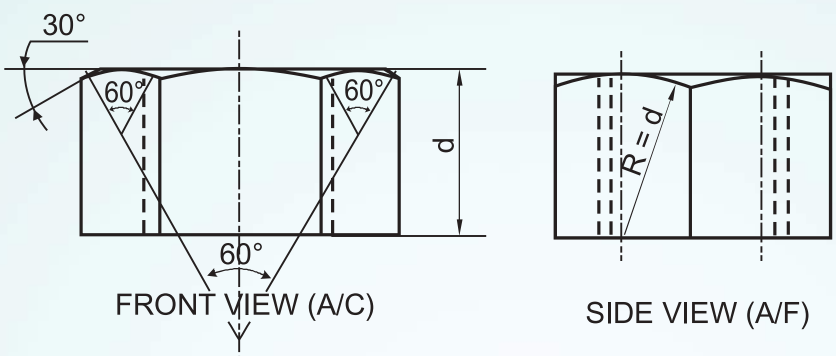
The most commonly used type of nut is the hexagonal nut. It is a hexagonal prism provided with a threaded hole. Upper corners of a nut are “chamfered” or “rounded- off”. The angle of chamfer is usually "30° with the base of the nut". The chamfering gives arcs on the vertical faces of the nut and circle on the top surface of the nut. The chamfering circle on the top surface touches the mid points of all the sides of the nut which can be seen in the top view. All dimensions of hexagonal bolt and hexagonal nut are same except the height/thickness of the hexagonal head.

Fig. 2.20

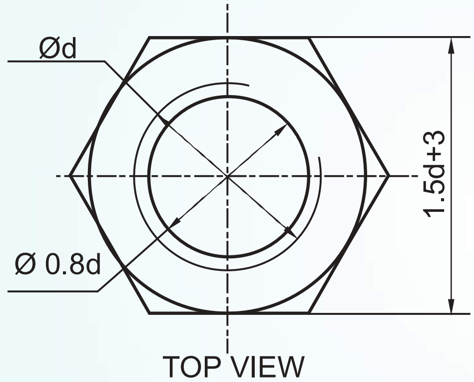
Let us now learn to draw the views of a hexagonal nut.

Example 10 : Draw to scale 1:1, the front view, top view and side view of a hexagonal nut of size M30, keeping the axis perpendicular to H.P. Give standard dimensions.

Solution Refer Fig 2.21



d	30
0.8d	24
1.5d+3	48



NOTE : The size of chamfer circle can be taken 1.5d or 1.5d+3 in square / hex. head bolt and nut.

HEXAGONAL NUT

Fig. 2.21

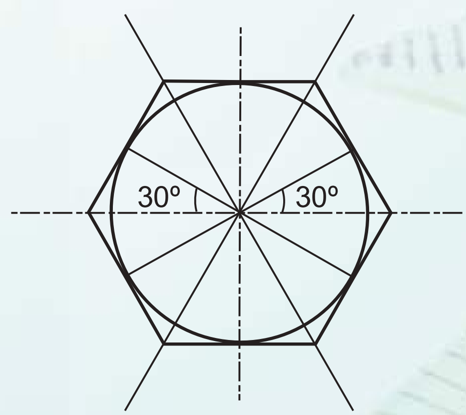
Steps Involved

(i) Start with the top view, where circles are seen. Draw a circle of diameter d = 30mm. Describe this circle as discontinuous circle to indicate the internal thread of a nut.

(ii) Draw an another circle of diameter 0.8d = 24mm

(iii) Draw the third circle which is of chamfering circle of diameter 1.5d+3 = 48mm.

(iv) Circumscribe a hexagon around the chamfering circle using the 30° - 60° degree set square and mini drafter as shown in Fig. 2.22.



HEXAGONAL NUT

Fig. 2.22

(v) Project the top view to get front view. Front view has three faces if nut is placed across corner (A/C) and front view has two faces if the nut is placed across flats (A/F). The common position for the nut is A/C.

(vi) Chamfering arcs in the front view may be done by any suitable method. One of the methods is clearly shown in figure 2.21.

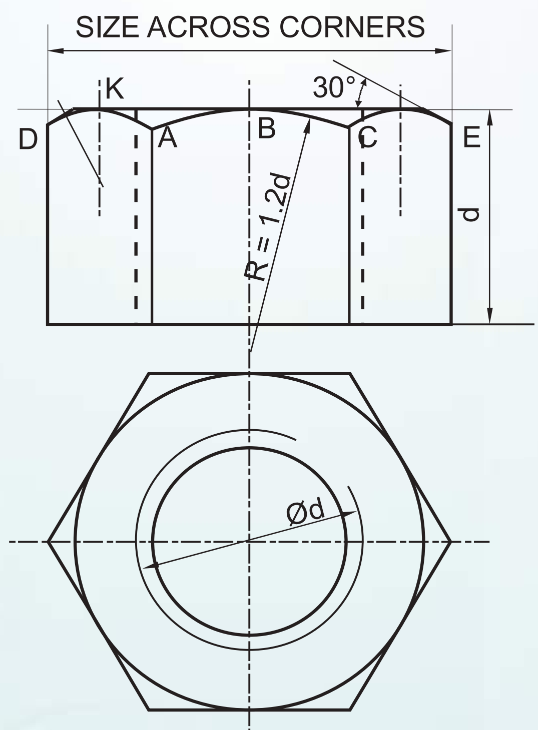
The alternate method is given below for your reference.

- On the front view, describe arc ABC [Fig.2.23] of radius 1.2d = 3mm. It cuts the verticals in A and C. Here d = 25mm.
- Bisect the chord between D and A and between C and E.
- On the bisectors we shall expect to find the center of the arcs which pass through DKA and CE.
- Join DK and bisect at right angles, thus locating the center of arc DKA.

Note that arc CE will also have the same radius.

(vii) Side view is projected from front view and top view. Side view and front view have same height but different width.

(viii) Give the standard dimensions as shown in Fig 2.21.



HEXAGONAL NUT

Fig. 2.23

2.7.2 SQUARE NUT

A square nut is also one of the main forms of nut. It is a square prism provided with a threaded hole. The upper corners of a square nut are chamfered in the same way as that of a hexagonal nut. The dimensions of square head are same as that of square bolt except the height/thickness. Now, let us learn to draw the views of a square nut.

SQUARE NUTS
Fig 2.24

Example 11: Draw to scale 1:1, the Front elevation and Plan of a square nut of diameter 25mm, keeping its axis vertical and two of the opposite edges of the square face parallel to V.P.

Solution: Refer Fig 2.25

Steps Involved

(i) Start with the top view. With same point as center, draw three circles of diameter d = 25 mm, 0.8d = 20 mm, 1.5d =37.5 mm respectively.

Indicate the internal thread of the nut by drawing Ød circle discontinuous.

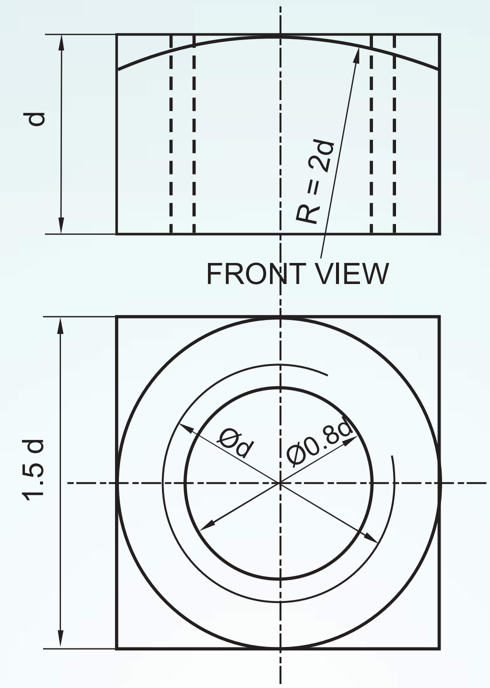
(ii) Circumscribe square around the chamfering circle of diameter 1.5d (37.5 mm)

(iii) Project the top view to get the front view. Front view is a rectangle of size (1.5dxd) 37.5x25 mm.

