INTERNAL ASSESSMENT EXAMINATION – II

19ME402 – Metrology and Measurements

Question Bank with Answers

PART A

Q.No	Question
1.	List any four angular measuring instruments.
2.	Why are sine bars are not used for measuring large angles?
3.	What are the factors affecting surface roughness?
4.	Define straightness of line in two planes.
5.	What is gear run out?
6.	State the principle of interferometry.
7.	Why are sine bars are not used for measuring large angles?
8.	Define Lead.
9.	Define straightness of a line in two planes.
10.	What is backlash?

PART B

6. (a) Explain the working principle of Mechanical comparator and Pneumatic comparator with neat sketches.

(b) Illustrate the working principle of angle Dekkor with a neat sketch.

7. (a) Elucidate the various methods used for checking the profile of a spur gear.

(b) Explain the direct methods of surface finish measurements using neat sketch.

PART C

8. (a) Explain the methods to measure the major, minor and effective diameter of a screw thread.

(b) Explain the various methods by which roundness is measured.

PART B

6. (a) Explain the working principle of autocollimator and mention its applications.

(b) Explain the working principle of Optical comparator and Pneumatic comparator with neat sketches.

7. (a) Elucidate the various methods used to measure the pitch of a spur gear.

(b) Explain the tooth thickness measurement using Gear tooth vernier caliper.

PART C

8. (a) Explain the methods to measure the major, minor and effective diameter of a screw thread.

(b) Explain the various methods by which roundness is measured.

Part-A

1. **List any four angular measuring instruments**

   Sinebar

   - Bevel protractor
   - Autocollimeter
   - Angle dekkor

2. **Why are sine bars not used for measuring large angles**.

   - The sine bar is physically clumsy to hold in position.
   - The body of the sine bar obstructs the gauge block stack even if relieved
   - Slight errors of the sine bar cause large angular errors

3. **State the principle of interferometry.**

   Interferometry makes the use of the principle of superposition to combine separate wave together in a way that will cause the result of the combination to have some meaningful property that is diagnostic of the original state of the waves.

4. **Classify the comparator according to the principles used for obtaining magnification.**

   The common types are: (i) Mechanical comparators. (ii) Electrical comparators. (iii) Optical comparators. (iv) Pneumatic comparators. 34. How the mechanical comparator works? The method of magnifying small movement of the indicator in all mechanical comparators are effected by means of levers, gear trains or a combination of these elements.

5. **How the mechanical comparator is used?**

   State with any one example. Let us assume that the required height of the component I s 32.5mm. Initially, this height is built up with slip gauges. The slip gauge blocks are placed under the stem of the dial gauge. The pointer in the dial gauge is adjusted to zero.

PART-B

Give a brief note on slip gauges and what are the safety precaution to be followed in the use of slip gauge blocks and also explain the type of limit gauge with neat sketches

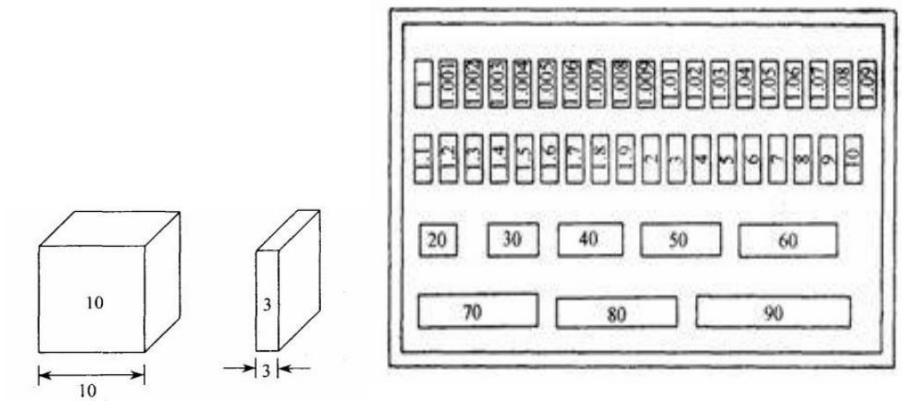
SLIPGAUGES

These may be used as reference standards for transferring the dimension of the unit of length from the primary standard to gauge blocks of lower accuracy and for the verification and graduation of measuring apparatus.

