Screw Thread Measurement

Screw threads are used to transmit the power and motion, and also used to fasten two components with the help of nuts, bolts and studs. There is a large variety of screw threads varying in their form, by included angle, head angle, helix angle etc. The screw threads are mainly classified into 1) External thread 2) Internal thread.

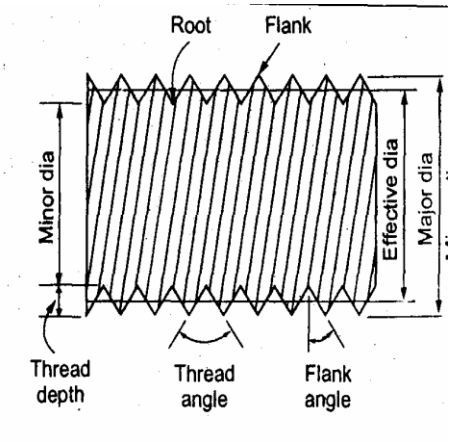


Fig 3.1 External Thread

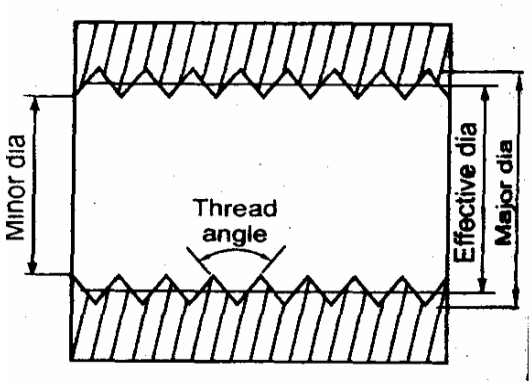


Fig 3.2 Internal Thread

Measurement of various elements of Thread

To find out the accuracy of a screw thread it will be necessary to measure the following:

1. Major diameter.
2. Minor diameter.
3. Effective or Pitch diameter.
4. Pitch
5. Thread angle and form

1. Measurement of major diameter:

The instruments which are used to find the major diameter are by

- Ordinary micrometer
- Bench micrometer.

- **Ordinary micrometer**

The ordinary micrometer is quite suitable for measuring the external major diameter. It is first adjusted for appropriate cylindrical size (S) having the same diameter (approximately).This process is known as 'gauge setting'. After taking this reading 'R the micrometer is set on the major diameter of the thread, and the new reading is 'R2.

- **Bench micrometer**

For getting the greater accuracy the bench micrometer is used for measuring the major diameter. In this process the variation in measuring Pressure, pitch errors are being neglected. The fiducial indicator is used to ensure all the measurements are made at same pressure. The instrument has a micrometer head with a vernier scale to read the accuracy of 0.002mm. Calibrated setting cylinder having the same diameter as the major diameter of the thread to be measured is used as setting standard. After setting the standard, the setting cylinder is held between the anvils and the reading is taken. Then the cylinder is replaced by the threaded work piece and the new reading is taken.

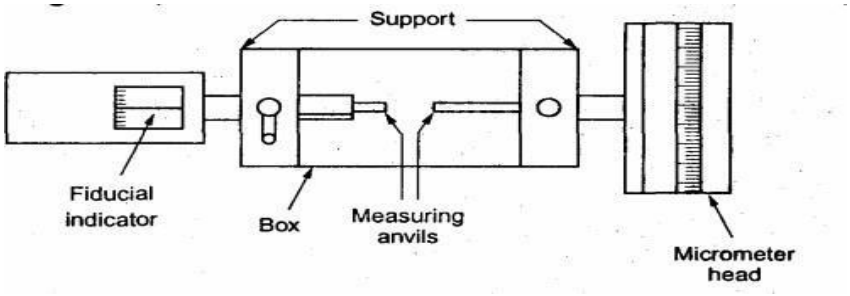


Fig 3.6 Bench Micrometer

∴ The major diameter of screw thread

$= S \pm (D_2 - D_1)$

Where, S = Diameter of the setting cylinder.