(v) Chamfering arc in the front view is drawn with the radius R = 2d = 50 mm.

NOTE: If one face of the square nut is seen in the front view, make the corners squared. (at 90° degree)

(v) Dimensioning is done as shown in Fig. 2.25.



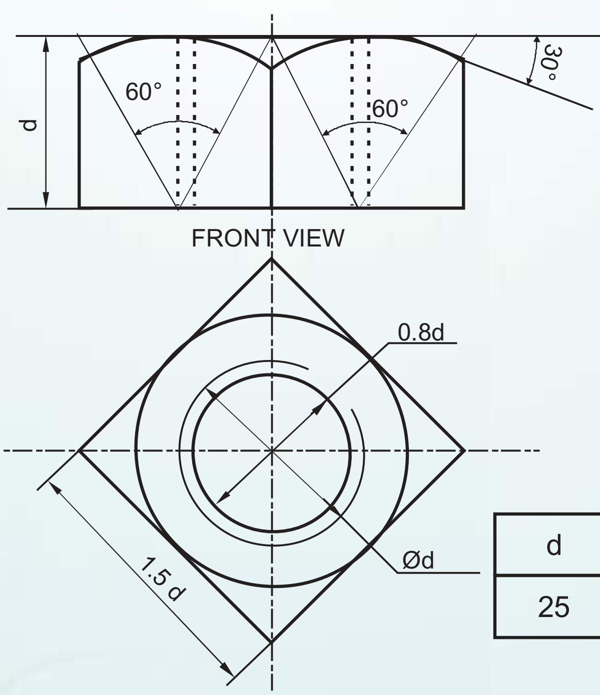
d	25
0.8d	20
1.5d	37.5

SQUARE NUT ACROSS FLAT

TOP VIEW

Fig. 2.25

Example 12 : Draw to scale full size the Front View and Top View of a square nut of diameter 25mm, keeping its axis vertical with the diagonal on the square face parallel to V.P.



d	0.8d	1.5d
25	20	37.5

SQUARE NUT ACROSS CORNER

Fig. 2.26

Solution : Refer Fig. 2.26

Steps Involved :

(i) Start with the top view. Describe three circles of diameter d = 25mm, 0.8d = 20mm, 1.5d = 37.5mm respectively. (Ød circle is broken to represent the internal thread of the nut.)

(ii) Circumscribe square around the chamfering circle as shown in Fig 2.26.

(iii) Project the Top View to draw the Front View

(iv) Complete the Front View as shown in Fig. 2.26.

NOTE: When two faces of square nut are seen in front view, the corners are chamfered.

ADDITIONAL INFORMATION

The hexagonal nut takes preference over the other nuts. A spanner is used to turn the nut on or off the bolt. The jaws of the spanner come across the opposite flats of the nut. The angle through which the spanner will have to be turned to get another hold is only 60° in case of a hexagonal nut but 90° for a square nut. Though the angle is 45° in case of the octagonal nut, it is rarely used due to its complicated process of construction. So, it is more convenient to screw on a hexagonal nut than a square nut in a limited space for turning the spanner.

Exercises :

NOTE : Assume missing dimensions proportionately

1. Draw to scale 1:1, the front elevation and plan of a hexagonal nut keeping axis vertical, when two of the opposite sides of the hexagon are parallel to V.P. Give standard dimensions, taking the diameter of bolt = 24 mm.

2. Draw to scale 1:1, the Plan and Front View of a hexagonal nut, taking nominal diameter of the bolt = 30mm, keeping the axis perpendicular to H.P and two opposite sides of the hexagon perpendicular to V.P. Give standard dimensions.

3. Draw to scale 1:1, the Front View and Top View of a square nut, taking nominal diameter =30mm, keeping the axis perpendicular to H.P and two opposite sides of the square perpendicular to V.P. Give standard dimensions.

4. Draw to scale 1:1, the front view and plan of a square nut, taking d = 30mm, keeping the axis perpendicular to H.P and the diagonal of the square face parallel to V.P. Give standard dimensions.

2.8 WASHER

You must have seen the circular plate called washer fitted in your mini drafter. Even, in jewellery item like ear tops/studs, washer may be used to tighten the screw. There are two main kinds of washer used in machinery, namely

(i) Plain washer.

(ii) Spring washer.

We are going to study only about the plain washer in our syllabus.

2.8.1 PLAIN WASHER

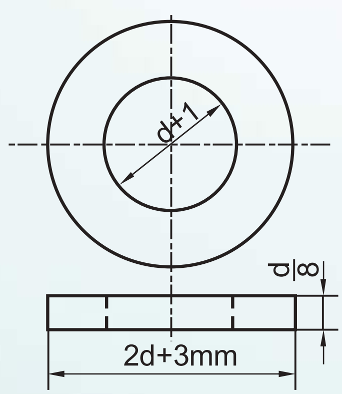
A plain washer see Fig. 2.27 is a circular plate having a hole in its centre. It is placed below the nut to provide a flat smooth bearing surface. The use of a washer is recommended where the surface of the machine part is rough for a nut to seat. Washer also prevents the nut from cutting into the metal thus allowing the nut to be screwed more tightly.

WASHER

Fig. 2.27

Example 13: Draw to scale 1:1, the front view and top view of a washer, taking the nominal diameter of the bolt on which the washer is used = 25mm. Keep the circular face of the washer parallel to V.P

Solution: Refer Fig. 2.28



d	2d+3	d/8
25	53	3

PLAIN WASHER

Fig. 2.28

Steps Involved

(i) Start with the Front View, which comprises of two circles with diameter d+1 = 25mm, 2d+3 = 53mm.

(ii) Project the front view to get the Top View which is a rectangle of size, [(2d+3) x d/8], 53x3 mm. Complete the Top View as shown in the Fig. 2.28

2.9 COMBINATION OF BOLT, NUT AND WASHER FOR ASSEMBLING TWO PARTS TOGETHER

In common machineries used at home, we might have observed the assembly of bolt, nut and washer to connect two parts together. See Fig 2.29.

