ENGINEERING GRAPHICS

Ist year

GBN Govt. Polytechnic Nilokheri

Electrical Engg. Department

Unit:10.2 to 12

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ENGINEERING GRAPHICS

Ist year

Unit- 10.2. Nuts and Bolts:

10.2. Nuts and bolts:

The bolt and nut joint or screwed fastening is a temporary joint. A bolt is used to join two assembled parts with the help of a mating part, the nut. A screw is used to join two parts by making its own thread in the joining part while screwing itself. We have different types of bolts and nuts classified based on the type of thread and also based on the type of application. The nut and bolt are shown in fig. 10.2.1.

Figure 10.2.1: Nut and blot

10.2.1 Nuts: Nut is an internally threaded component joined to the externally threaded bolt.

A nut and a screw or a bolt comprises what is known as a screw pair.

Types of Nuts:

1. Hexagonal Nuts
2. Square Nuts.

1. Hexagonal nut:

The upper corners of this nut are rounded-off or chamfered. The chamfering is generally conical. The angle of chamfer is 30° or 45° with the base of the nut. Due to chamfering, an arc is formed on each vertical face, and a circle is formed on the top surface of the nut. Hexagonal nut projection is shown in fig 10.2.2.

Approximately standard dimensions may be adopted.

If D = the nominal diameter of the bolt,

Thickness of the nut, T = D

Width across flats, W = 1.5D + 3 mm

Angle of chamfer = 30°

Radius of chamfer arc, R = 1.4D (approx.)

Very often, and especially when a nut is shown in one view only, the following rough rule dimensions are used.

Thickness of the nut, T = D

Distance across diagonally opposite corners = 2D

Angle of chamfer = 30°

Radius of chamfer arc, R = 1.5D(approx.).

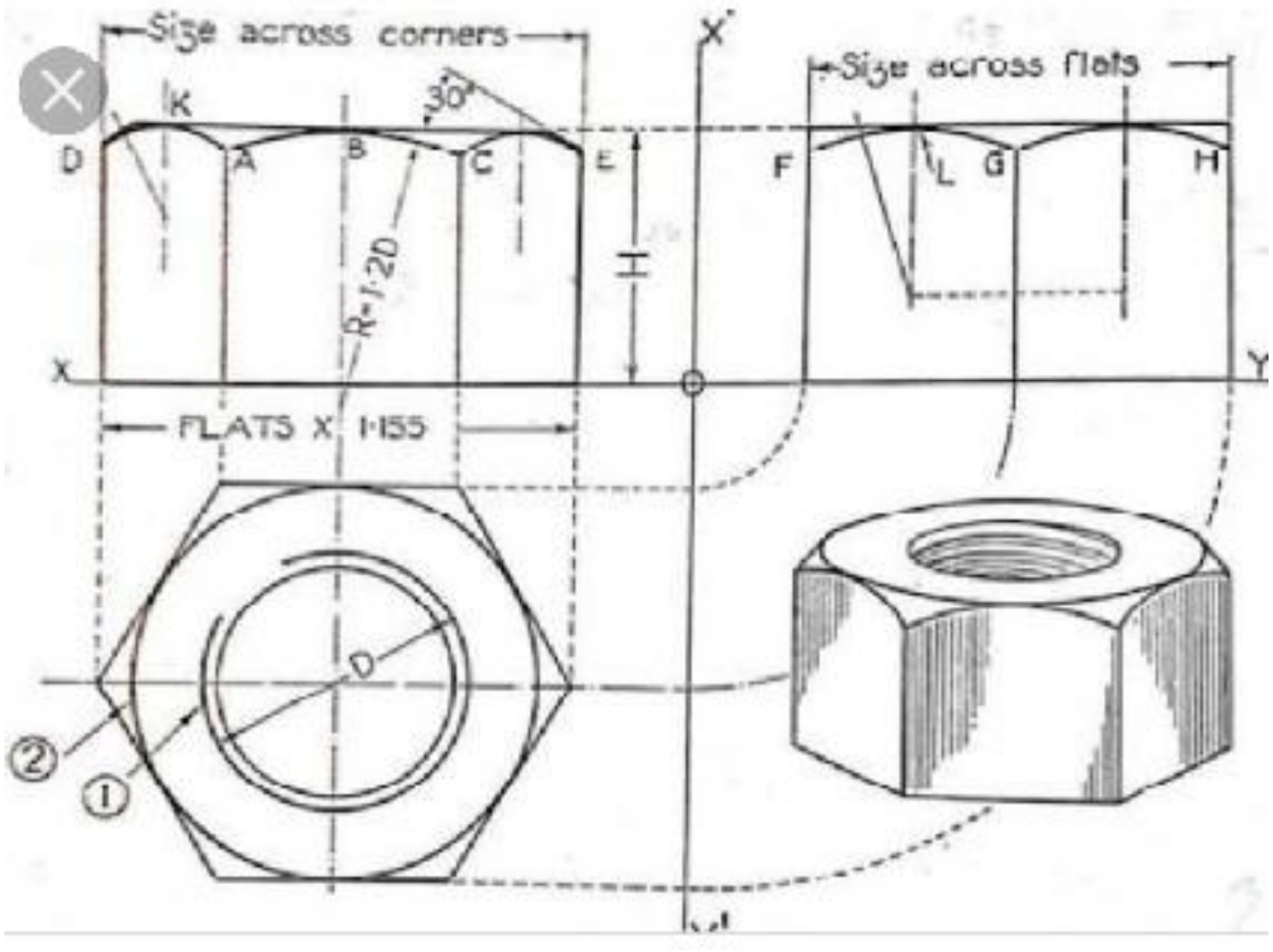


Figure 10.2.2: Hexagonal nut

2. Square nut:

The upper corners of the square nut are also chamfered in the same manner as those of the hexagonal nut. The widths across flats of a square nut and a hexagonal nut, for the same size of bolt, are also equal.Sqaure Nut projection design is shown in fig 10.2.3

Dimensions of a square nut:

If D = the nominal diameter of the bolt,

Thickness of the nut, T = D

Width across flats, W = 1.5D + 3mm

Angle of chamfer = 30°

Radius of chamfer arc, R = 2D (approx.).

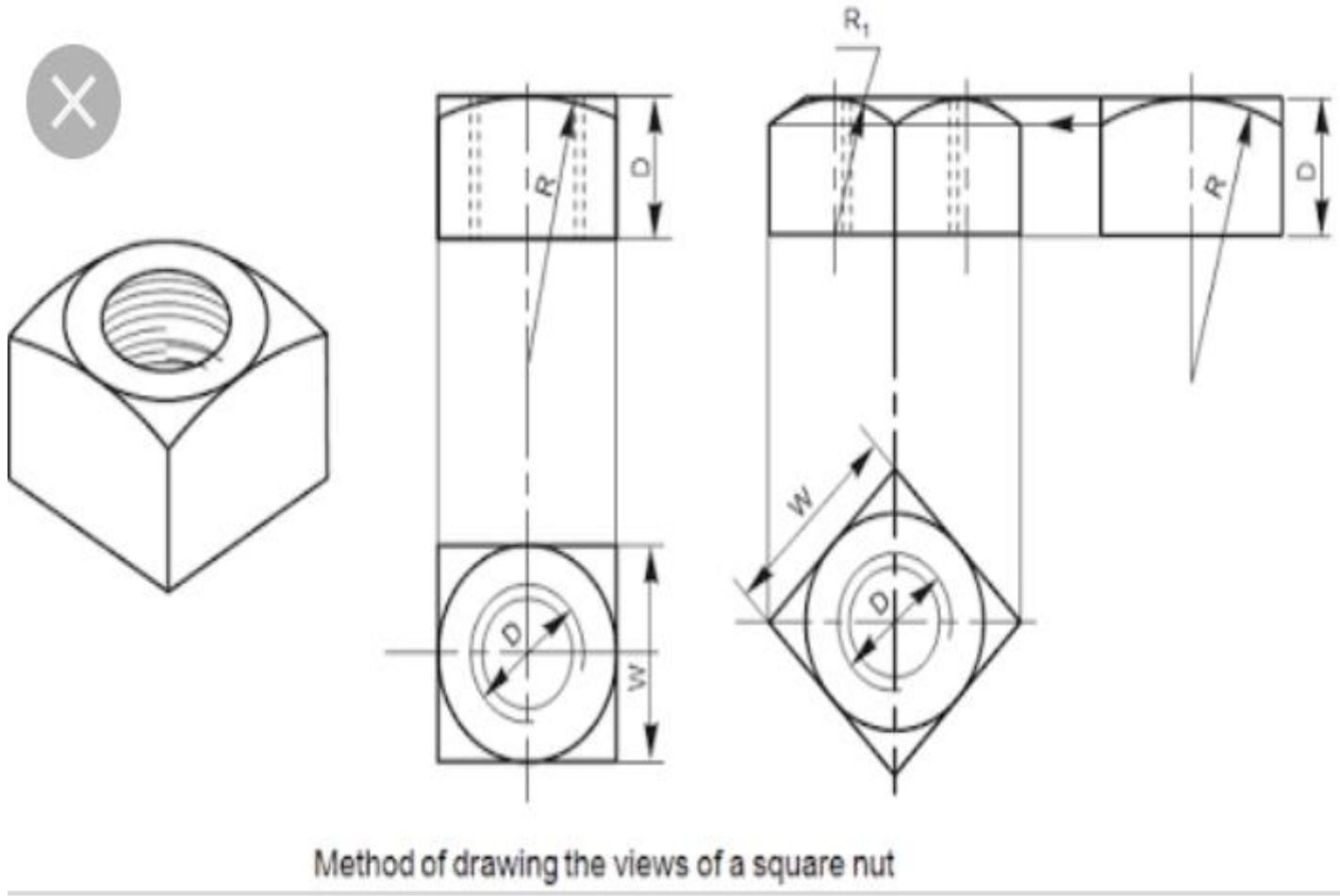


Figure10.2.3: Square Nut

10.2.2 Bolts:

A bolt comprises of two parts a shank and a head. The shank is cylindrical and is threaded at the tail end for a sufficient length so as to effectively engage with a nut. The shape of the head depends upon the purpose for which the bolt is required. While considering the length of the bolt, the thickness of the head is not taken into account.

Types of Bolts:

1. Hexagonal headed bolt
2. Square Headed Bolt

1. Hexagonal-headed bolt:

This is the most common form of a bolt. The hexagonal head is chamfered at its upper end. To prevent rotation of the bolt while screwing the nut on or off it, the bolt-head is held by another spanner. The dimensions of the bolt-head are the same as those of the hexagonal nut, except for the thickness. Its picture and projection are shown below in fig. 10.2.4

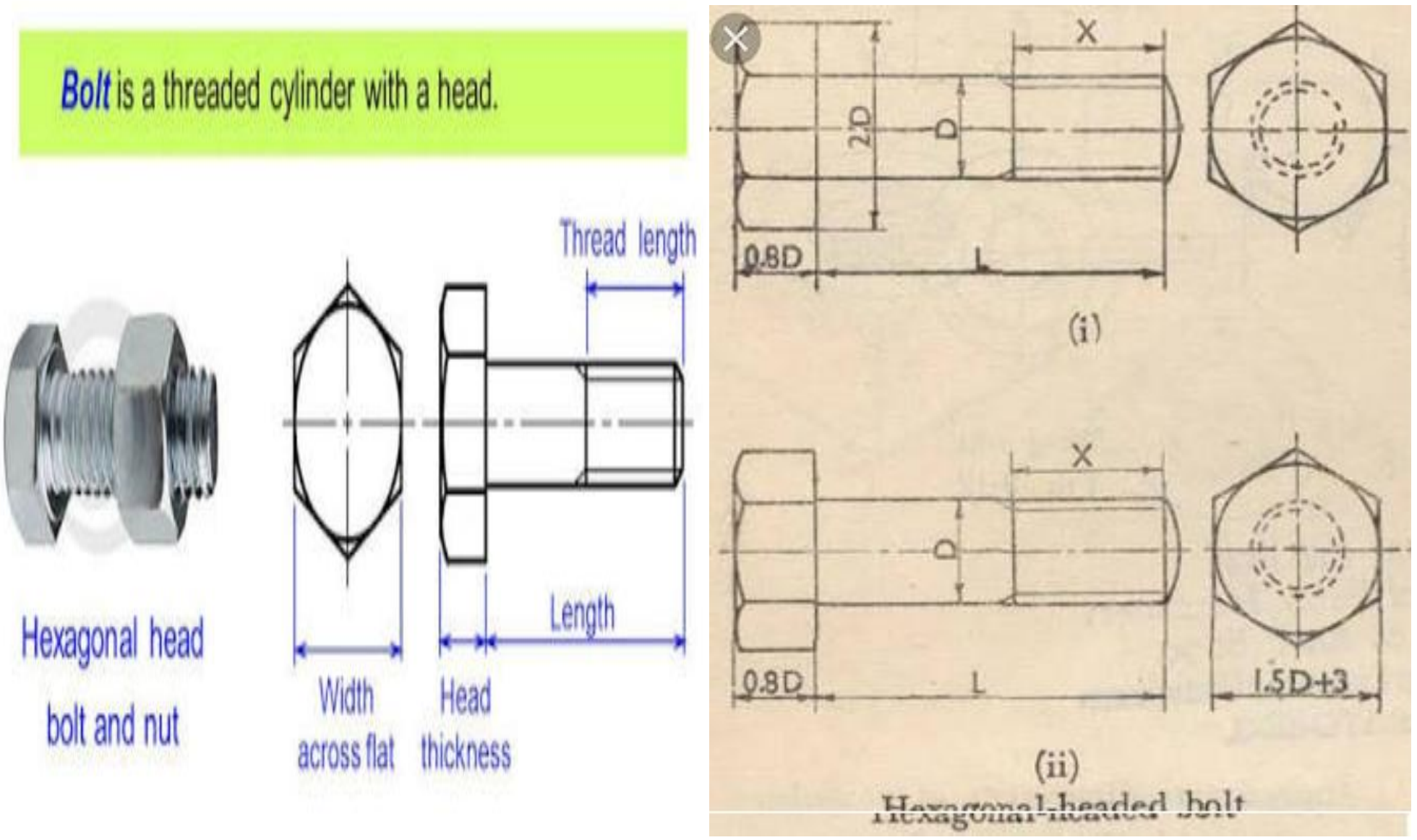


Figure 10.2.4: Hexagonal headed bolt

2. Square-headed bolt:

This bolt is generally used when the head is to be accommodated in a recess. This recess also is made of square shape so that the bolt is prevented from turning when the nut is screwed on or off it. This bolt is commonly used in bearings for shafts. The bolt-head is chamfered as its upper end. Its picture and projection are shown in fig. 10.2.5.