These are high carbon steel hardened, ground and lapped rectangular blocks, having cross sectional area 0f 30mm, 10mm. Their opposite faces are flat, parallel and are accurately the stated distance apart.

The opposite faces are of such a high degree of surface finish, that when the blocks are pressed together with a slight twist by hand, they will wring together. They will remain firmly attached to each other. They are supplied in sets of 112 pieces down to 32pieces.

Due to properties of slip gauges, they are built up by, wringing into combination which gives size, varying by steps of 0.01 mm and the overall accuracy is of the order of 0.00025mm. Slip gauges with three basic forms are commonly found, these are rectangular, square with center hole, and square without center hole.



Precautions

- The blocks should be kept in the box and it it should not dropped on the irregular surfaces.
- Surfaces of slip gauges should be cleaned before it is used.
- The slip gauge block should be in particular temperature condition to eliminate the thermal expansion which causes in accuracy during measurement.
- While using slip gauses for measurement it should be kept iin a flat surface to get high accurate readings.

LIMITGAUGES

- A limit gauge is not a measuring gauge. Just they are used as inspecting gauges.
- The limit gauges are used in inspection by methods of attributes.
- This gives the information about the products which maybe either within the prescribed limit or not.
- By using limit gauges report, the control charts of P and C charts are drawn to control invariance of the products.
- This procedure is mostly performed by the quality control department of each and every industry.
- Limit gauge are mainly used for checking for cylindrical holes of identical components with a large numbers in mass production.

Purpose of using limit gauges

- Components are manufactured as per the specified tolerance limits, upper limit and lower limit. The dimension of each component should be within this upper and lower limit.
- If the dimensions are outside these limits, the components will be rejected.
- It is just enough whether the size of the component is within the prescribed limits or not. For this purpose, we can make use of gauges known as limit gauges.

The common types are as follows:

1) Plug gauges.

2) Ring gauges.

3) Snap gauges.

PLUGGAUGES

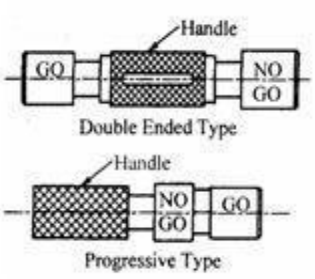
- The ends are hardened and accurately finished by grinding. One end is the GO end and the other end is NOGO end.
- Usually, the GO end will be equal to the lower limit size of the hole and the NOGO end will be equal to the upper limit size of the hole.
- If the size of the hole is within the limits, the GO end should go inside the hole and NOGO end should not go.
- If the GO end and does not go, the hole is under size and also if NOGO end goes, the hole is over size. Hence, the components are rejected in both the cases

1. **Double ended plug gauges**

In this type, the GO end and NOGO end are arranged on both the ends of the plug. This type has the advantage of easy handling.

2. **Progressive type of plug gauges**

In this type both the GO end and NOGO end are arranged in the same side of the plug. We can use the plug gauge ends progressively one after the other while checking the hole. It saves time. Generally, the GO end is made larger than the NOGO end in plug gauges.