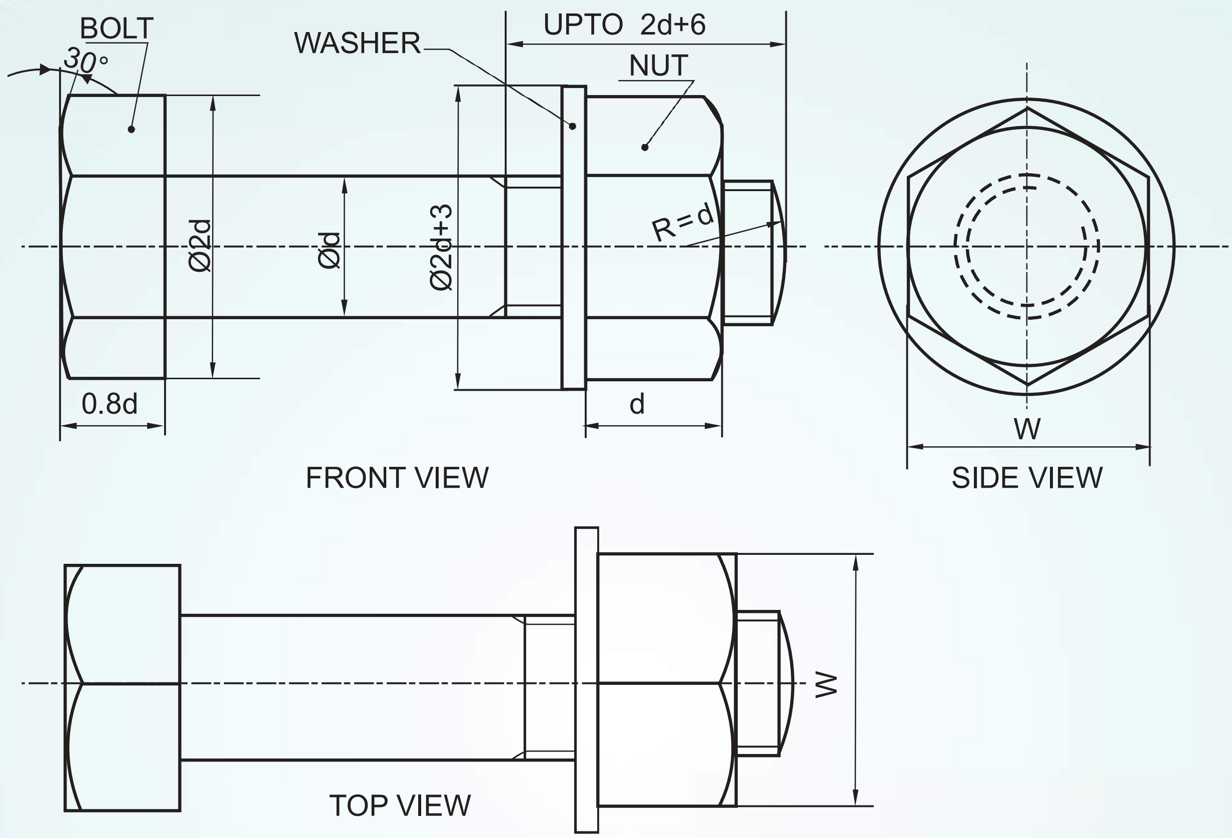
NUT, BOLT AND WASHER

Fig. 2.29

In the earlier topics, we learnt how to draw the views of bolt, nut and washer separately. Now, we will draw the views of the assembly of bolt, nut and washer.

Example 14: Draw to scale 1:1, the Front View, Top View and side view of a hexagonal headed bolt of diameter 25mm with hexagonal nut and washer, keeping the axis parallel to V.P and H.P

Solution: Refer Fig. 2.30.



COMBINATION OF HEXAGONAL HEADED BOLT WITH HEXAGONAL NUT & WASHER

Fig. 2.30

Steps Involved:

(i) Since the axis is parallel to both V.P and H.P, the side view reveals more information about the shape of the object. So start with side view, where circles are seen.

(ii) Draw two circles of diameter d = 25mm and 0.8d = 20mm, in dotted lines to indicate the invisible feature from left side.

(iii) Draw the chamfering circle of diameter, 1.5d + 3mm =40.5mm

(iv) Circumscribe hexagon around the chamfering circle, using set-square and minidrafter.

(v) Then draw a circle of diameter 2d + 3mm = 53mm for washer.

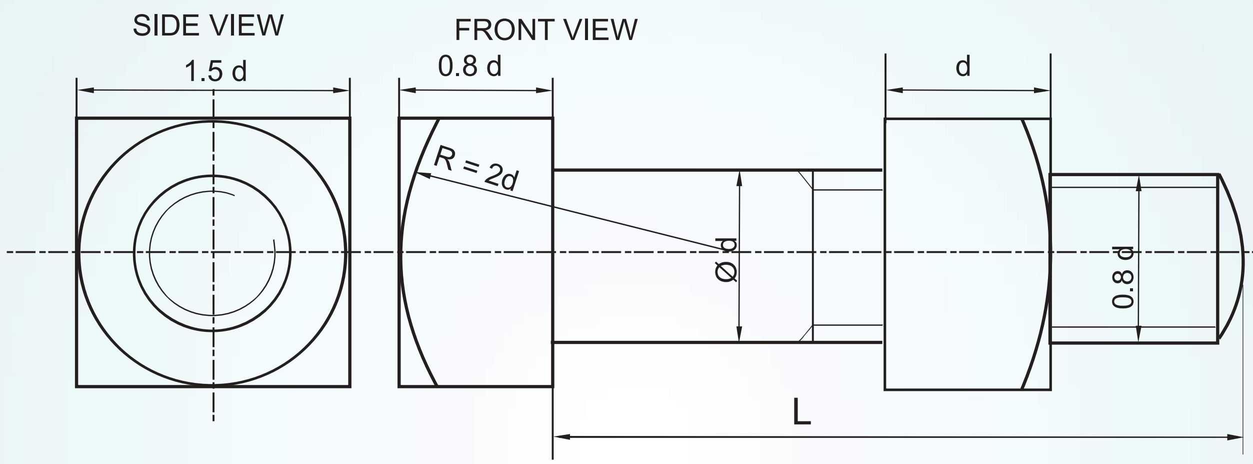
(vi) Project the side view to front view and top-view.

(vii) Both the views are completed as shown in the Fig. 2.30.

Example 15: Draw to scale 1:1, the Front View and Side View of an assembly of a square bolt of diameter 25 mm and a square nut, keeping the axis parallel to V.P and H.P. Take length of the bolt as 100 mm.

Solution: Refer Fig 2.31

The figure is self explanatory.



d	0.8d	1.5d	2d	2d+6	L
25	20	37.5	50	56	100

SQUARE BOLT AND SQUARE NUT IN POSITION

Fig. 2.31

Exercises :

1. Draw to scale 1:1, the front view and side view of an assembly of hexagonal headed bolt of 30mm diameter with hexagonal nut and washer, keeping the axis parallel to V.P and H.P. Give standard dimensions.

2. Draw to scale 1:1, the front view and side view of a square headed bolt of size M24, fitted with a square nut and a washer, keeping their common axis parallel to V.P. and H.P.

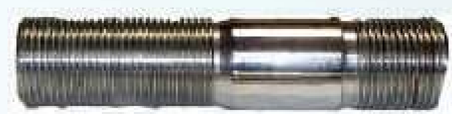
3. Draw to scale 1:1, the front view and side view of the assembly of square headed bolt with a hexagonal nut and a washer, with the diameter of bolt as 30mm, keeping their axis parallel to V.P and H.P and two of the opposite sides of the square head of the bolt and of the hexagonal nut, parallel to V.P.

2.10 STUDS

A stud is a cylindrical piece of metal having threads at both ends and is a plain cylinder or plain cylinder with square cross section/ square neck or with collar in the central portion.