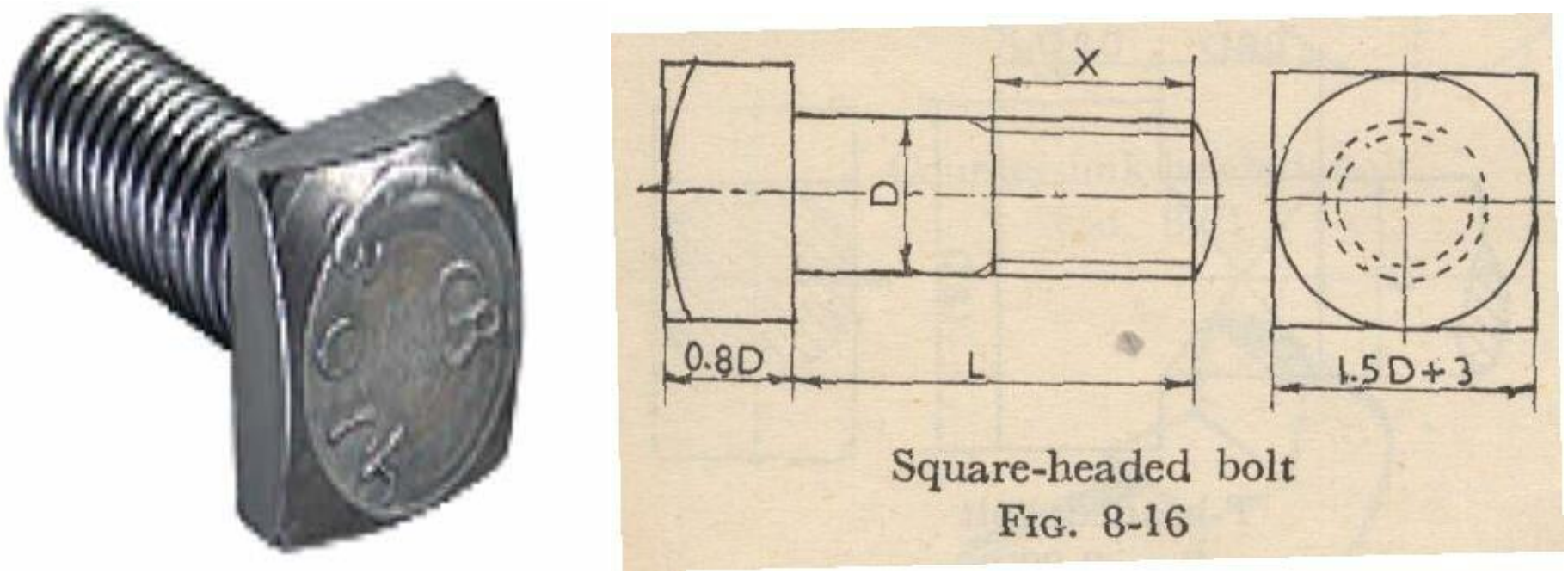


Figure10.2.5 Square headed Bolt

10.2.3 Washer:

A small flat ring made of rubber, metal, or plastic placed between two surfaces to make a connection tight. It is a thin plate with a hole that is normally used to distribute the load of a threaded

fastener, such as a bolt or nut. A washer is used to provide a smooth surface for the nut to turn on.fig 10.2.6 show the pictures of washers, 102.7 shows the pictures of nut, bolt and washer and washer projection is shown in fig. 10.2.8.

Figure10.2.6: Washer

Fig. 10.2.7: Nut, bolt and washer

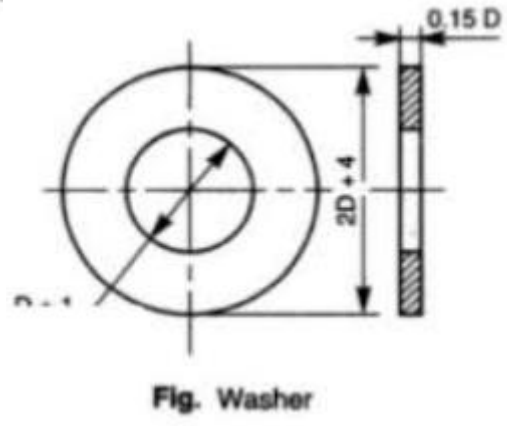


Fig. Washer

Fig. 10.2.8: projection of washer

10.2.4. Hexagonal headed bolt with hexagonal Nut and washer: Figure 10.2.9 shows the projections of hexagonal headed bolt with hexagonal nut and washer.

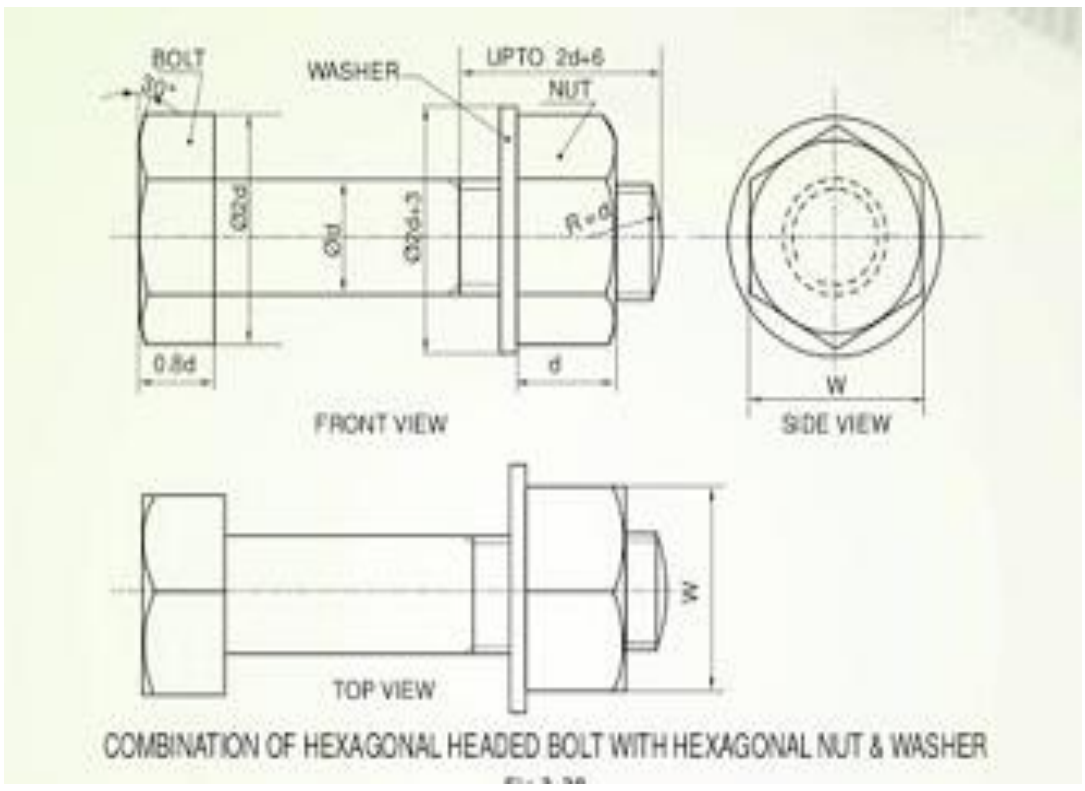


Figure10.2.9. : Hexagonal headed bolt with hexagonal Nut and washer:

UNIT-10.3

LOCKING DEVICE

10.3 Locking Device:

In a bolted joint, the nut may become loose, due to vibration. This may loosen the joint itself. To avoid this, another nut is used to lock the original nut. The thickness of a lock nut is usually two-thirds D, where D is the major diameter of the bolt. The lock nut is usually placed below the standard nut. To make the joint, the lock nut is first screwed tightly and then the standard nut is tightened till it touches the lock nut. Afterwards, the locknut is then screwed back on the standard nut, which is held by a spanner. Fig. 10.3.1 shows the lock nuts.

Figure 10.3.1: Lock Nut

10.3.1 Types of lock nuts:

1. **Jam Nut or lock nut.** This is about one half or two third thickness of standard nut.
2. **Castle nut.** It is a hexagonal nut with cylindrical upper part. This part is slotted in line with the centre of each face. A split pin is inserted through two slots in the nut and a hole in the bolt. This used in automobile industry.
3. **Sawn nut.** It has a slot sawn half way through. After the nut is tightened, the small screw is screwed which produces more friction between the nut and the bolt preventing the loosening of the nut.
4. **Penn, ring or grooved nut.** It has a upper hexagonal part and a lower cylindrical part. The bottom cylindrical portion is recessed to receive the tip of locking set screw.
5. **Locking with pin.** The nuts are locked by means of taper pin or cotter pin.
6. **Locking with plate.** A plate or locking plate is used to lock the bolt.
7. **Spring lock washer.** As the nut is tightened, one edge of the washer will be digging itself in that piece thus increasing the resistance so that the nut will not be loosened.

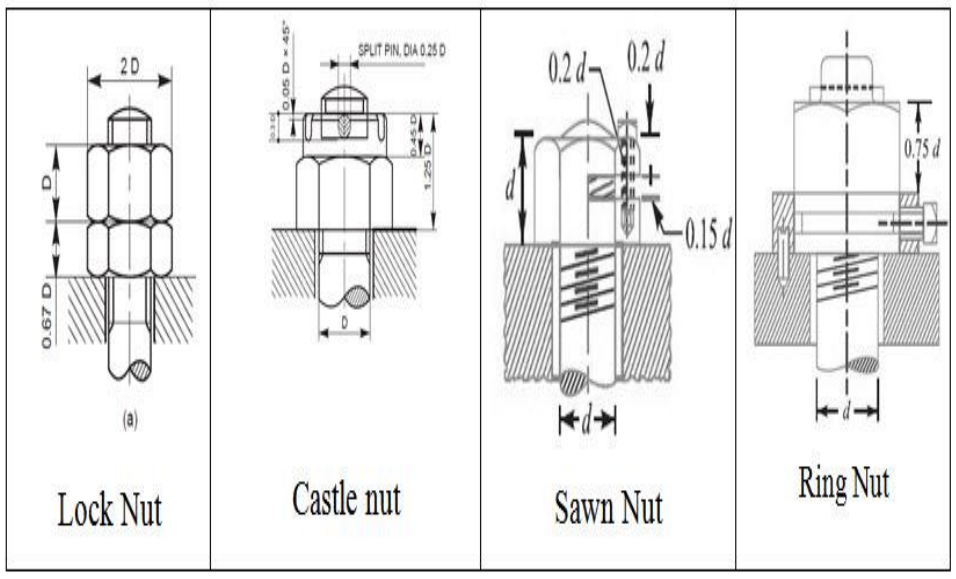


Fig.10.3.2. Types of Lock Nuts

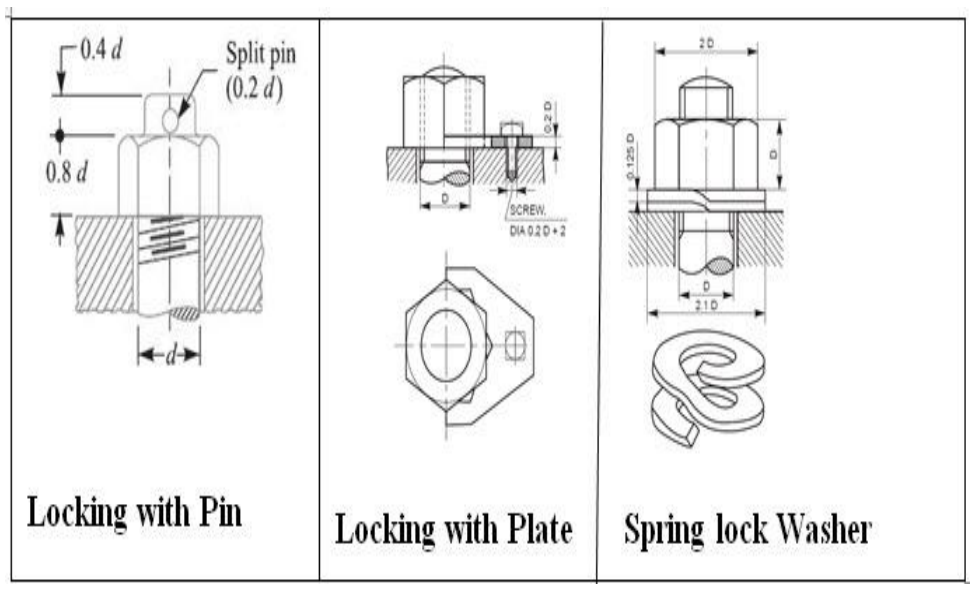


Fig.10.3.3. Types of Locking

10.3.2. Foundations bolt:

They are used for holding machine frames, engine beds, roof trusses, etc., to concrete or masonry foundations. Following are various types of foundation bolt used for fixing the heavy machines.