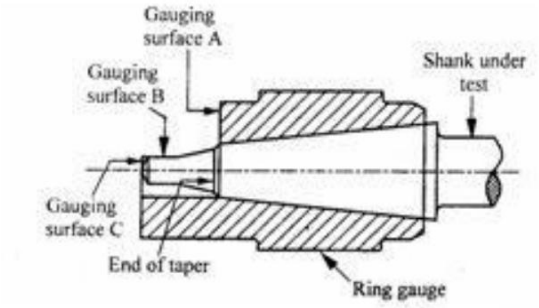


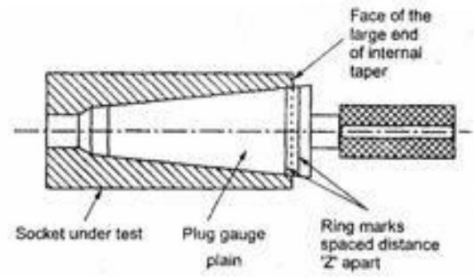
TAPER PLUG GAUGE

Taper plug gauges are used to check tapered holes. It has two check lines. One is a GO line and another is a NOGO line. During the checking of work, NOGO line remains outside the hole and GO line remains inside the hole.

They are various types taper plug gauges are available as shown in fig. Such as

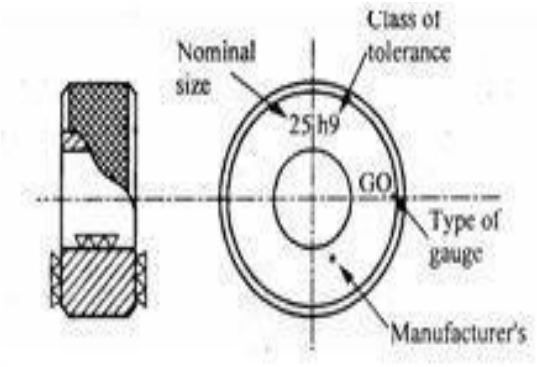
1) Taper plug gauge— plain
2) Taper plug gauge— tanged.
3) Taper ring gauge plain
4) Taper ring gauge — tanged





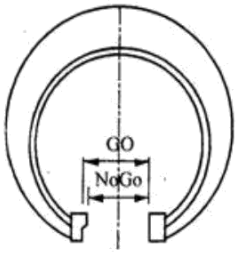
RING GAUGES

- Ring gauges are mainly used for checking the diameter of shafts having a central hole. The hole is accurately finished by grinding and lapping after taking hardening process.
- The periphery of the ring is knurled to give more grips while handling the gauges. We have to make two ring gauges separately to check the shaft such as GO ring gauge and NOGO ring gauge.
- But the hole of GO ring gauge is made to the upper limit size of the shaft and NOGO for the lower limit.
- While checking the shaft, the GO ring gauge will pass through the shaft and NO GO will not pass.
- To identify the NOGO ring gauges easily, are mark or a small groove cut on its periphery.



SNAP GAUGE

Snap gauges are used for checking external dimensions. They are also called a snap gauges. The different types of snap gauges are:



Double Ended Snap Gauge

This gauge is having two ends in the form of anvils. Here also, the GO anvil is made to lower limit and NOGO anvil is made to upper limit of the shaft. It is also known as solid snap gauges

Progressive Snap Gauge

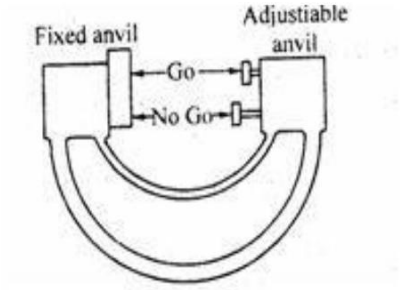
This type of snap gauge is also called caliper gauge. It is mainly used for checking large diameters up to 100mm. Both GO and NOGO anvils at the same end.

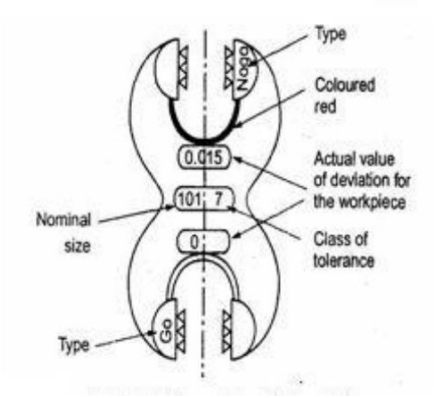
The GO anvil should be at the front and NOGO anvil at the rear. So, the diameter of the shaft is checked progressively by these two ends. This type of gauge is made of horse shoe shaped frame with I section to reduce the weight of the snap gauges.