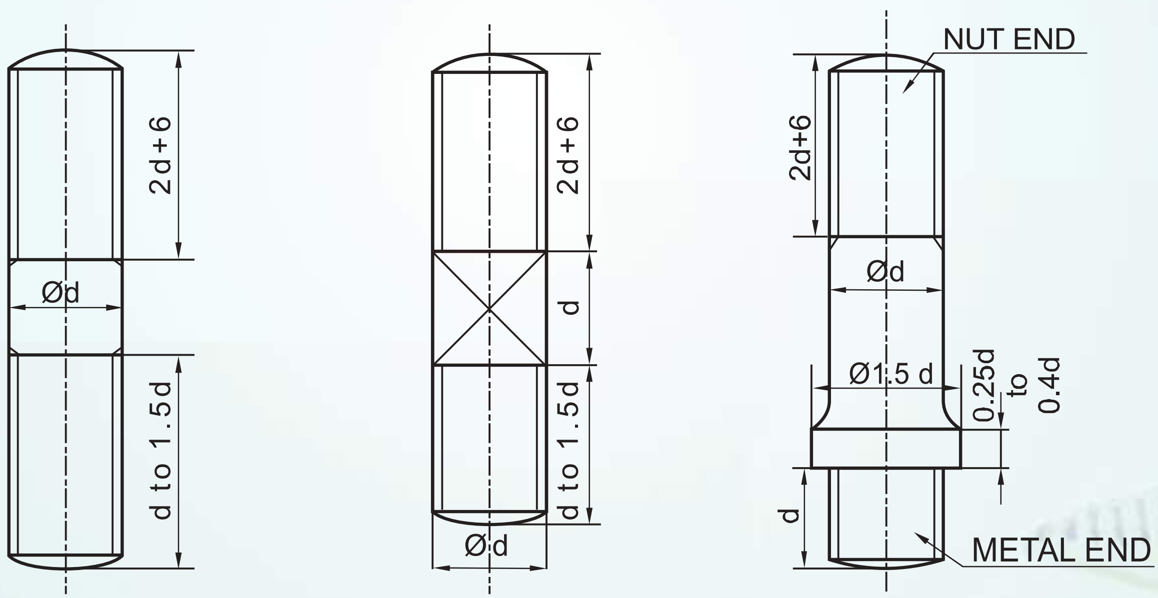
For connecting two parts, one end (metal end) of the stud is screwed into a threaded hole in one part and the other end (nut end) is passed through a clearance hole in the other part, so that the plain portion of the stud remains within this hole. A nut is screwed on the open end of the stud. The portion of the stud where nut is screwed on is called nut end and the other end of the stud is called metal end or stud end.

Stud is a headless bolt and is used where sufficient space for bolt head is not available. The following Fig 2.33 shows the view of a plain stud, stud with square neck and stud with collar.



STUD

Fig 2.32



(i) PLAIN STUD

(ii) STUD WITH SQUARE NECK

(iii) STUD WITH COLLAR

Fig 2.33

Example 16: Sketch freehand the Front view and Top view of a Plain stud of diameter = 20mm, keeping its axis vertical.

Solution: Refer Fig 2.34

Steps Involved:

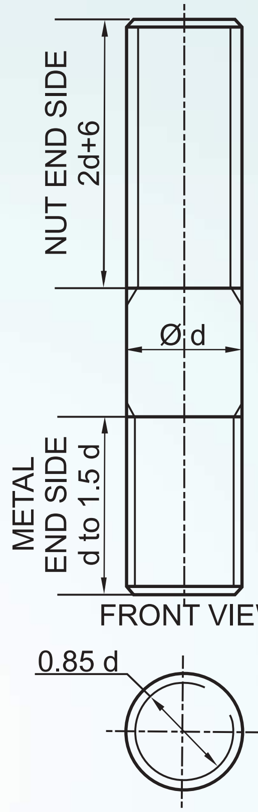
(i) Calculate the values of standard dimensions.

(ii) Draw free-hand two circles of diameters d =20mm and 0.85d = 17 mm as top view.

(iii) Draw a rectangle for the front view with approximate measurements.

(iv) The metal end and the nut end is either chamfered or rounded.

(v) Dimension the views in terms of ‘d’.



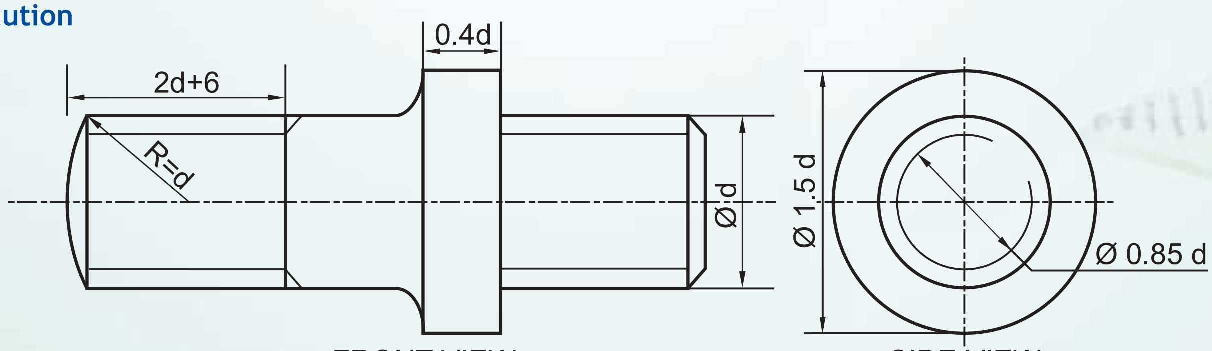
d	20
0.85d	17
1.5d	30
2d+6	46

PLAIN STUD

Fig. 2.34

Example 17: Sketch free hand the Front view and Side view of a collar stud with diameter 20 mm, when its axis is parallel to V.P and H.P. Give standard dimensions.

Solution



d	1.5d	2d+6	0.4d	0.85d
20	30	46	08	17

COLLAR STUD

Fig. 2.35

Exercises:

1. Sketch freehand the Front elevation and Side view of a Plain stud of diameter d = 25mm, with its axis parallel to V.P and H.P. Give standard dimensions.

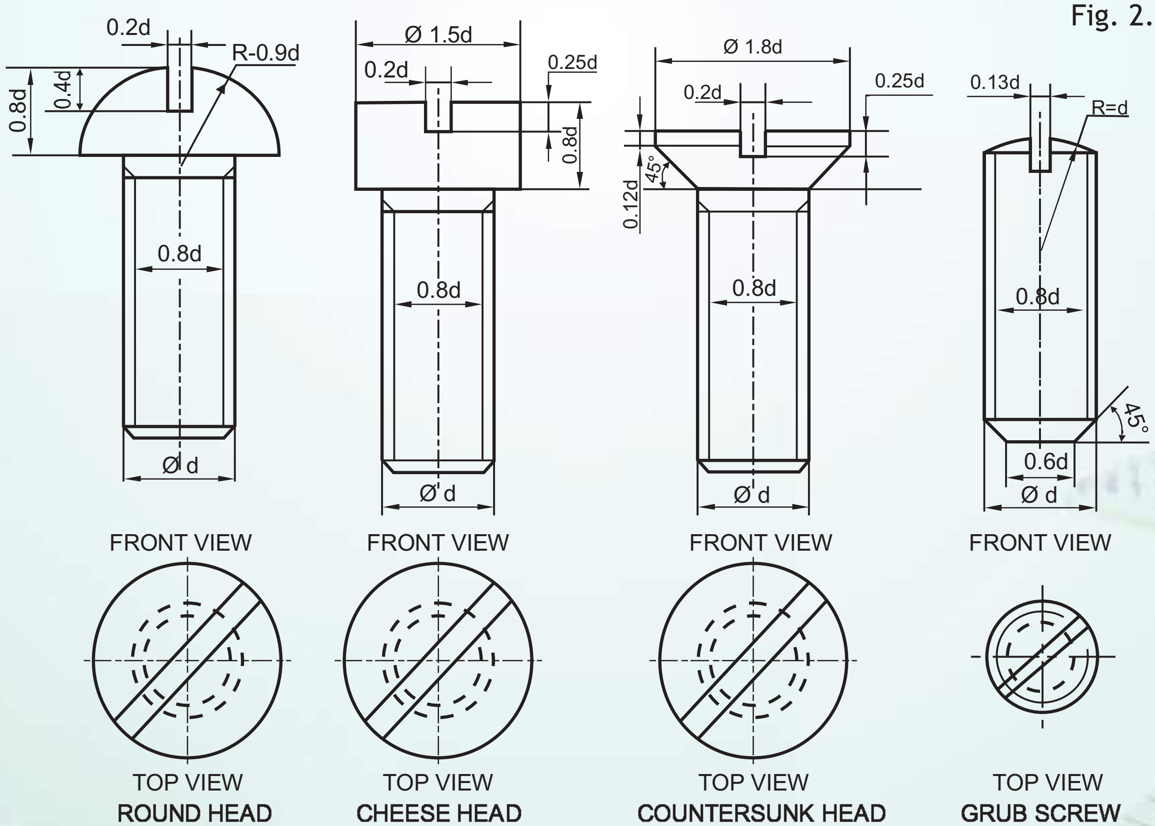
2. Sketch freehand the Front view and Top view of a stud with a square neck of diameter d = 20mm, keeping the axis perpendicular to H.P. Give standard dimensions.