1. Rag foundation bolt

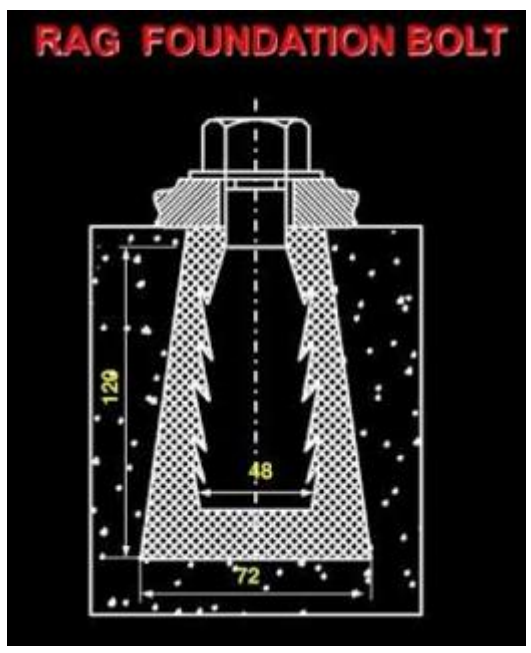
2. Lewis Foundation bolt

3. Bent or curved Foundation Bolt

4. Eye Foundation Bolt.

1. Rag foundation bolt:

The rag bolt shown in Fig. below has the shank tapered of pyramidal form with jagged edges. A hole wider at the bottom than at the top is cut in the stone. The bolt is then placed in position and molten lead or sulphur poured in the space between the stone and head. Of course this bolt is difficult to remove and is used for permanent fastenings.



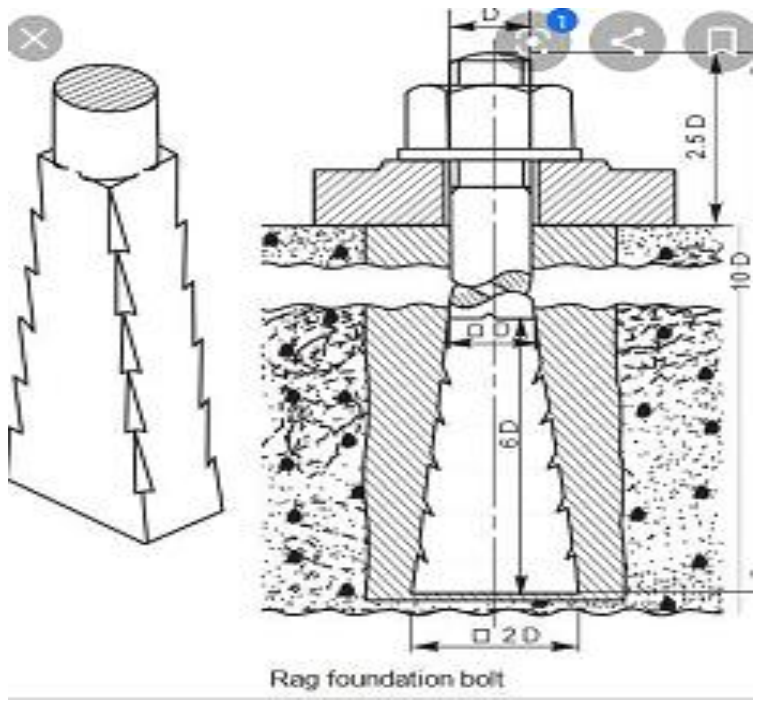
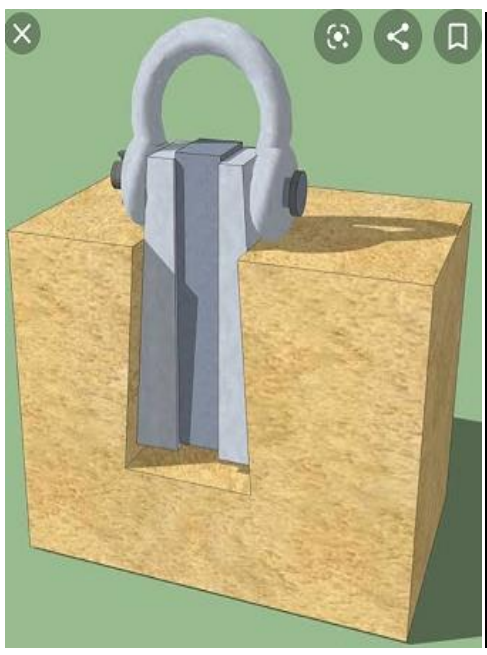
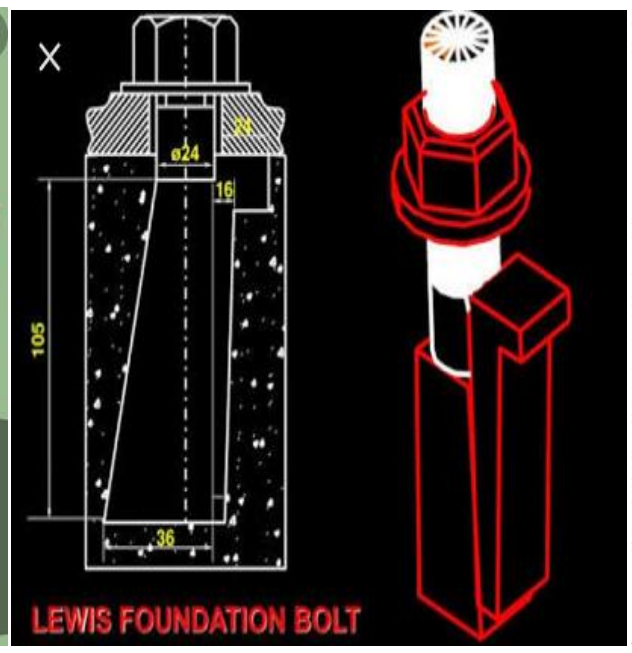


Fig10.3.4. Rag Foundation Bolt

2. Lewis Foundation bolt:

The Lewis Bolt has a shank of rectangular section. One side of the head is parallel to the center line of the bolt and the other tapering as shown in Fig10.3.5. To fix the bolt in position it is dropped in the hole and moved over against the tapering side of the hole, after which the key is dropped in. Tightening the nut wedges the head and key firmly in the hole. There should be some clearance below the head to facilitate the removal of the bolt. This bolt is used mainly to lift and shift heavy stones. Therefore other end of the bolt can be forged into a loop to allow for its easy lifting.





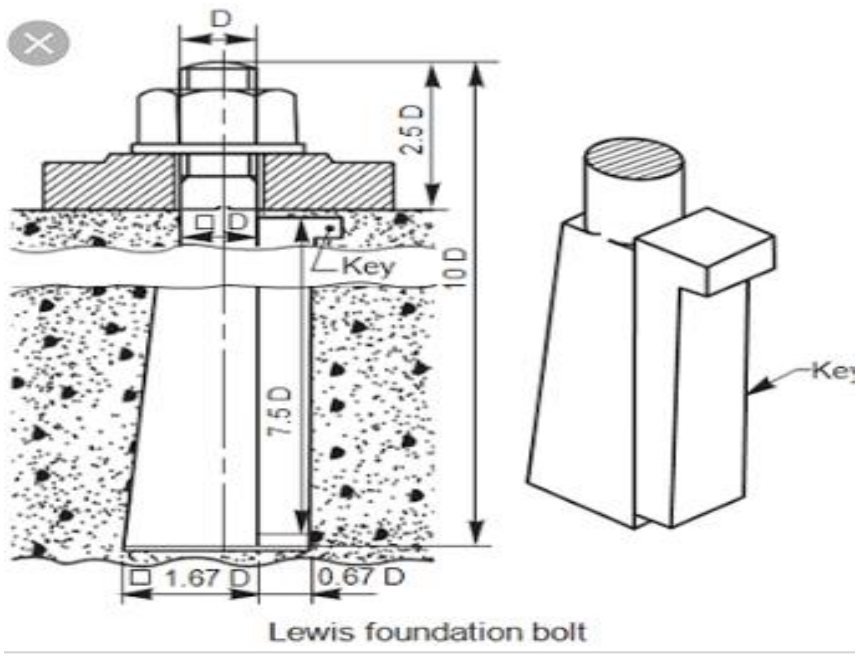


Fig10.3.5. Lewis Foundation Bolt

3 Bent or curved Foundation Bolt:

These bolts feature a signature bend on one end and can be set in either concrete or stone bends. The bolts are initially set in lead and then the whole assembly is set in concrete for improved hold. To secure the base of the machines in plate, an industry-grade screw is used. The bend on the lower end results in a firmer grip.

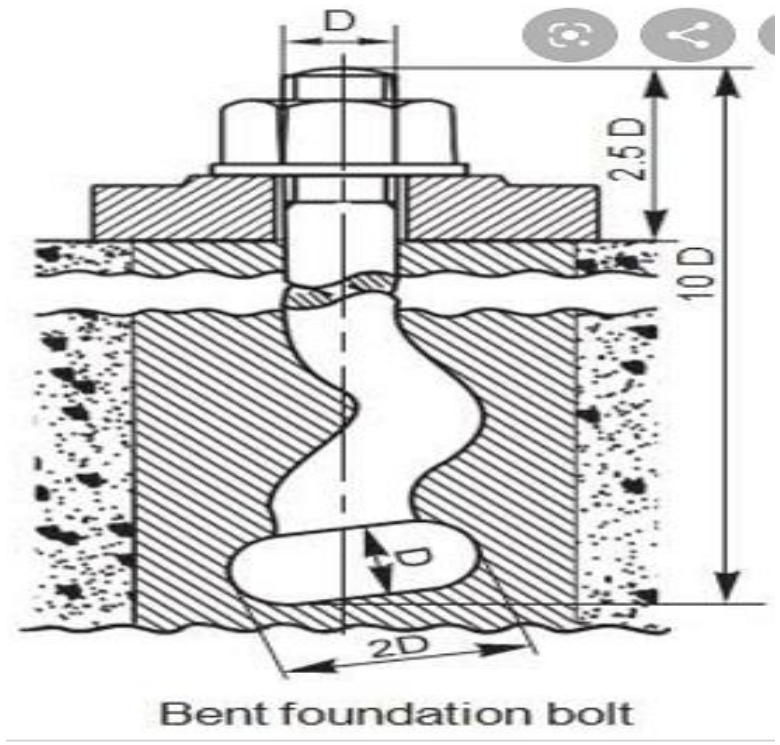


Fig10.3.6. Bent or curved Foundation Bolt

4. Eye Foundation Bolt.

The eye foundation bolt has one end of it forged to bend and look likes an eye. The eye –end also has a cross piece fixed in it for the setting of the machine. These bolts are also used to securely hold industrial grade cables which need to be able to withstand strong movements, wind and pressure. Lifting Eye Bolts are used for the purpose of attaching a hoisting rope or hook.