Adjustable Snap Gauge

Adjustable snap gauges are used for checking large size shafts made with horse shoe shaped frame of I section. It has one fixed anvil and two small adjustable anvils. The distance between the two anvils is adjusted by adjusting

the adjustable anvils by means of set screws. This adjustment can be made with the help of slip gauges for specified limits of size.





Combined Limit Gauges

A spherical projection is provided with GO and NOGO dimension marked in a single gauge. While using GO gauge the handle is parallel to axes of the hole and normal to axes for NOGO gauge.

Position Gauge

It is designed for checking the position of features in relation to another surface. Other types of gauges are also available such as contour gauges, receiver gauges, profile gauges etc.

12. Explain the construction and working of vernier caliper. Enumerate the different types of vernier caliper with neat sketches also explain the construction and working of micrometers. Enumerate the micrometer with neat sketches . (APRIL/MAY 2015)

VERNIERCALIPERS

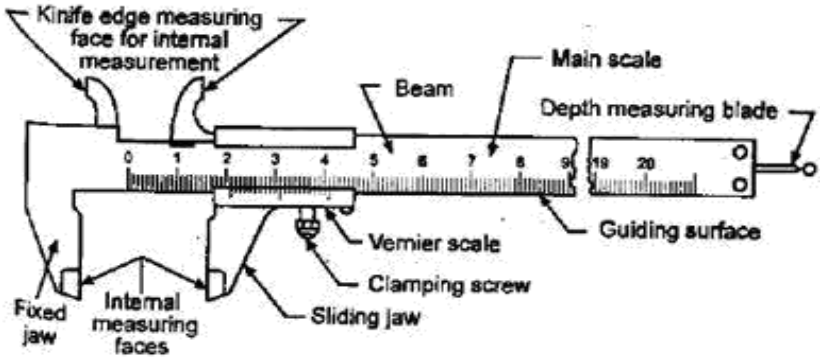
The vernier instruments generally used in workshop and engineering metrology have comparatively low accuracy. The line of measurement of such instruments does not coincide with the line of scale. The accuracy therefore depends upon the straightness of the beam and the squareness of the sliding jaw with respect to the beam.

To ensure the squareness, the sliding jaw must be clamped before taking the reading. The zero error must also be taken into consideration. Instruments are now available with a measuring range up to one meter with a scale value of 0.1 or0.2 mm.

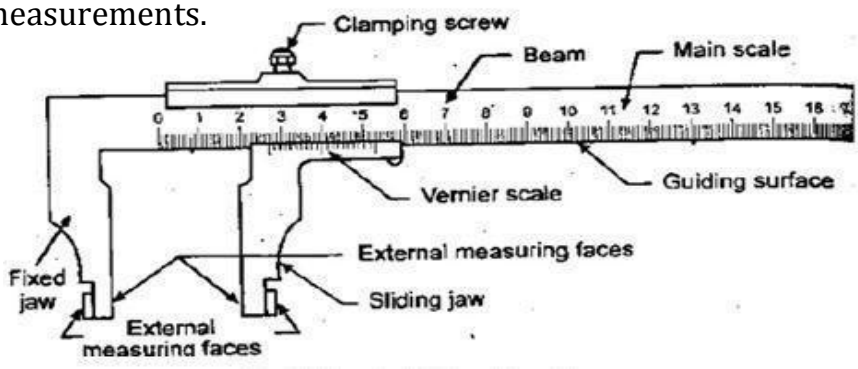
Types of Vernier Calipers

According to Indian Standard IS:3651- 1974, three types of vernier calipers have been specified to make external and internal measurements and are shown in figures respectively. All the three types are made with one scale on the front of the beam for direct reading.