3. Sketch freehand, the Front view and Plan of a stud with collar of diameter d = 20mm keeping the axis vertical. Give standard dimensions.

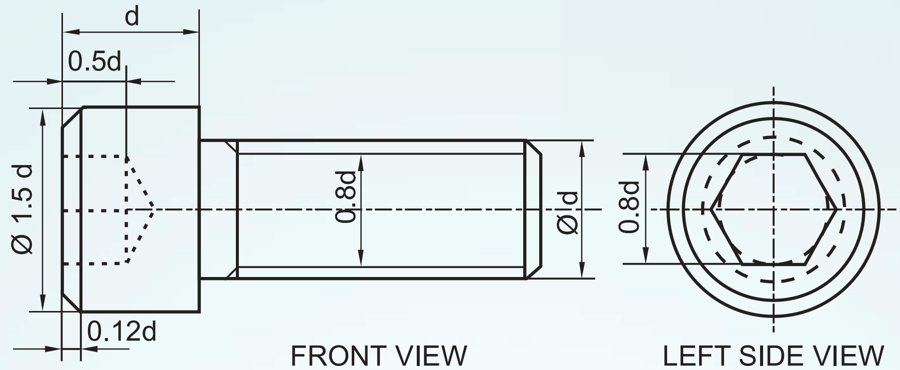
2.11 MACHINE SCREWS

A screw is similar to a bolt which is threaded throughout its length. Generally it is screwed into a threaded hole/tapped hole. Screws or machine screws are available with different shapes of heads. The commonly used types of machine screws are shown in Fig 2.37.

SCREW
Fig. 2.36



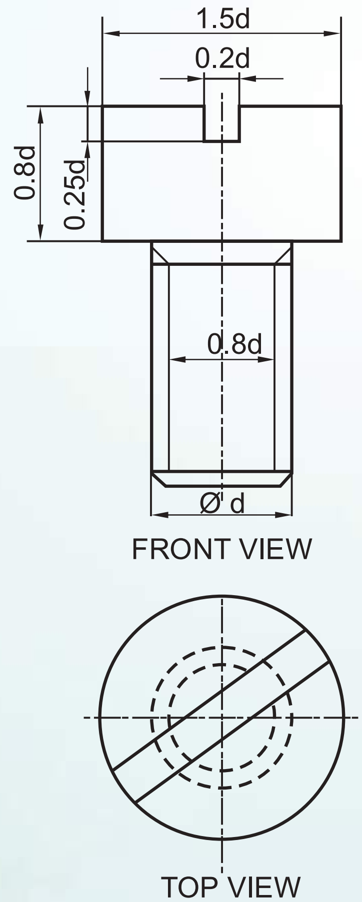
MACHINE SCREWS
Fig. 2.37



HEXAGONAL SOCKET HEAD SCREW

Example 18: Sketch freehand the front view and top view of a cheese head screw of size M20, keeping its axis vertical. Give standard dimensions.

Solution: Refer Fig. 2.38



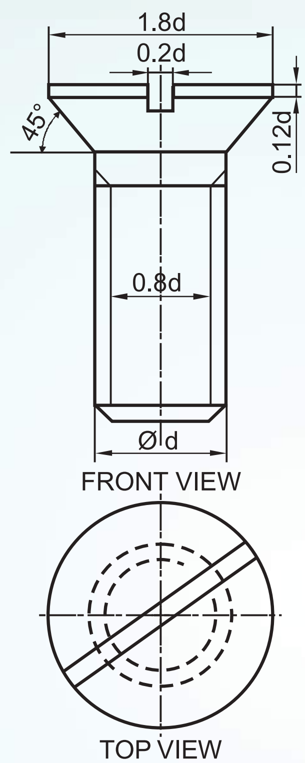
d	20
0.85d	17
0.2d	04
0.25d	05
0.8d	16
1.5d	30

CHEESE HEAD SCREW

Fig. 2.38

Example 21: Sketch freehand the front view and top view of a 90° flat counter sunk machine screw of size M20, keeping its axis vertical. Give standard dimensions.

Solution: Refer Fig. 2.39



d	20
0.2d	4
0.25d	5
d/8	2.5
0.85d	17
1.8d	36

90° FLAT CSK HEAD SCREW

Fig. 2.39

Exercises

1. Sketch freehand the Front view and Side view of a round head screw of size M10, keeping its axis horizontal. Give standard dimensions.
2. Sketch freehand the Front view and Side view of cheese head machine screw of size M10, keeping its axis horizontal and parallel to V.P. and H.P. Give standard dimensions.
3. Sketch freehand the Front view and Top view of a 90 degree flat counter sunk machine screw of size M10, keeping its axis vertical. Give standard dimensions.
4. Sketch freehand the Front view and Side view of a hexagonal socket head machine screw of size M20, keeping its axis parallel to V.P and H.P. Give standard dimensions.
5. Sketch freehand the Front view and Top view of a grub screw of size M10, keeping its axis vertical. Give standard dimensions.

2.12 RIVETS AND RIVETED JOINTS.

We are familiar with riveted joints with our kitchen wares likes pressure cooker and frying pan. In pressure cooker, the handle is joined to the body by means of rivets. We can even notice the rivets fitted, in shoes, belts etc.

Rivets are one of the permanent fasteners and is used widely in steel structures. Rivets are used in bridges, boilers and other engineering works. A rivet is a simple round rod having head at its one end (see Fig. 2.40 (i) and the other end is made in the form of head when it is assembled to fasten the parts.