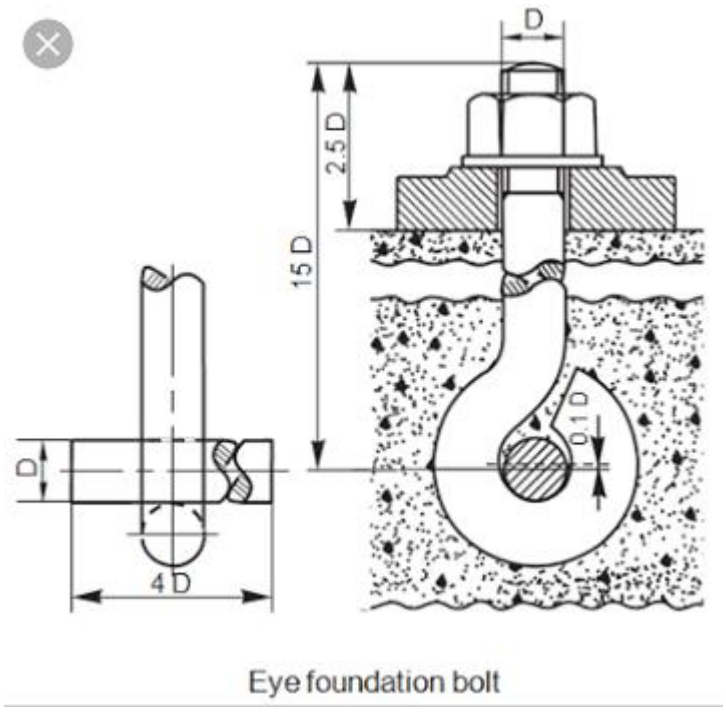


Fig10.3.7. Eye Foundation Bolt

10.3.3 Studs:

A stud is a cylindrical piece of metal having threads at both ends and is plain cylinder or square cross section/ square neck or plain cylinder 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

Fig10.3.8. picture of stud

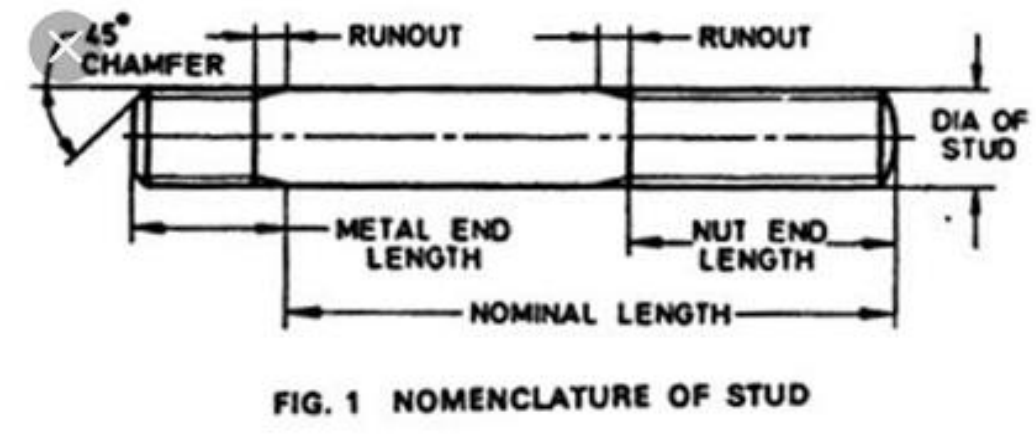


Fig10.3.9. Nomenclature of stud

10.3.3.1 Types of studs:

1. Plain stud,

2. Stud with square neck and

3. Stud with collar:

Unit-11

Keys and Cotters

11. 1 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 also used to prevent the relative movement between the shaft and the parts mounted on it. Whenever required, it can be removed easily. So key is one of the temporary fasteners. 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.

11.1.1 Types of Keys:

1. Round key
2. Saddle key
3. Key on flat
4. Flat key or rectangular key
5. Gib headed key
6. Woodruff Key

1. Round key :

It is a cylinder and requires a hole to pass as shown in fig 11.1 (a). Half of the hole is in the shaft and other half in the hub. It is used when load is low and shaft diameter is small. Making of hole is not easy and costly if made separately in two halves in two parts. Since the cylindrical holes do not have sharp corners they still represent a better choice. Taper round keys produce tighter joint. The taper may be as gentle as 1 : 100.

2. Saddle key:

It is shown in Figure11.1 (b). It sits on the curved surface of shaft and fits in the rectangular slot of hub. No keyway in the staff is required and frictional force between the seat of key and surface of the shaft is responsible for transmission of the torque. Either for transmission of light torque or holding the mating part in position during assembly such saddle key is used.

3. Key on Flat:

It is similar to saddle key on three sides except at the bottom where it is flat. It will of course require a flat narrow surface machined on the shaft, while it fits into the keyway made in the hub. Such flat region machined on the surface of the shaft does not affect the strength because much material is not removed no corners are created as will happen if keyway is machined. It is shown in fig 11.1(c)

4. Flat key or rectangular key:

Figure11.1 (d) and square key Figure11.1 (f) are essentially same and used universally between shaft and any mating part like gear and pulley. Very large torque or power can be transmitted by both but square key is often preferred for equal strength in shear and crushing.

5. Gib headed key:

Shown in Figure 11.1 (g) is in fact a rectangular cross section prismatic bar with taper (1 : 100) along the length and having a Gib head at largest cross section. It is inserted in the keyslot and head helps both in insertion and extraction of the key. The Gibhead, being a projection on the shaft, presents a hazard of collecting loose Garments or cotton waste hence should be protected. It may be pointed out here that a taper key is not preferred in precise machines because it causes varying information of

6. Woodruff key:

Shown in Figure 11.1 (h) is a segment of a disc whose rounded part enters the corresponding shape cut in the shaft. The key provides the advantage of easy assembly and disassembly but weakens the shaft due to deep groove. The key is cut from a disc of radius R = 0.4 D with w = 0.2 D. Its total depth is 95% of radius and radius is 0.4 D. Three fourths of depth is in shaft.

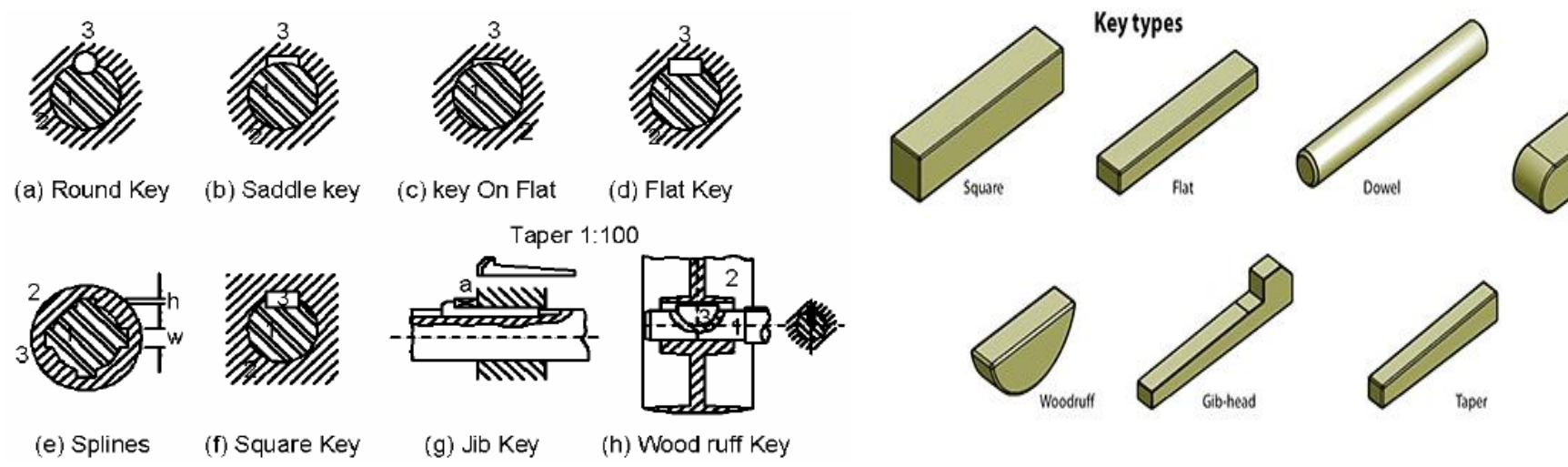


Figure 11.1 : Types of Keys

The projection views of saddle keys and gib headed key are shown in fig. 11.1.2 and 11.1.3.

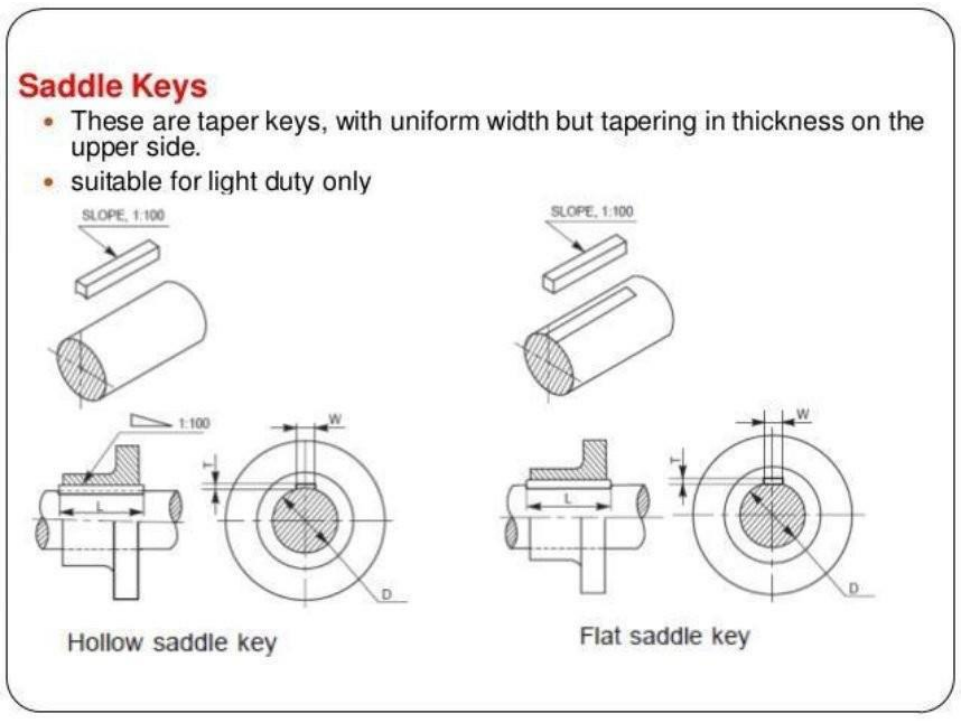


Figure 11.2 : projection views of saddle key

The rectangular sunk key with head at one end is known as **GIB HEAD KEY.** The head is provided to facilitate the removal of key.

Width $w = d/4$

Thickness at large end $t = 2w/3 = d/6$

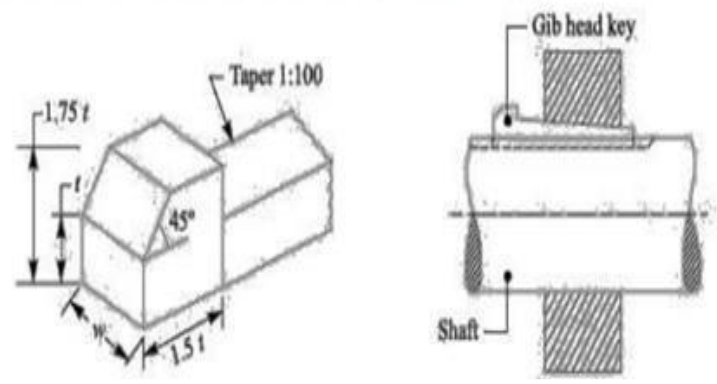


Figure 11.3 : projection views of GIB headed key

11.2 Cotter and cotter joint:

A cotter is a flat wedge shaped piece, made of steel. It is uniform in thickness but tapering in width, generally on one side; the usual taper being 1:30. The lateral (bearing) edges of the cotter and the bearing slots are generally made semi-circular instead of straight as shown in fig 11.4 (a). This increases the bearing area and permits drilling while making the slots. The cotter is locked in position by means of a screw as shown in fig 11.4 (b)

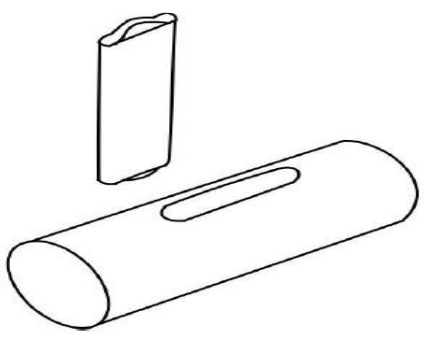


Fig 11.4 a: cotter and beraing slot

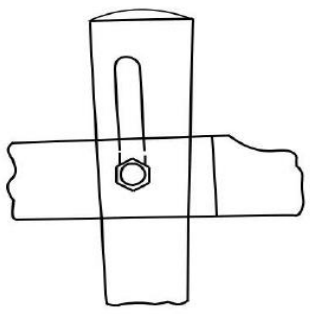


Fig 11.4 b: locking arrangement of cotter

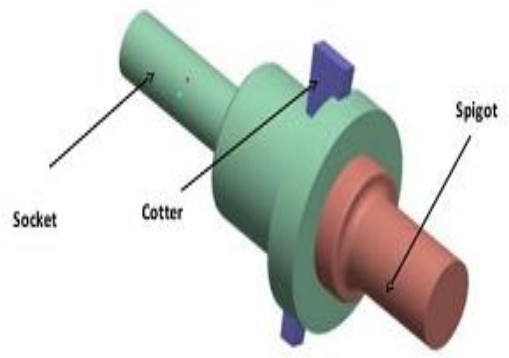


Fig 11.4c: picture of cotter joint

11.2.1 Types of cotter joints:

1. Cotter joint with sleeve
2. Socket and spigot cotter joint.
3. Knuckle Joint
4. Gib and cotter joint

1. Cotter Joint with Sleeve:

This is the simplest of all cotter joints, used for fastening two circular rods. To make the joint, the rods are enlarged at their ends and slots are cut. After keeping the rods butt against each other, a sleeve with slots is placed over them. After aligning the slots properly, two cotters are driven-in through the slots, resulting in the joint as shown in fig 11.5 b.