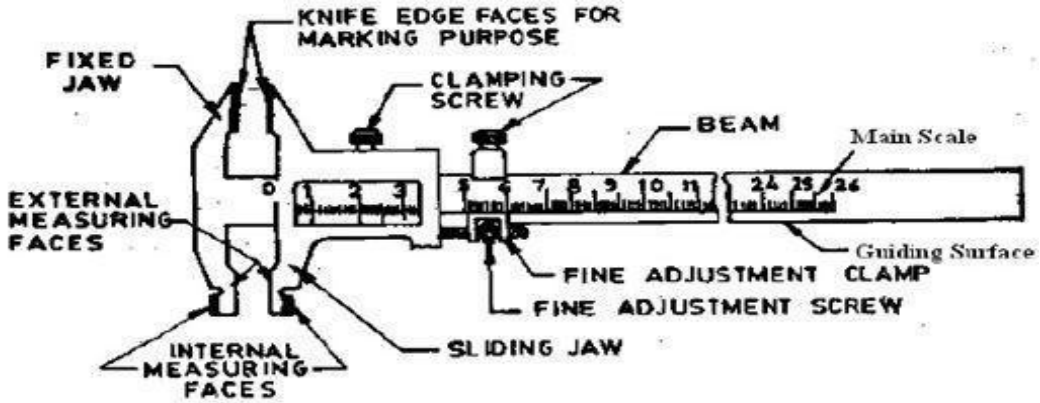
TypeA : Vernier has jaws on both sides for external and internal measurementsand a blade for depth measurement.



Type B: It is provided with jaws on one side for external and internalmeasurements.



Type C: It has jaws on both sides for making the measurement and for markingoperations

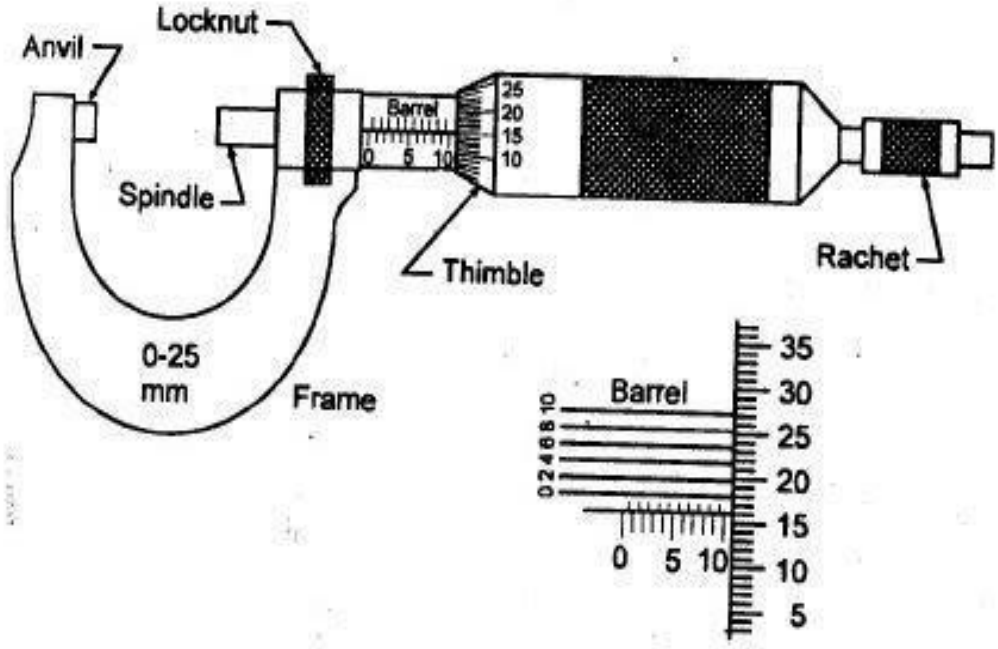


MICROMETERS

There are two types in it.

- Outside micrometer— To measure external dimensions.
- Inside micrometer—To measure internal dimensions

An outside micrometer is shown. It consists of two scales, main scale and thimble scale. While the pitch of barrel screw is 0.5mm the thimble has graduation of 0.01mm. The **least count** of this micrometer is 0.01 mm.