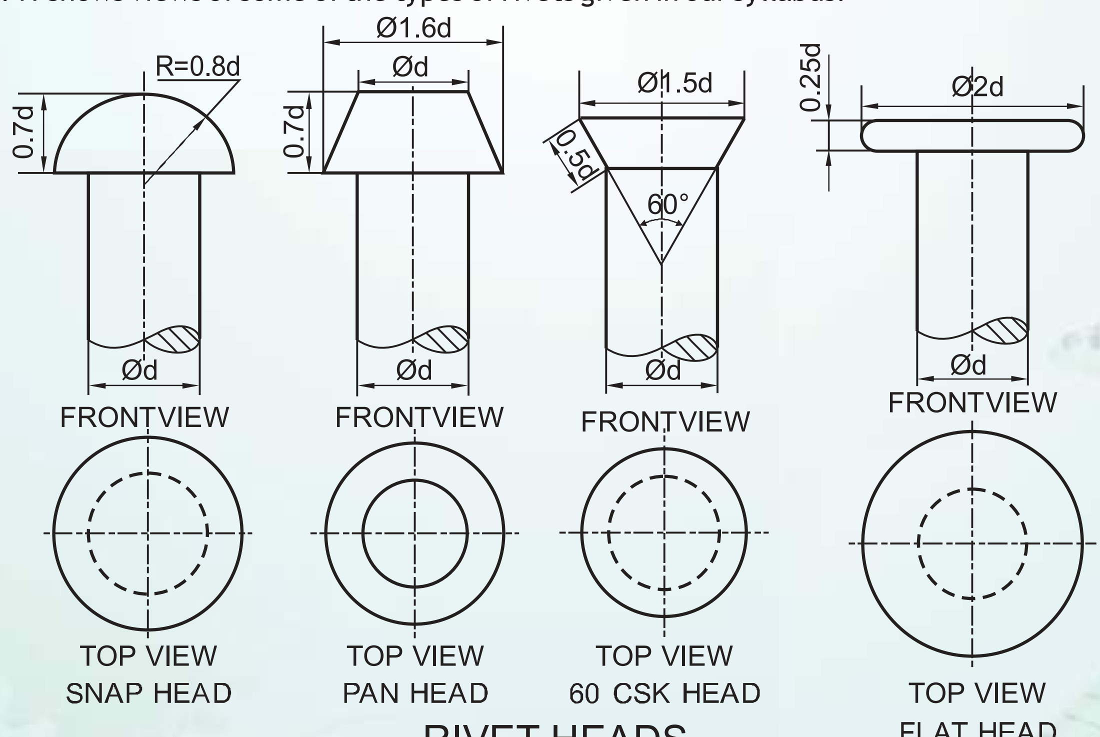
Rivet heads are of many shapes.

RIVET
Fig. 2.40 (i)

TYPES OF RIVETS
Fig. 2.40 (ii)

2.12.1 TYPES OF RIVETS

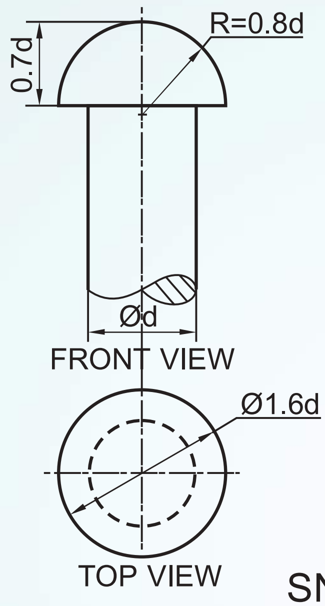
Fig. 2.41 shows views of some of the types of rivets given in our syllabus.



RIVET HEADS
Fig. 2.41

Example 23: Sketch freehand the Front view and Top view of a snap head rivet of diameter 20mm, keeping its axis vertical. Give standard dimensions.

Solution: Refer Fig 2.42



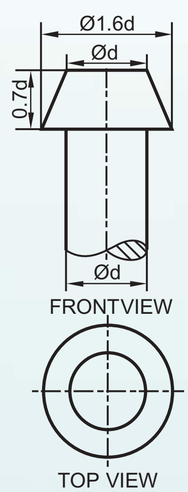
d	20
0.7d	14
0.8d	16
1.6d	32

SNAP HEAD RIVET

Fig. 2.42

Example 24: Sketch freehand the front view and top view of a pan head rivet of diameter 20mm, keeping its axis vertical. Give standard dimensions.

Solution: Refer Fig 2.43



d	20
0.7d	14
1.6d	32

PAN HEAD RIVET

Fig. 2.43

EXERCISES

1. Sketch freehand the Front view and Top view of a snap head rivet of diameter 25mm, keeping its axis vertical. Give standard dimensions.
2. Sketch freehand the Front elevation and Plan of a pan head rivet of diameter 25mm, keeping its axis vertical. Give standard dimensions.
3. Sketch freehand the Front view and Top view of a 60° counter sunk flat head rivet of diameter 20mm, keeping its axis vertical. Give standard dimensions.
4. Sketch freehand the Front view and Top view of a flat head rivet of diameter 20mm, keeping its axis vertical. Give standard dimensions.

2.12.2 RIVETED JOINTS

Riveted joints are of two types namely

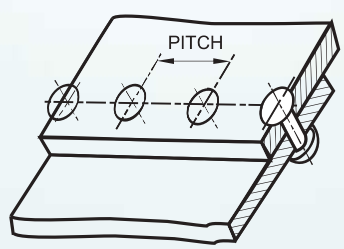
(i) Lap joint

(ii) Butt joint

Lap joints may be single, double and multiple riveted. In class XII, we are going to study the views of "single" riveted lap joint.

ORTHOGRAPHIC VIEWS OF SINGLE RIVETED LAP JOINT

In single riveted lap joint, the plates to be joined together overlap each other and "a single row of rivets" passes through both the plates.



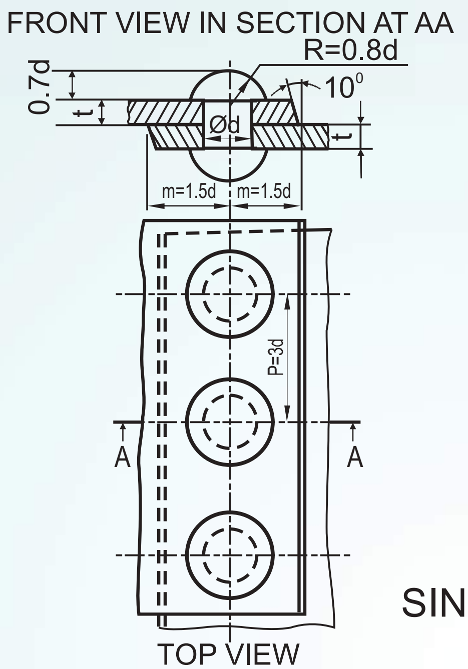
SINGLE RIVETED LAP JOINT.

Fig. 2.44

Let us now learn how to draw the views of single riveted lap joint.

Example 17: Draw to scale 1:1, the top view and sectional front view of single riveted lap joint, when the thickness of the plates to be joined = 16mm.

Solution: Refer Fig. 2.44



t	16
d=$6\sqrt{t}$	24
m=1.5d	36
P=3d	72

SINGLE RIVETED LAP JOINT
Fig. 2.44

Steps Involved:

Before starting the view, the standard dimensions are to be calculated as follows.

Let't' be the thickness of the plates to be be joined. Here t =16mm

The empirical formula for calculating the diameter'd' of the rivet to be used is given as $d = 6\sqrt{t} = 24$mm.

The margin 'm' is "the distance from the centre of the rivet to the nearest edge of the plate", and is taken as m = 1.5d = 36 mm.

The pitch 'p' is the distance between the centres of the adjacent rivets, and is taken as

P = 3d = 72 mm

The angle 10 degree is made by the fullering tool (a special punch or chisel) to make the joint leak proof. (The process of fullering is beyond the scope of this book.)

Then the top view and the sectional front view are to be done as shown clearly in Fig 2.44.

The edges of the plates in the top view are shown in wavy lines to represent a part of plates.