Two plain cylindrical ends are made to butt each other and a single sleeve covers both. Two slots are made in the sleeve, each coinciding with the slot in the rod end. The rod end may be enlarged to compensate for the slot.

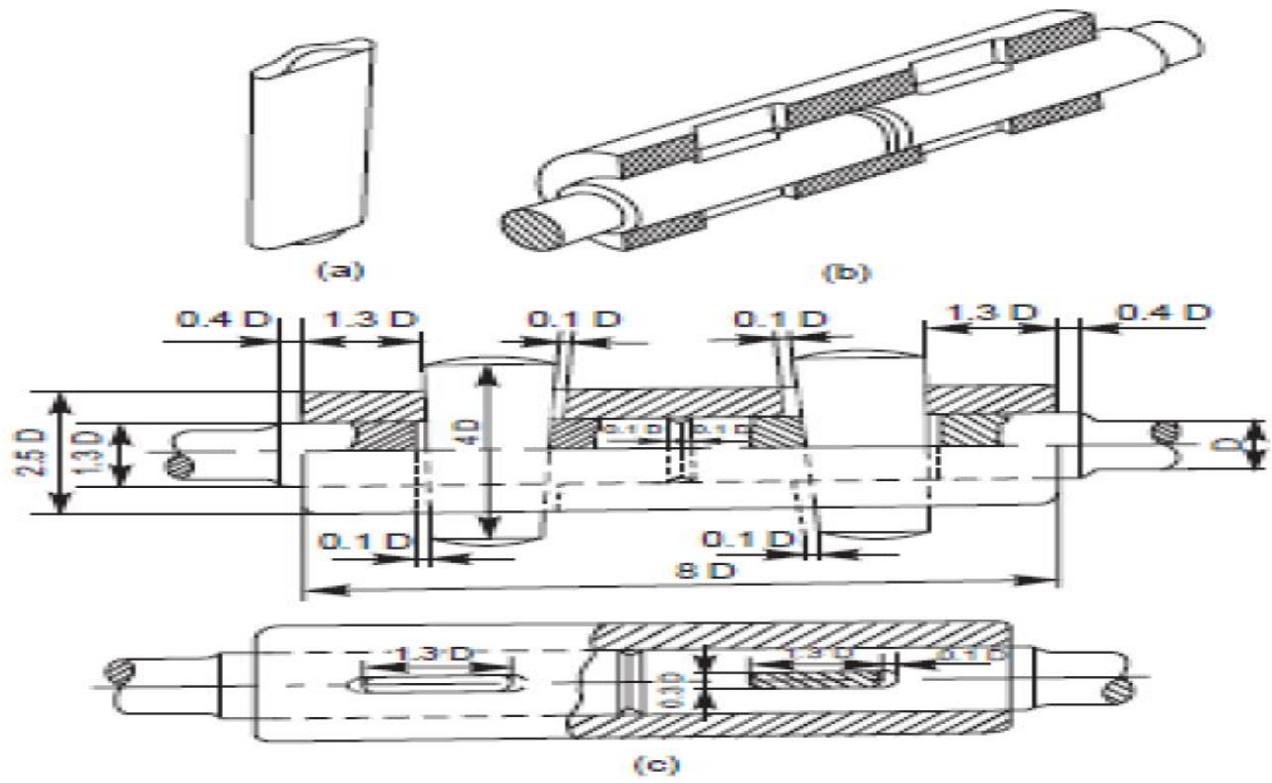


Fig 11.5 : Projections of Cotter Joint with Sleeve

2. SOCKET AND SPIGOT COTTER JOINT:

One end of a rod carries a socket while other end of another rod carries a spigot. The socket is a hollow and spigot a solid cylinder with a collar. The socket also has a collar. The spigot the socket and the cotter are shown in Figure in fig 11.5(a) and its projection is shown in fig. 11.5(b)

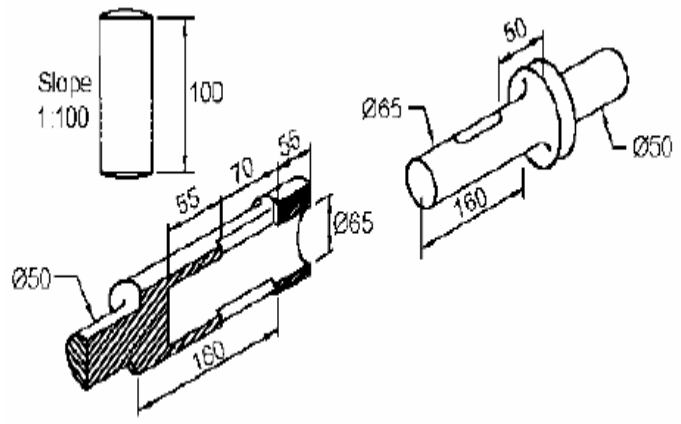


Figure11.5 (a): Cotter, socket and spigot

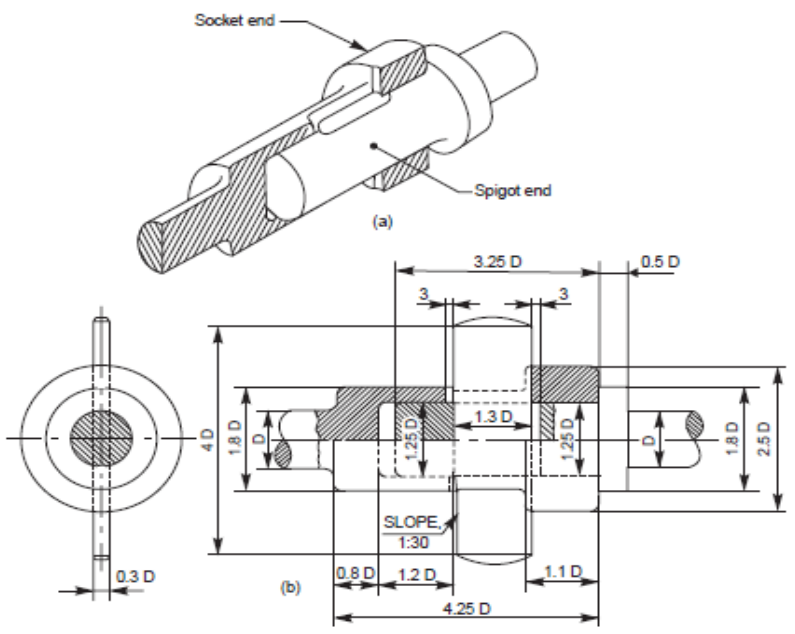
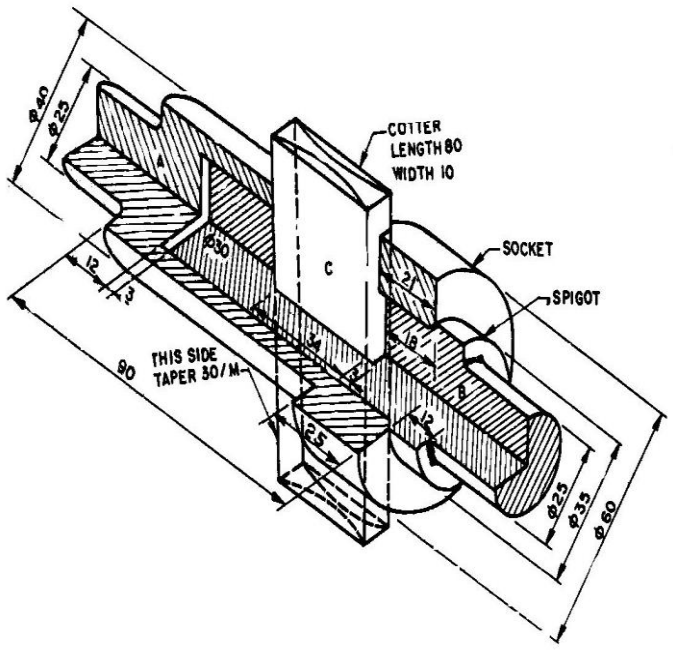


Figure11.5 (b): cotter joint with socket and spigot end

Q1. Draw the projection of cotter joint with socket and spigot end by dimensions as shown in fig11.6 below.

Solution:



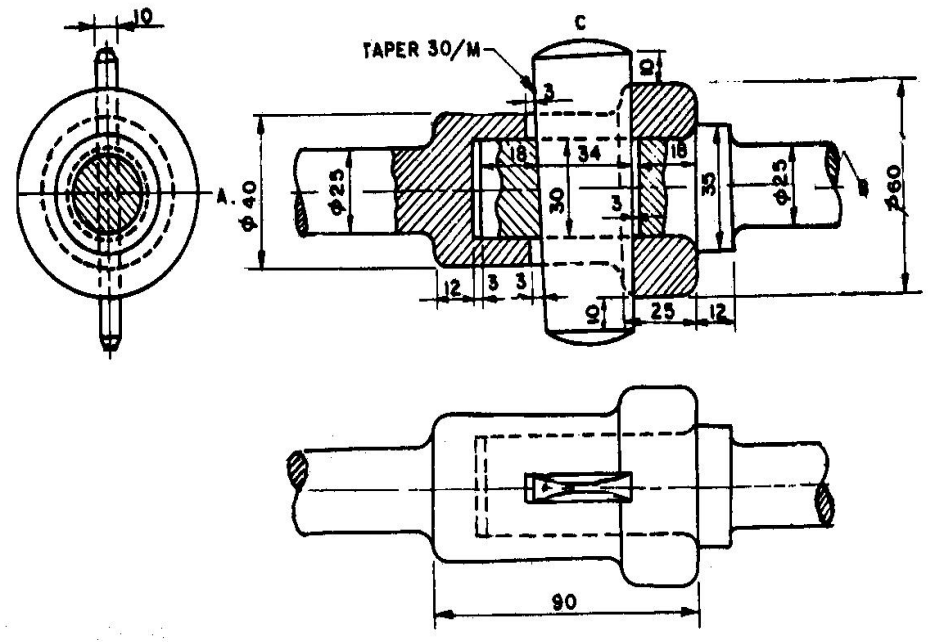
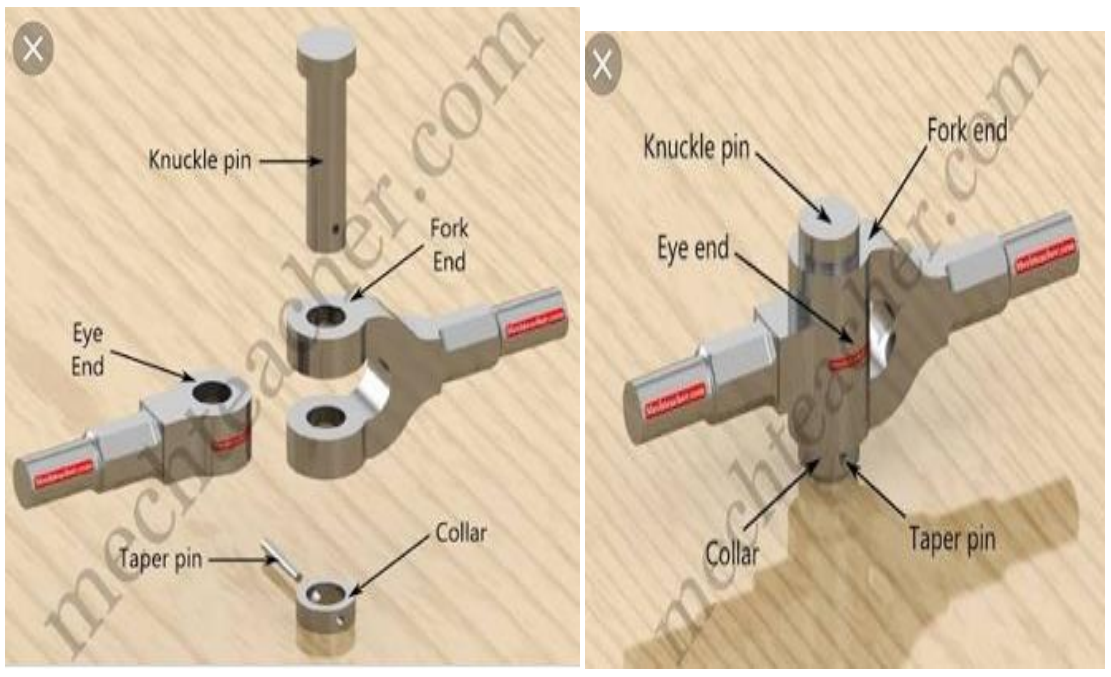


Figure11.6 : Cotter, socket and spigot

Figure 11.7 : projection of Cotter, socket and spigot

3. Knuckle Joint:

A knuckle joint is a pin joint used to fasten two circular rods. In this joint, one end of the rod is formed into an eye and the other into a fork (double eye). For making the joint, the eye end of the rod is aligned into the fork end of the other and then the pin is inserted through the holes and held in position by means of a collar and a taper pin. Once the joint is made, the rods are free to swivel about the cylindrical pin. Knuckle joints are used in suspension links, air brake arrangement of locomotives, etc.