The micrometer requires the use of an accurate screw thread as a means of obtaining a measurement. The screw is attached to a spindle and is turned by movement of a thimble or ratchet at the end. The barrel, which is attached to the frame, acts as a nut to engage the screw threads, which are accurately made with a pitch of 0.05mm. Each revolution of the thimble advances the screw 0.05mm. On the barrel a datum line is graduated with two sets of division marks.

13. Explain the working principle of mechanical comparator ,optical comparator and Pneumatic comparator with neat sketches (MAY/JUNE 2014)

COMPARATORS

Comparators are one form of linear measurement device which is quick and more convenient for checking large number of identical dimensions. Comparators normally will not show the actual dimensions of the work piece. They will be shown only the deviation in size.

During the measurement a comparator is able to give the deviation of the dimension from the set dimension. This cannot be used as an absolute measuring device but can only compare two dimensions. Comparators are designed in several types to meet various conditions.

Comparators of every type in corporate some kind of magnifying device. The magnifying device magnifies how much dimension deviates, plus or minus, from the standard size.

The comparators are classified according to the principles used for obtaining magnification. The common types are:

1) Mechanical comparators
2) Electrical comparators
3) Optical comparators
4) Pneumatic comparators

MECHANICAL COMPARATORS

Mechanical comparator employs mechanical means for magnifying small deviations. The method of magnifying small movement of the indicator in all mechanical comparators are effected by means of levers, gear trains or a combination of these elements.

Mechanical comparators are available having magnifications from 300 to 5000 to 1. These are mostly used for inspection of small parts machined to close limits.

Dial indicator

A dial indicator or dial gauge is used as a mechanical comparator. The essential parts of the instrument are like a small clock with a plunger projecting at the bottom as shown in fig.

Very slight upward movement on the plunger moves it upward and the movement is indicated by the dial pointer. The dial is graduated into 100 divisions.

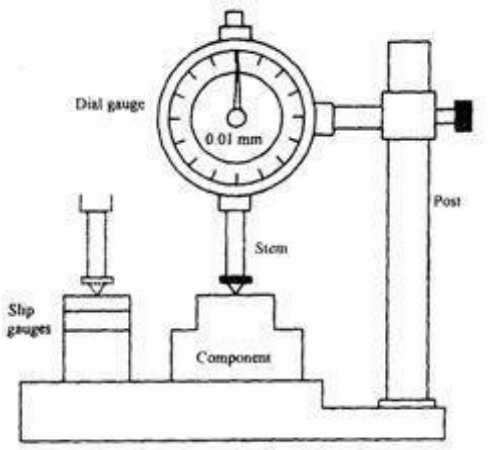
A full revolution of the pointer about this scale corresponds to1mm travel of the plunger. Thus, a turn of the pointer b one scale division represents a plunger travel of 0.01mm.

Experimental setup

The whole setup consists of worktable, dial indicator and vertical post. The dial indicator is fitted to vertical post by on adjusting screw as shown in fig. The vertical post is fitted on the worktable; the top surface of the work table is finely finished. The dial gauge can be adjusted vertically and locked in position by a screw.

Procedure

Let us assume that the required height of the component is 32.5mm. Initially this height is built up with slip gauges. The slip gauge blocks are placed under the stem of the dial gauge. The pointer in the dial gauge is adjusted to zero. The slip gauges are removed.