Exercises :

1. Draw to scale full size, the full sectional front view of a single riveted lap joint, taking thickness of the plates as 9mm. Give standard dimensions.
2. Draw to scale 1:1, the front view in section and plan of a single riveted lap joint, taking the thickness of the plates as 25mm. Give standard dimensions.

2.13 KEYS

Key is piece of metal which is used to fasten two parts together, specially to join two circular parts together. For example, pulleys, flywheels etc. are joined to the shaft by means of a key. Key is one of the temporary fasteners as it can be removed easily whenever required. The groove cut on the shaft to accommodate a key is called key seat and the corresponding groove in the matting piece is called key way.

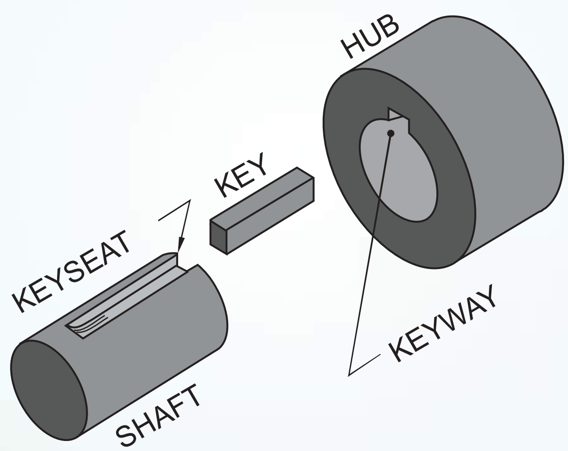


Fig. 2.45

2.13.1 TYPES OF SUNK KEYS

Sunk key means, half of the thickness (0.5T) (measured at the side not on centre line) lies within the key seat and the other half thickness (0.5T) lies within the keyway (see Fig 2.46 (a). A sunk key is designated by its width X thickness X length (W X T X L). There are different types of sunk keys viz.

(i) rectangular taper key

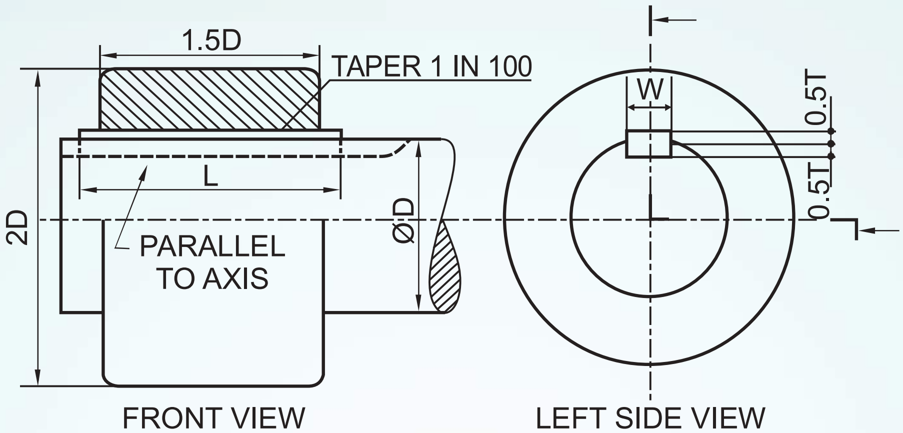
(ii) woodruff key

(iii) double head feather key

Let us now learn how to draw the views of these sunk keys.

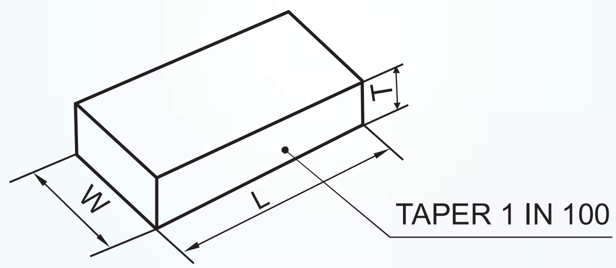
2.13.1.1 RECTANGULAR TAPER KEY

Rectangular sunk taper key is of rectangular cross section, with the thickness not uniform throughout the length of the key. See Fig 2.46



RECTANGULAR TAPER KEY (IN POSITION)

Fig. 2.46 (a)

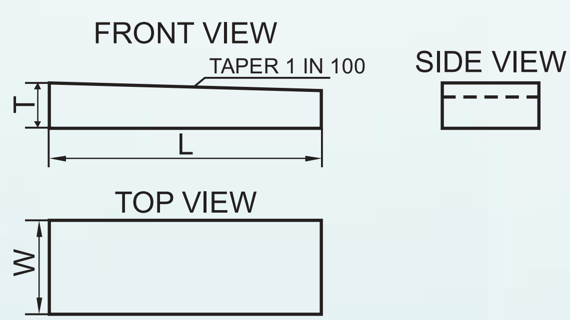


RECTANGULAR TAPER KEY

Fig. 2.46 (b)

Example :

Sketch freehand the front view, side view and top view of a rectangular taper key for a shaft of diameter 40mm. Give standard dimension.



D	40
T=D/6	7
W=D/4	10

VIEWS OF A RECTANGULAR TAPER KEY

Fig. 2.47

Drawing proportions for a rectangular taper key are as follows.

Let 'D' be the diameter of the shaft, then width of the key, W=D/4

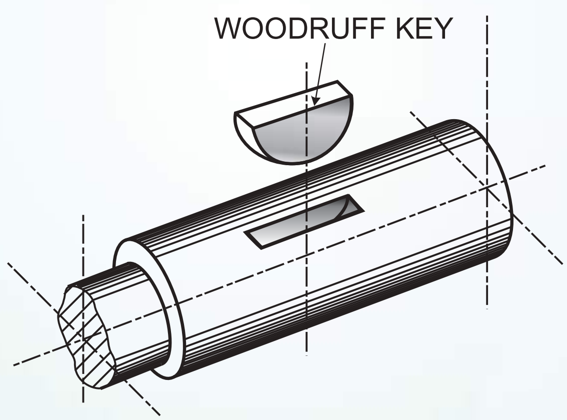
Thickness of the key, T=D/6

Length=1.5D to 2D, Taper = 1 in 100

The taper key prevent relative rotational as well as axial movement between the two mating pieces. Generally, the upper surface of the key is tapered and hence the keyway is also correspondingly tapered. The tapered end is hammered to remove the key from the joint.

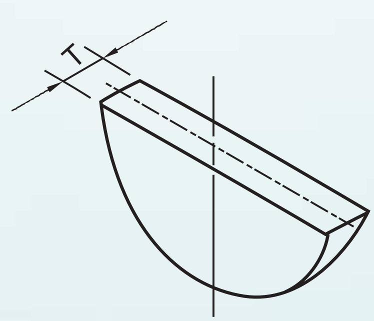
2.13.1.2 WOODRUFF KEY

Woodruff key is a special sunk key. It looks like a segment of a circular disc. The key seat is semi circular in shape but the keyway is rectangular. The keyway is smaller in size than the key seat. The advantage of woodruff key is that it can be easily adjusted in the recess. It is largely used in machine tools and automobile works.