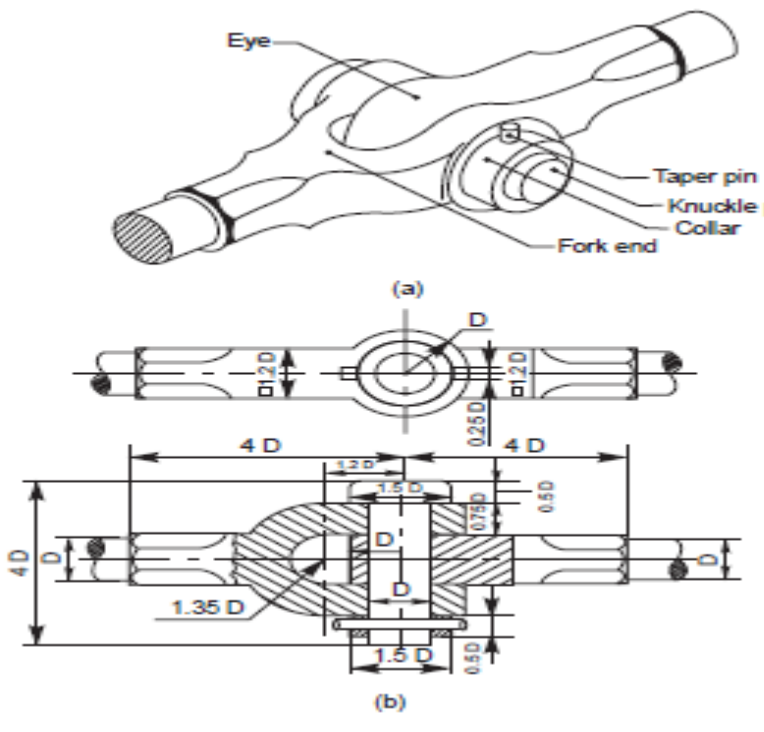
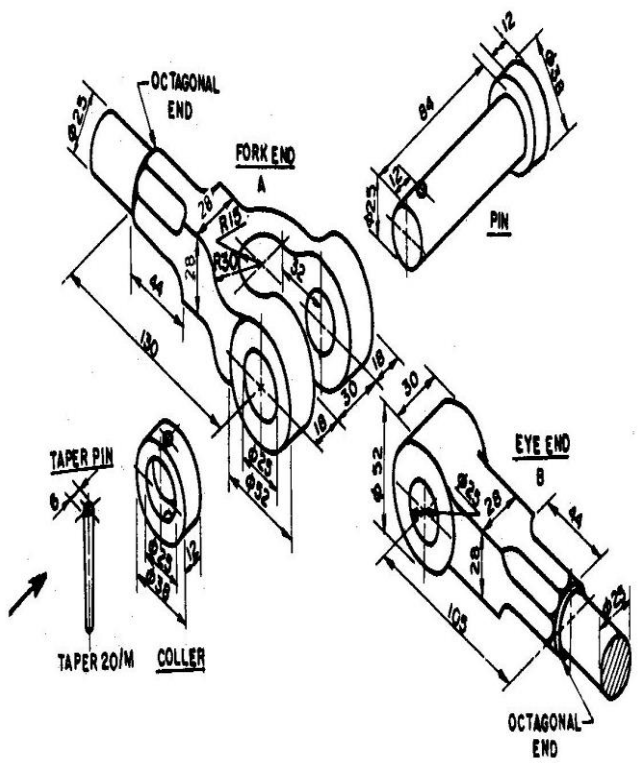


Figure 11.7 : Picture of knuckle joint

Figure 11.8 : projection views of knuckle joint

Q1.Assemble the different parts of knuckle joint and draw its projection view shown in fig 11.9.

Question: **Solution:**



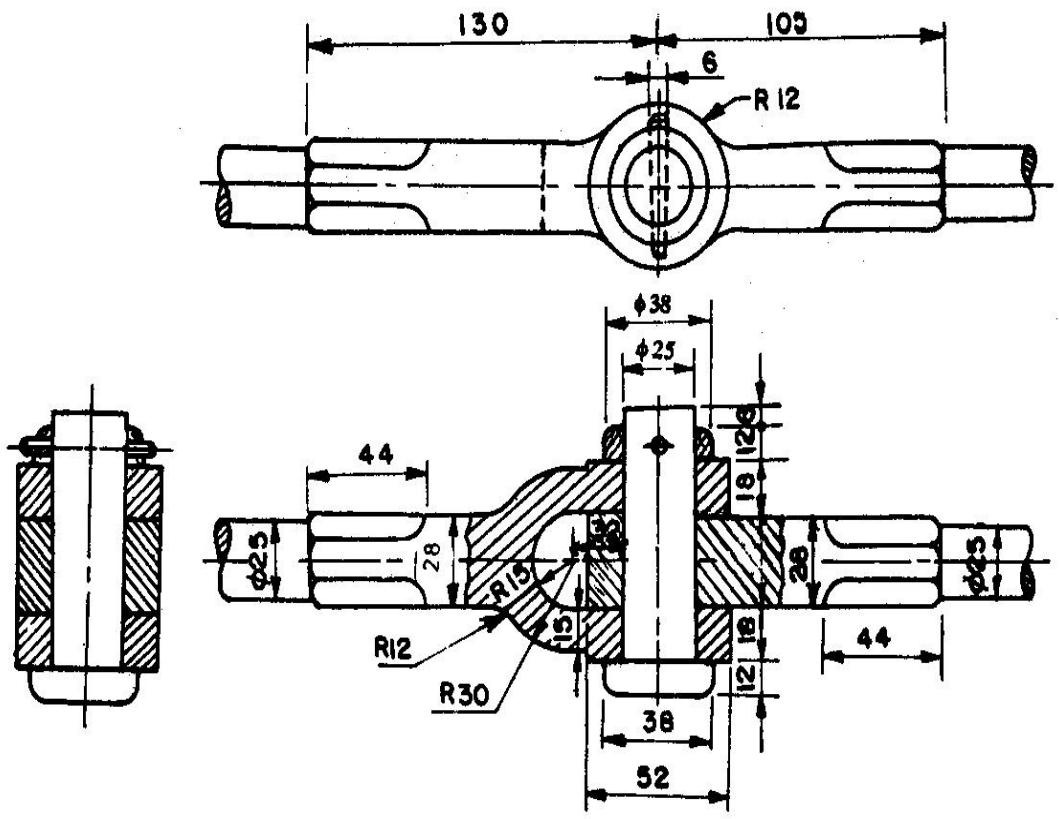


Figure 11.9: parts of knuckle joint

Figure 11.10: projection of knuckle joint

4.Gib and cotter joint :

A Gib is used along with the cotter. Gib is like a cotter but two gibs head at its end. The thickness of gib and cotter are same.

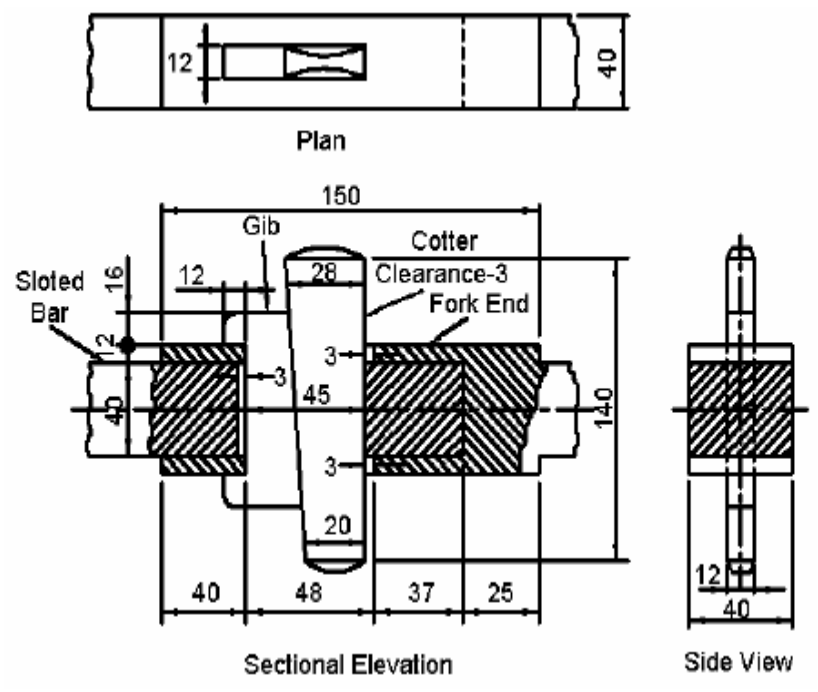


Figure 11.10: projection views of Gib and cotter joint

Q1.Assemble the glib and cotter joint as shown in fig 11.11 below and draw its projection views.

Question:

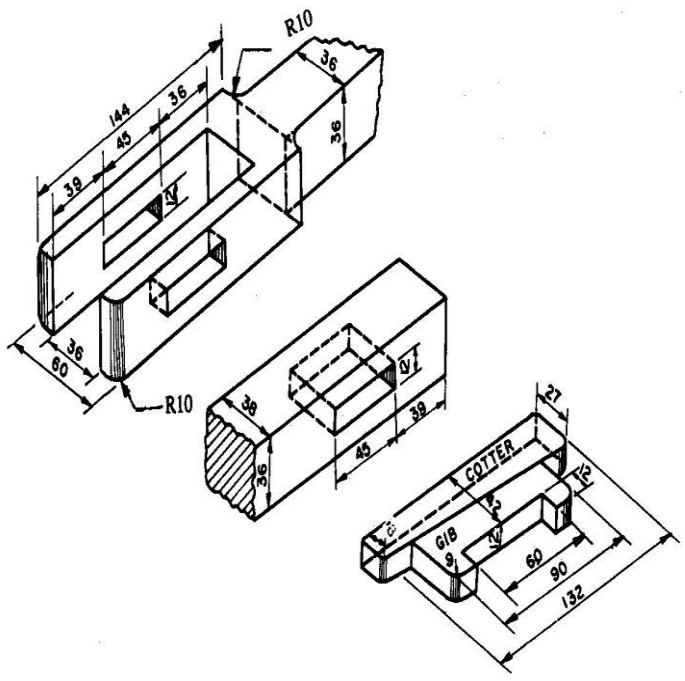


Fig. 11.11: Different parts of Gib and cotter joint

Solutions:

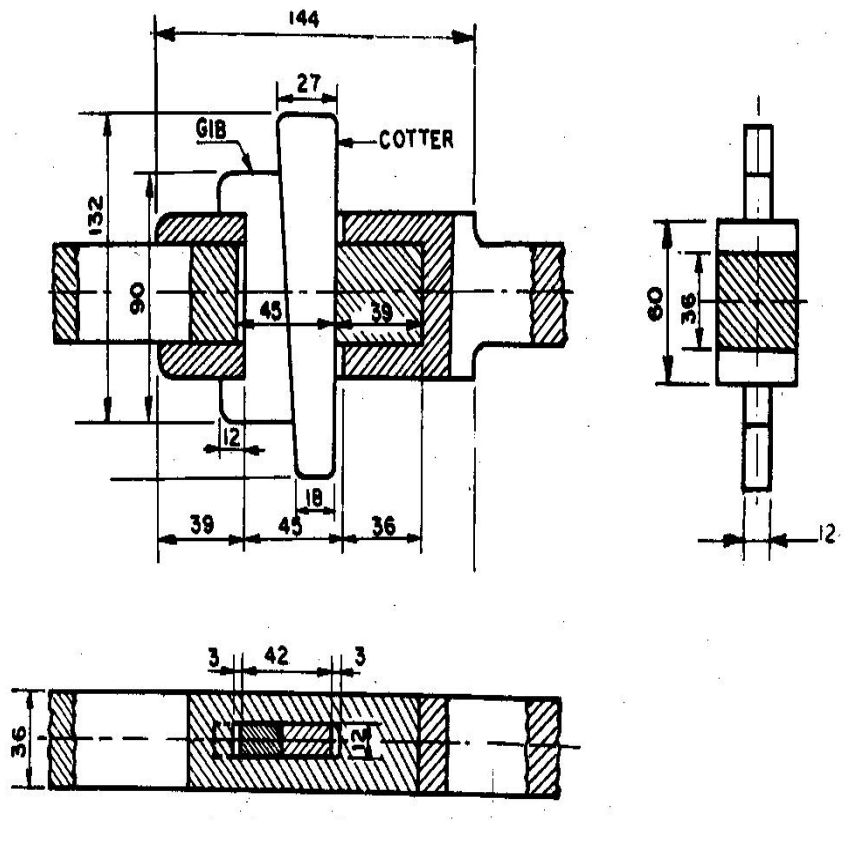


Fig.11.12: projection views of Gib and cotter joint

Unit- 12

Couplings

12.1 Couplings:

When a shaft is too long to be made in one length two or more lengths are used, joined together by couplings. In simple words, couplings are mechanical devices used to transmit power/torque from one shaft to another shaft. Shaft couplings are used to join or connect two shafts in such a way that when both the shafts rotate, they act as one unit and transmit power from one shaft to the other. Shafts to be connected or coupled may have collinear axes, intersecting axes or parallel axes at a small distance

Applications:

1. To transmit power from driver shaft to driven shaft.
2. To connect or couple two components which are manufactured separately e.g output motor shaft and generator.
3. To introduce protection against overloads.
4. To reduce the transmission of shock loads from one shaft to another by using flexible couplings.