R_2 = Micrometer Reading on screw thread

R_1 = Micrometer reading on setting cylinder.

- **Measurement of the major diameter of an Internal thread**

The Inter thread major diameter is usually measured by thread comparator fitted with ball-ended styli. First the Instrument is set for a cylindrical reference having the same diameter of major diameter of internal thread and the reading is taken. Then the floating head is retracted to engage the tips of the styli at the root of spring under pressure. For that the new reading is taken,

major diameter of internal thread is $= D \pm (R_2 - R_1)$

D = Cylindrical standard diameter

R_2 = Thread reading

R_1 = Dial Indicator reading on the standard.

2. Measurement of Minor diameter

The minor diameter is measured by a comparative method by using floating carriage diameter measuring machine and small V pieces which make contact with the root of the thread. These V pieces are made in several sizes, having suitable radii at the edges. V pieces are made of hardened steel. The floating carriage diameter-measuring machine is a bench micrometer mounted on a carriage.

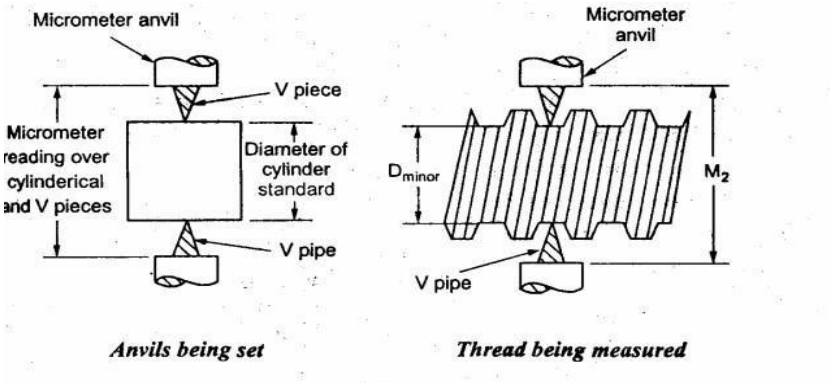


Fig 3.7 Measurement of Minor diameter

- **Measurement process**

The threaded work piece is mounted between the centers of the instrument and the V pieces are placed on each side of the work piece and then the reading is noted. After taking this reading the work piece is then replaced by a standard reference cylindrical setting gauge.

The minor diameter of the thread = $D \pm (R_2 - R_1)$

Where, D = Diameter of cylindrical gauge

R_2 = Micrometer reading on threaded work piece.

R_1 = Micrometer reading on cylindrical gauge.

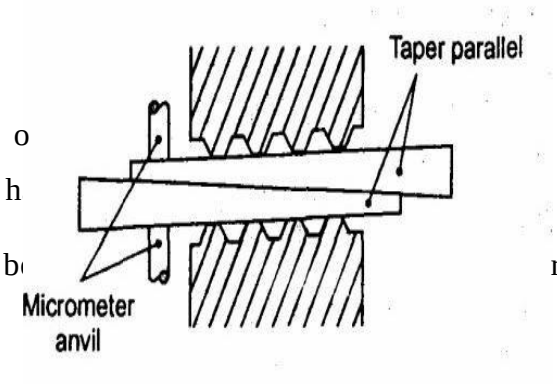
- **Measurement of Minor diameter of Internal threads**

  The Minor diameter of Internal threads are measured by

  1. Using taper parallels
  2. Using Rollers.

  - **Using taper parallels**

    For diameters less than 200mm the use o y common. The taper parallels are pairs of wedges h edges. The diameter across their outer edges can b r.



  - **Using rollers**

    For more than 20mm diameter this method is used. Precision rollers are inserted inside the thread and proper slip gauge is inserted between the rollers. The minor diameter is then the length of slip gauges plus twice the diameter of roller.

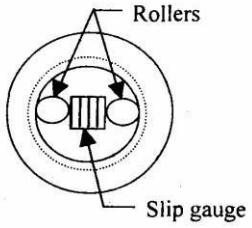


Fig 3.9 Roller gauge

3. Measurement of effective diameter

Effective diameter measurement is carried out by following methods.