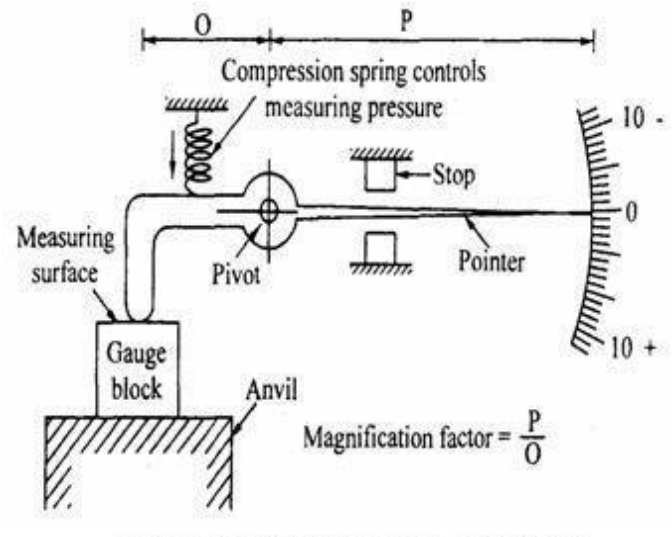


Now the component to be checked is introduced under the stem of the dial gauge. If there is any deviation in the height of the component, it will be indicated by the pointer.

Mechanism

The stem has rack teeth. A set of gears engage with the rack. The pointer is connected to a small pinion. The small pinion is independently hinged. i.e. .it is not connected to the stern. The vertical movement of the stem is transmitted to the pointer through a set of gears. A spring gives a constant downward pressure to the stem.

READ TYPE MECHANICAL COMPARATOR



In this type of comparator, the linear movement of the plunger is specified by means of read mechanism. The mechanism of this type is illustrated in fig. A spring- loaded pointer is pivoted. Initially, the comparator is set with the help of a known dimension eg. Set of slip gauges as shown in fig. Then the indicator reading is adjusted to zero. When the part to be measured is kept under the pointer, then the comparator displays the deviation of this dimension either in ± or — side of the set dimension.

Advantages

- It is usually robust, compact and easy to handle.
- There is no external supply such as electricity, air required.

- It has very simple mechanism and is cheaper when compared to other types.
- It is suitable for ordinary workshop and also easily portable.

Disadvantages

- Accuracy of the comparator mainly depends on the accuracy of the rack and pinion arrangement. Any slackness will reduce accuracy.
- It has more moving parts and hence friction is more and accuracy is less.
- The range of the instrument is limited since pointer is moving over a fixed scale.

OPTICAL COMPARATOR

In this type of comparator, small plunger displacement is amplified by both mechanical and optical system. The amplification is first done by pivoted lever and then by a simple optical systems.

Construction details

The optical comparator consist of the following parts such as

(1) Pivoted lever
(2) Objective lens
(3) Scale
(4) Plunger
(5) Table and base
(6) Mirror

Pivoted lever

The pivoted lever amplifies the plunger movement mechanically .It is pivoted near the plunger. One end is fitted with the plunger and other end is fitted with a mirror.

Objective lens

The main function of objective lens is to convert the incoming light rays from the source into parallel beams

Screen and scale

It is final display device from which the readings can be obtained.It is semi transparent glass

Plunger

It is reciprocating member. During the measurement, the plunger actuates.

Table

The work is palced on the table to carry out the task.

Base

It is rigid support over which the table is mounted

Mirror

It reflects the incoming light rays from the source which is hinged at the other end of the lever.

Working Principle

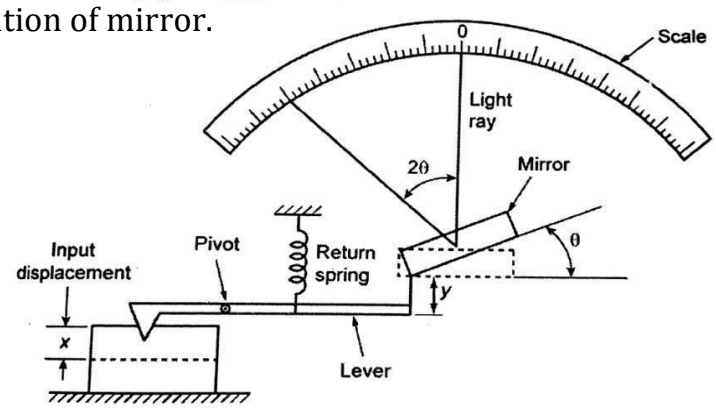
During measurement, the vertical displacement of the plunger is magnified by the ratio of the lever arm. The lever title the mirror about its hinged to again magnify. The light rays from the lamp are condensed by a condensing less. Then, the condensed light falls on the objective lens. The light rays are converted into parallel beams again the parallel beam of light ray fall on the mirror.