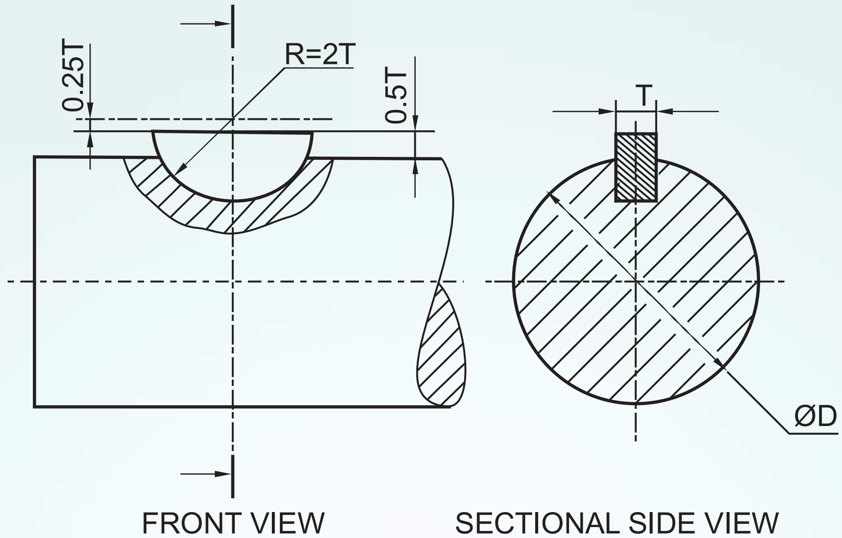
WOODRUFF KEY WITH KEY SLOT IN SHAFT

Fig. 2.48 (a)



WOODRUFF KEY

Fig. 2.48 (b)

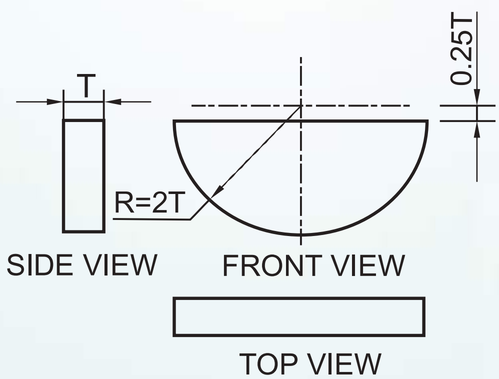


WOODRUFF KEY WITH SHAFT

Fig. 2.48 (c)

Example 26: Sketch freehand the Front view, Top view and Side view of a woodruff key, suitable for a shaft of diameter 40mm. Give standard dimensions.

Solution: Refer Fig 2.49



D	$T = \frac{D}{6}$	R = 2T	0.25T
40	6.7	13.4	10

WOODRUFF KEY

Fig. 2.49

2.13.1.3 DOUBLE HEAD FEATHER KEY WITH GIB HEAD ON BOTH ENDS

Feather key is a kind of sunk parallel key. In a parallel key, the thickness remains same throughout the length of the key. Fig 2.51 shows a feather key with gib head. A double head feather key with gib head on both ends grips the hub between its heads.

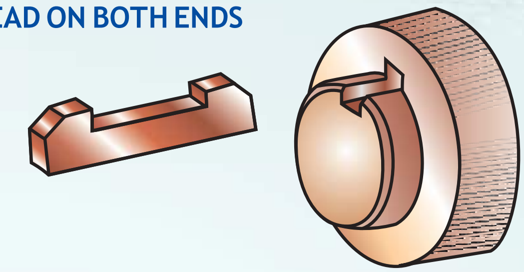


Fig. 2.50

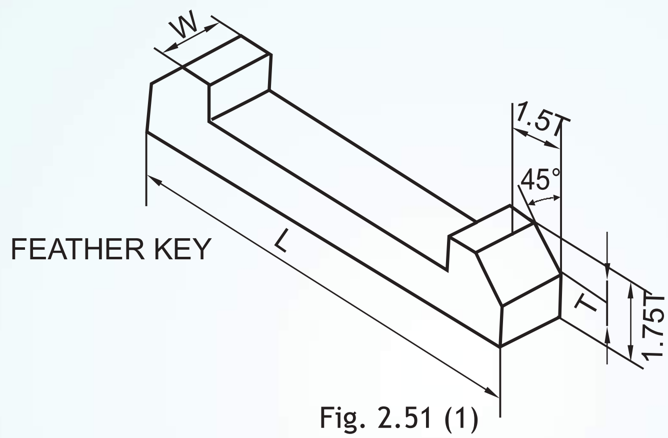
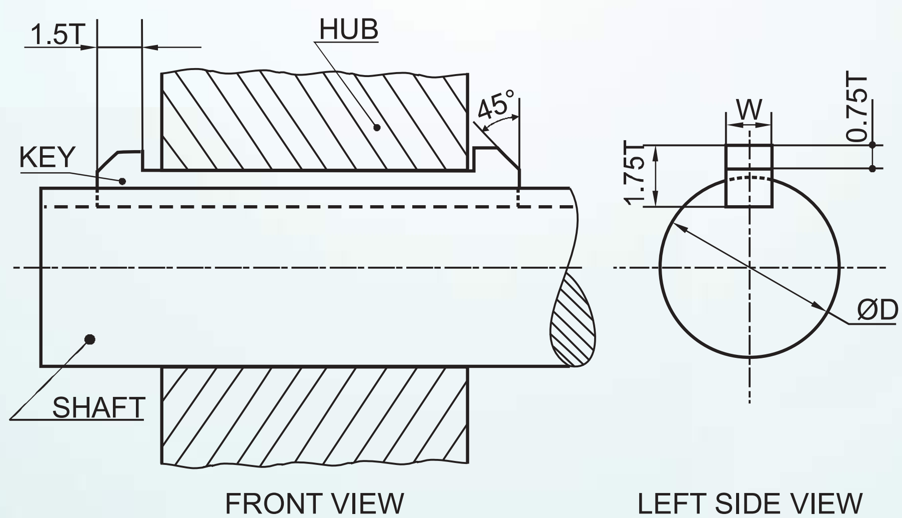


Fig. 2.51 (1)

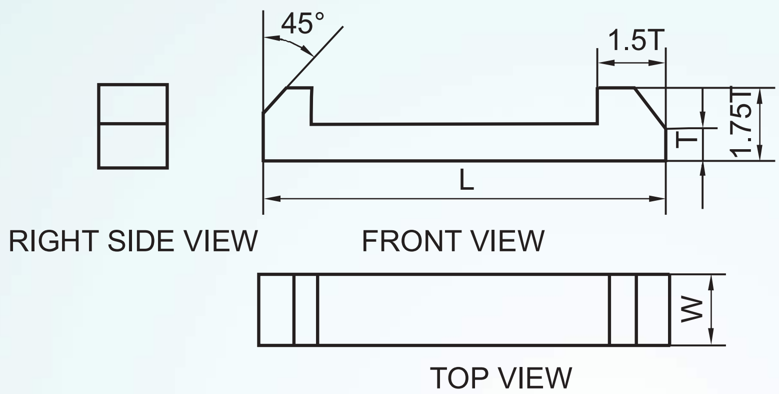


DOUBLE HEAD GIB HEADED FEATHER KEY [IN POSITION]

Fig. 2.51 (b)

Example 28: Sketch freehand the front view, side view and plan of a double-head gib key for a shaft of diameter 60mm. Give standard dimensions.

Solution: Refer Fig 2.52



D	60
W	15
T	10
1.5T	15
1.75T	17.5

DOUBLE HEAD FEATHER KEY WITH
GIB HEAD ON BOTH ENDS

Fig. 2.52

Exercises:

1. Sketch freehand the Front view, Side view and Plan of a rectangular taper key for a shaft of diameter 60mm. Give standard dimensions.
2. Sketch freehand the Front view, Side view and Plan of a woodruff key for a shaft of 60mm diameter. Give standard dimensions.
3. Sketch freehand the Front view, Top view and Side view of a double head gib key for a shaft of 40 mm diameter. Give standard dimensions.