12.2 Types of coupling: General types of couplings are:

1. Rigid coupling: for aligned shafts
2. Non Rigid coupling (Flexible coupling): for non-aligned shafts

12.2.1 Rigid coupling:

It is used to connect two shafts which are perfectly in axial alignment. These couplings do not allow any relative rotation between the two shafts.

Fig. 12.1 Picture view of rigid coupling

12.2.1.2 Types of Rigid coupling:

(A) Sleeve or Muff Coupling

(B) Clamp or Split Muff or Compression Coupling

(C)Flange Coupling

(a) Unprotected type

(b) Protected type

(A)Sleeve or Muff Coupling

This is the simplest form of rigid coupling. It is made up of cast iron and very simple to design and manufacture. Sleeve couplings are nothing but just sort of thick hollow cylinder/pipe called as sleeve or muff. The sleeve is manufactured keeping the diameter of shaft in mind so that the shaft fits perfectly into the sleeve.

Applications:

They are used where the shafts don't require any alignments and load capacity is light to medium duty.

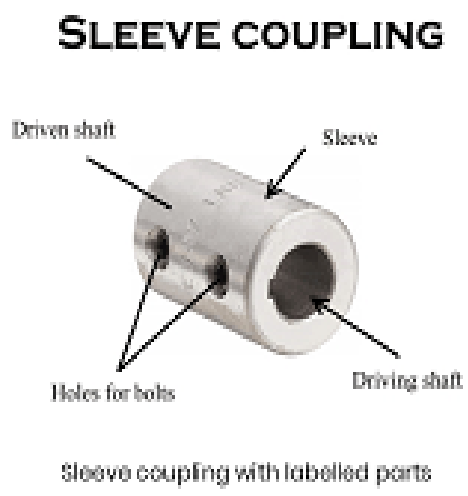


Fig. 12.2 Picture view of sleeve coupling

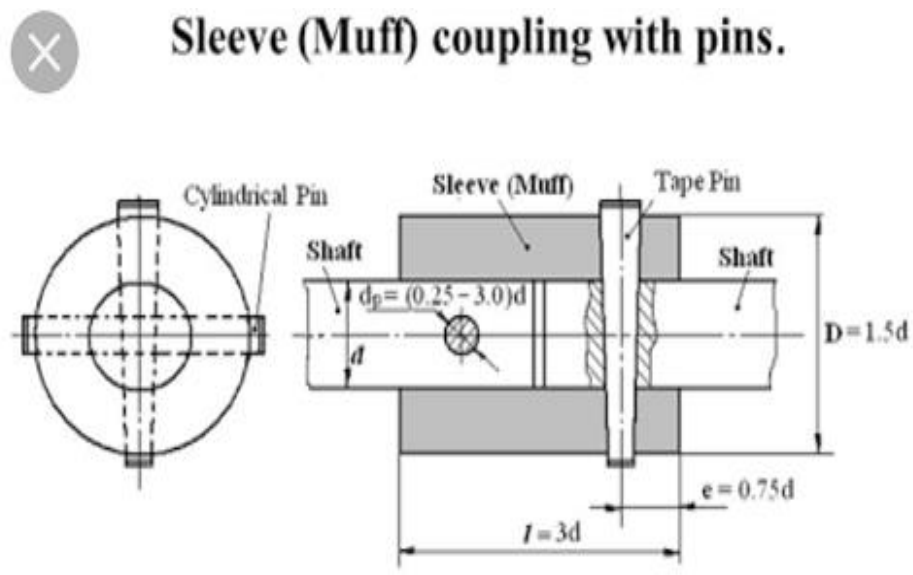


Fig. 12.3 projection view of sleeve coupling

(B)Split Muff Coupling:

In this coupling, the muff or sleeve is made into two halves parts of cast iron and they are joined together by means of mild steel studs or bolts and nuts as shown in figure12.3 and its projection view shown in fig. 12.4. The muffs are semi-cylindrical in shape which then fits over the shaft. The special feature of this coupling is that it can be assembled and disassembled without changing the position of shaft.

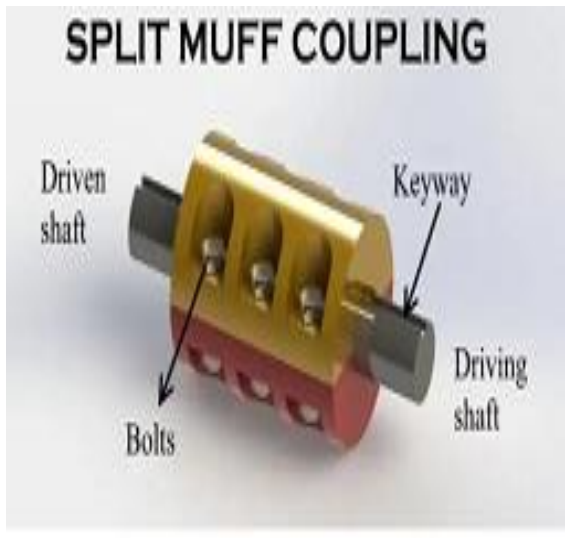


Fig. 12.3 Picture view of split Muff coupling

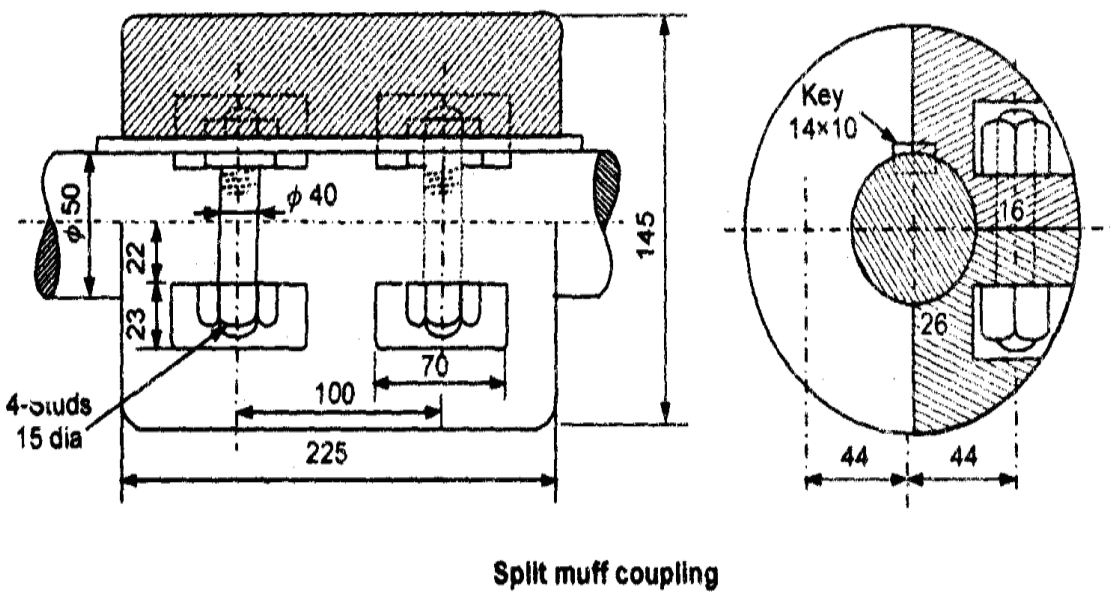


Fig. 12.4 projection view of split Muff coupling

Application: They are used for medium to heavy duty load with moderate speed.

(C)Flange Coupling:

Flange Couplings consists of two cast iron flanges or disks keyed to the ends of the shafts and held together by bolts as shown in fig. 12.5.

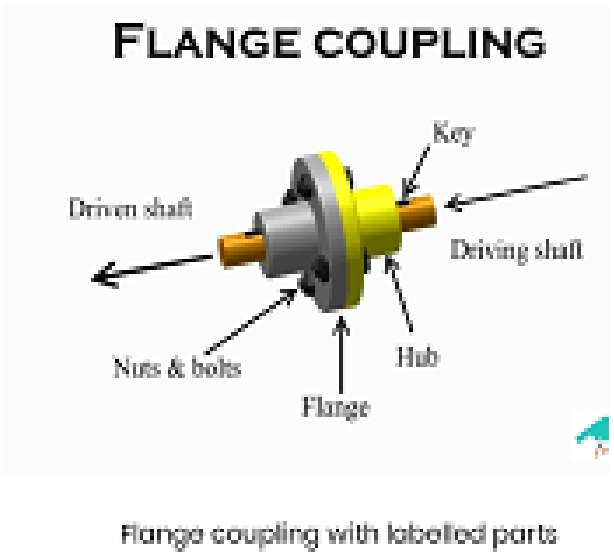


Fig. 12.5 Picture view of flange coupling

(a)Unprotected Type Flange Coupling:

This coupling is having two separate cast iron flanges as shown in figure 12.6 an unprotected type flange coupling. Each flange is mounted on the shafts end and keyed to it. The two flanges are coupled together by help of bolts and nuts. The projected portion of one of the flange and corresponding recess on other flange are help to bring the shafts into line and maintain alignment as shown in fig. 12.7