1. One wire,
2. Two wires, or
3. Three wires method.
4. Micrometer method.

a) One wire method

The only one wire is used in this method. The wire is placed between two threads at one side and on the other side the anvil of the measuring micrometer contacts the crests. First the micrometer reading dl is noted on a standard gauge whose dimension is approximately same to be obtained by this method.

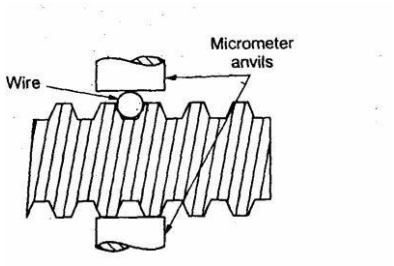


Fig 3.10 One wire method

i.e. 'd_2' then effective diameter = $D \pm (d_1 - d_2)$

When D = Size of setting gauge

Actual measurement over wire on one side and threads on other

b) Two wire method

Two-wire method of measuring the effective diameter of a screw thread is given below. In this method wires of suitable size are placed between the standard and the micrometer anvils. First the micrometer reading is taken and let it be R. Then the standard is replaced by the screw thread to be measured and the new reading is taken.

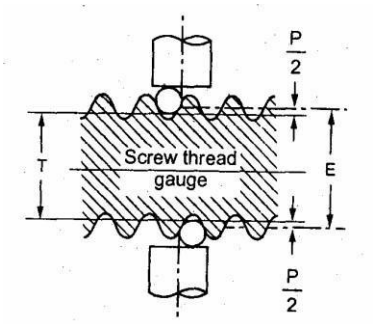


Fig 3.11 Two Wire Method

From the above reading

The effective diameter E is calculated by $E = T + P$

Where, T = Dimension under the wires = $M - 2d$

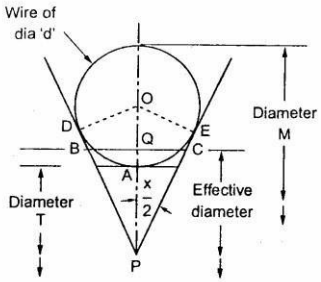
M = Dimension over the wires

d = diameter of each wire

If P' = Pitch of thread then

$$P = 0.9605\,P' - 1.1657d \Rightarrow \text{Whitworth thread.}$$

$$P = 0.866\,P' - d \Rightarrow \text{For metric thread.}$$



Here, P =The difference between the effective diamet and the diameter under the wires.

The diameter under the wires 'T' also can be determined by

$$T = S - (R_1 - R_2)$$

Where, S = The diameter of the standard.

The P value can be derived in terms of P (Pitch), d (Diameter of wire) and x thread angle is as follows

BC lies on the effective diameter.

$$\therefore BC = \frac{1}{2} Pitch = \frac{1}{2} P$$

$$\text{Next OP} = \frac{d\,Co\sec(x/2)}{2}$$

And AQ = PQ – AP

Where,

$PQ = QC\ Cot\ (x/2) = P/4\ Cot\ (x/2)$

$$PQ = \frac{P}{4} Cot(x/2)$$

c) Three-Wire method

The three-wire method is the accurate method. In this method three wires of equal and precise diameter are placed in the groves at opposite sides of the screw. In this one wire on one side and two on the other side are used. The wires either may held in hand or hung from a stand. This method ensures the alignment of micrometer anvil faces parallel to the thread axis.