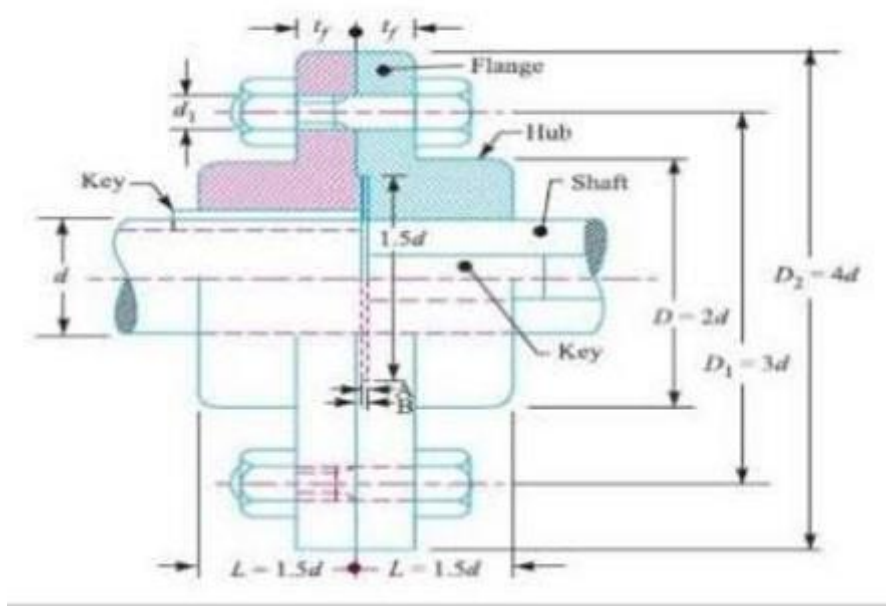


Fig. 12.6 Picture view and projection views of unprotected type flange coupling

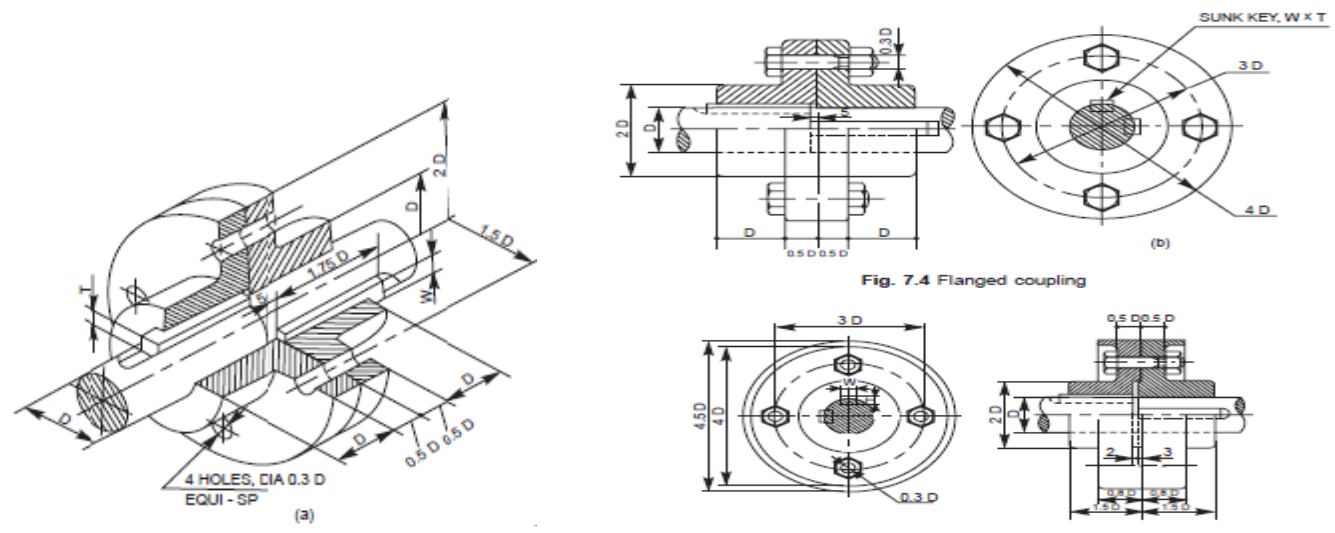


Fig. 7.4 Flanged coupling

Fig. 12.7 projection views of unprotected type flange coupling

(b) Protected type flange coupling:

A flange is provided with shroud which shelters the bolt heads and nuts as shown in figure 12.8 is called protected type flange coupling. This coupling prevents catching clothes of workman. Its projection views is shown in fig. 12.9

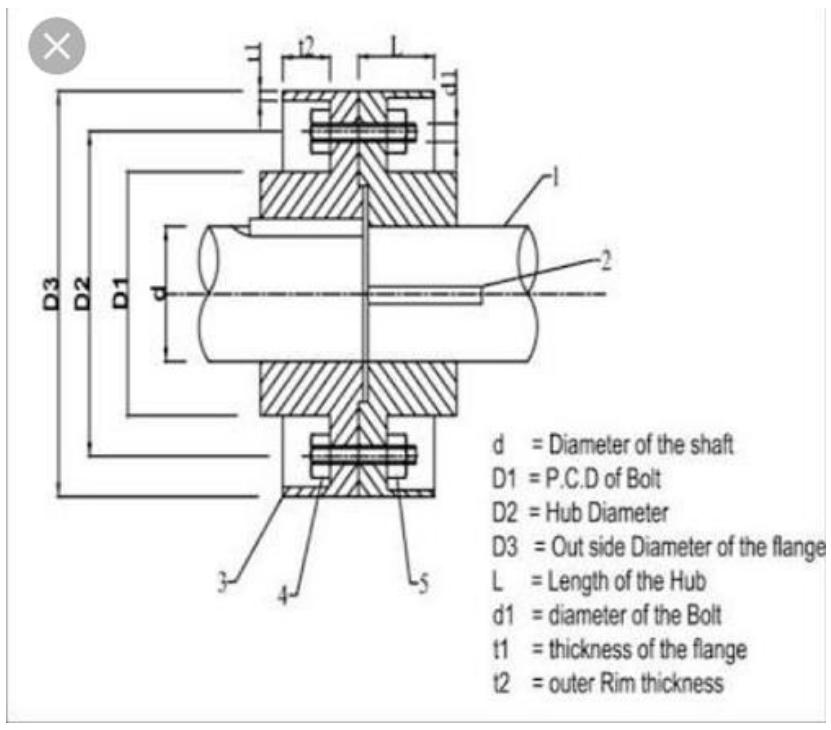


Fig. 12.8 Picture view of protected type flange coupling

Fig. 12.9 Projection view of protected type flange coupling

Applications:

Flange couplings are used for medium and heavy-duty industrial applications.

12.2.2 Flexible Couplings:

It is used to connect shafts which are slightly out of line or when one shaft is rigidly held from end play and the other is free to move a short distance. This coupling is used to protect the driving and driven machine members against harmful effects produce due to misalignment of shafts, vibration, and sudden shock load or shaft expansion.

Types of Flexible Coupling

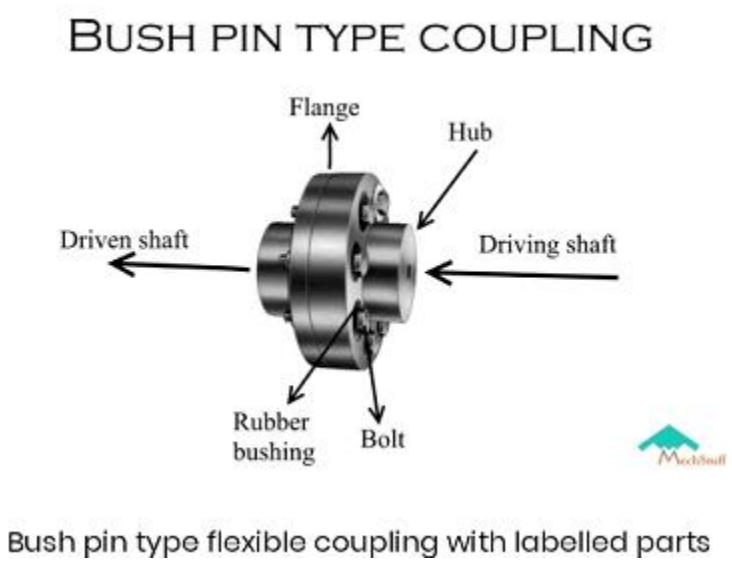
(a)Bush pin type flange coupling

(b)Universal coupling or Hooke's joint

(a) Bush Pin Type Coupling:

This is the modified form of flange coupling. The only difference between them is the usage of rubber bushings. Slightly thick rubber bushings are designed so that the studs or bolts perfectly fit inside it and bushing fits perfectly inside the holes provided.

The major advantage of using this coupling is that it can be used for slightly misaligned shafts. The rubber bushings add a certain amount of flexibility to the coupling which also helps to absorb shocks and vibrations.



Bush pin type flexible coupling with labelled parts

Fig. 12.10 Picture view Bush pin type coupling

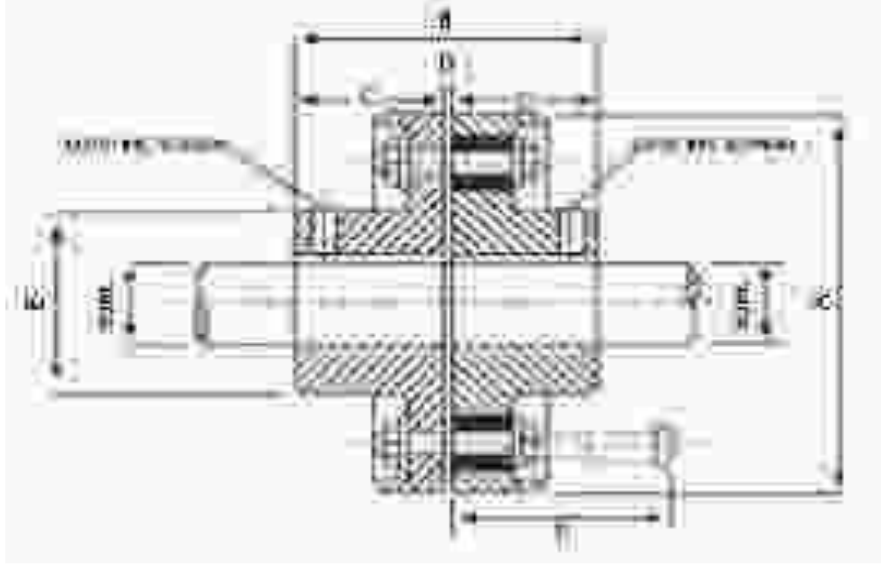


Fig. 12.11 Projection view of Bush pin type coupling

Applications:

This coupling is used to connect the small parallel misalignment and axial displacement. In this coupling rubber bush absorbs shock and vibration during its operation. This type of coupling is mostly used to couple an electric motor and machine.

(b)Universal coupling:

As the name suggests, this type of coupling can be used anywhere. The universal joint can transmit power even at high parallel or angular misalignments. It consists of a pair of hinges close together perpendicular to each other connected by cross shafts.fig 12.12 shows the picture view of universal coupling and 12.13 shows the projection view of universal coupling.

Fig. 12.12 Picture view Universal coupling

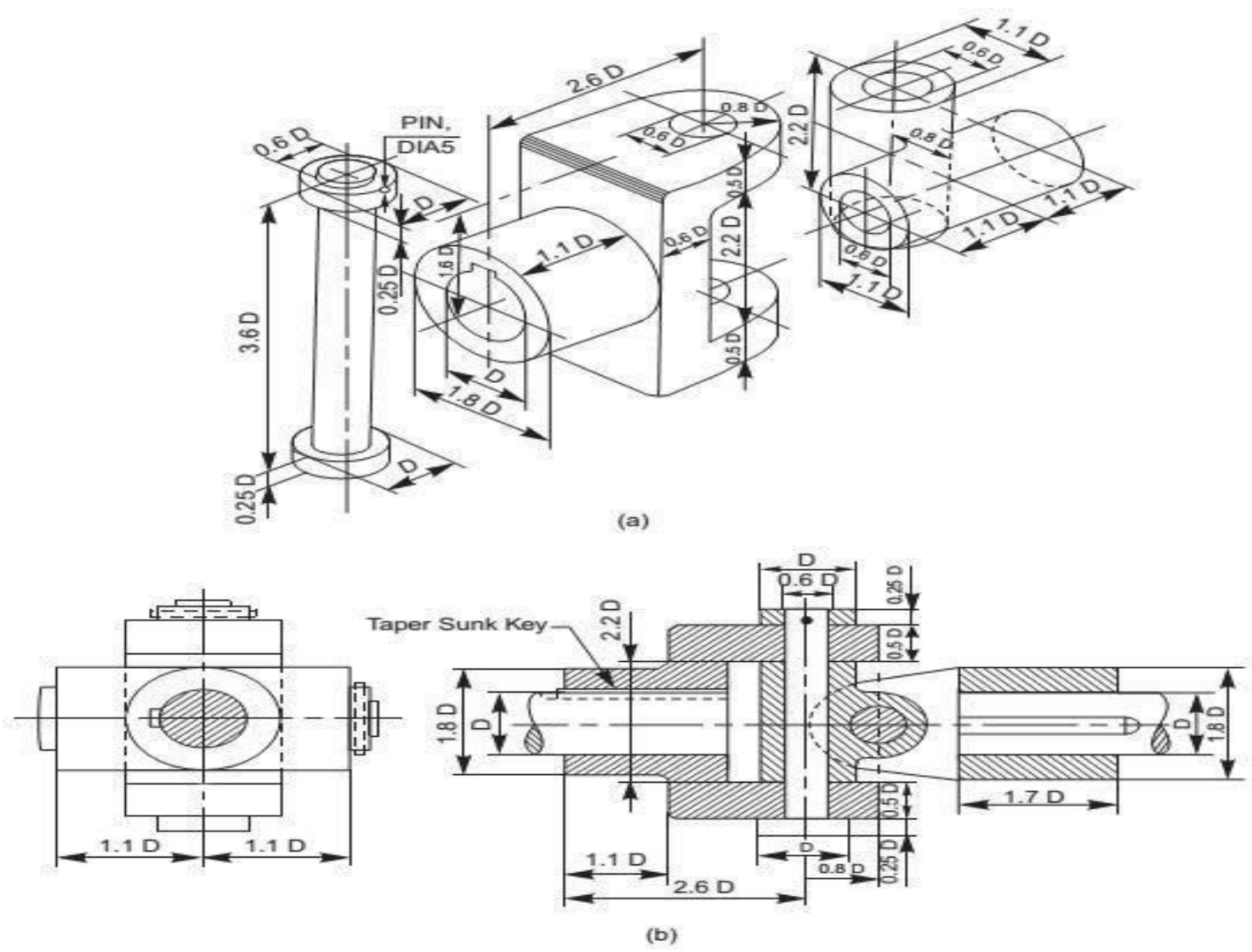


Fig. 12.13 Different parts of Universal coupling and its projection views

Applications:

Universal joints are used in machines where there are space restrictions or high flexibility is needed.