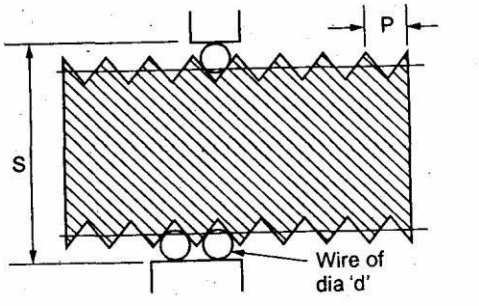
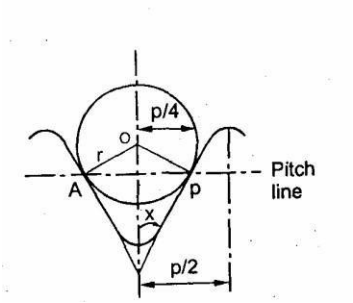


Fig 3.12 Three-Wire Method

- **BEST WIRE SIZE-DEVIATION**

Best wire diameter is that may contact with the flanks of the thread on the pitch line. The figure shows the wire makes contact with the flanks of the thread on the pitch.

Hence best wire diameter,



$$db = 2Ap\ secx$$

Where, db = Wire diameter

x = Included angle

$$AP = p/4$$

$$\therefore db = 2\ p/4\ sec\ x$$

$$\boxed{db = p_2\ secx}$$

4. Pitch measurement

The most commonly used methods for measuring the pitch are

1. Pitch measuring machine
2. Tool maker's microscope
3. Screw pitch gauge

- **Pitch measuring machine**

The principle of the method of measurement is to move the stylus along the screen parallel to the axis from one space to the next. The pitch-measuring machine provides a relatively simple and accurate method of measuring the pitch. Initially the micrometer reading is near the zero on the scale, the indicator is moved along to bring the stylus, next the indicator adjusted radially until the stylus engages between the thread flank and the pointer 'K' is opposite in the line L. To bring T in opposite in its index mark a small movement is necessary in the micrometer and then the reading is taken next. The stylus is moved along into the next space by rotation of the micrometer and the second reading is taken. The difference between these two-measured readings is known as the pitch of the thread.

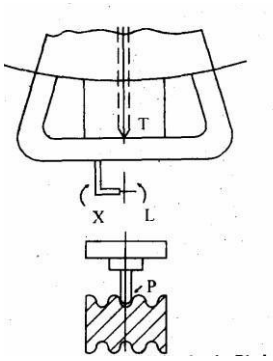


Fig 3.13 Pitch Measuring Machine

- **Tool makers microscope**

Working

Worktable is placed on the base of the base of the instrument. The optical head is mounted on a vertical column it can be moved up and down. Work piece is mounted on a glass plate. A light source provides horizontal beam of light which is reflected from a mirror by 900 upwards towards the table. Image of the outline contour of the work piece passes through the objective of the optical head. The image is projected by a system of three prisms to a ground glass screen. The measurements are made by means of cross lines engraved on the ground glass screen. The screen can be rotated through 360°. Different types of graduated screens and eyepieces are used.

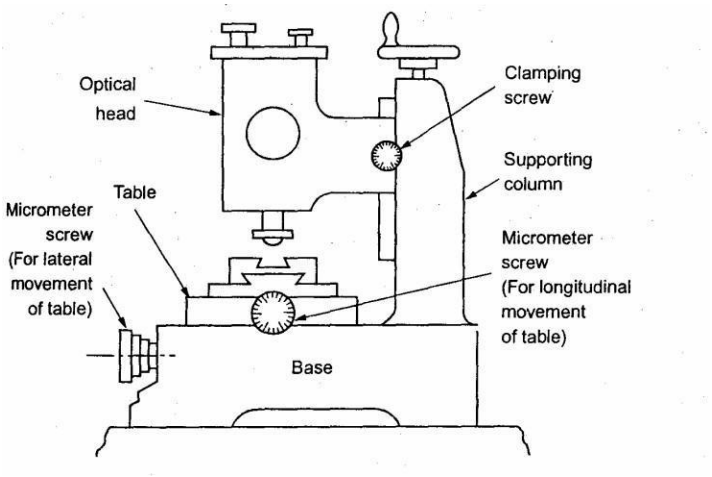


Fig 3.14 Tool Makers Microscope

- **Applications**
  - Linear measurements.
  - Measurement of pitch of the screw.
  - Measurement of pitch diameter.
  - Measurement of thread angle.
  - Comparing thread forms.
  - Centre to center distance measurement.
  - Thread form and flank angle measuremen