The mirror reflects the light rays on a screen As the screen is the semi transparentglass ,the image of work placed on the table will be reflected. The magnified master drawing is placed over the screen. The projected image is compared with the master drawing .This type of comparator can also used for inspecting small Parts such as screw, thread, saw teeth etc

The differences amplified by a lever to give a vertical displacement and an angular displacement .The difference x between two dimension may be used to actuate a lever to displace by y .same displacement causes a ray of light which is initially at zero angle to get displaced by 2 because the mirror is deflected by .The magnified reading is a measure of displacement x. the scale is calibrated by gauge blocks.

Advantages

- Small parts can also be inspected
- Different amplification can be obtained by adjuisting the projection lens and the position of mirror.



Pneumatic Comparator

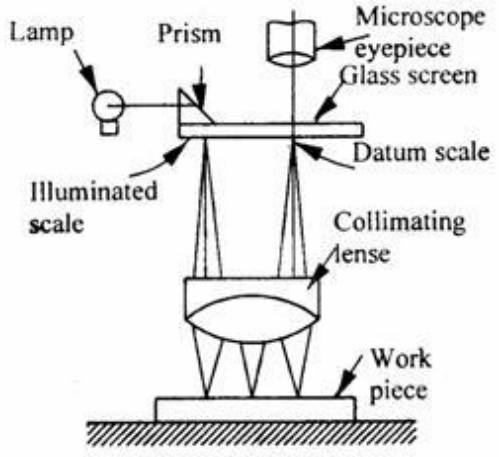
In this system, no physical contact is made either with the setting gauge or the part being measured, and that internal dimensions may be readily measured, not only with respect to tolerance boundaries, but also geometric form. Further, the system lends itself to the inspection of a single, or a number of dimensions simultaneously, either during or immediately after the operating cycle of a machine tool.Back-pressure (Pneumatic) comparator: It uses a water manometer for the indication of back pressure.

It consists of a vertical metal cylinder filled with water upto a certain level and a dip tube immersed into it upto a depth corresponding to the air pressure required. A calibrated manometer tube is connected between the cylinder and control orifice as shown in fig.. The air from its normal source of supply is filtered and passes through a flow valve.

Its pressure is then reduced and maintained at a constant value by a dip tube into a water chamber, the pressure value being determined by the head of the water displace, excess air escaping to atmosphere. The air at reduced pressure then passes through the control orifice, and escapes from the measuring orifice. The back pressure in the circuit is indicated by the head of water displaced in the manometer tube.

The tube is graduated linearly to show changes of pressure resulting from changes in dimension‘d’. Amplifications of up to 50000 are obtainable with this system.

14. Explain the working principle of angle Dekkor with a neat sketch. Also write the applications of angle Dekkor. And also explain how the measurements are made in optical bevel protractor. (NOV/DEC2014 & 2015,2016)



This is also a type of auto -collimator. There is an illuminated scale in the focal plane of the collimating lens.

This illuminated scale is projected as a parallel beam by the collimating lens which after striking a reflector below the instrument is refocused by the lens in the field of view of the eyepiece. In the field of view of microscope, there is another datum scale fixed across the center of screen.

The reflected image of the illuminated scale is received at right angle to the fixed scale as shown in fig. Thus the changes in angular position of the reflector in

two planes are indicated by changes in the point of intersection of the two scales. One division on the scale is calibrated to read1minute.

Uses of Angle Dekkor

Measuring angle of a component

Angle dekkor is capable of measuring small variations in angular setting i.e. determining angular tilt. Angle dekkor is used in combination with angle gauge. First the angle gauge combination is set up to the nearest known angle of the component.

Now the angle dekkor is set to zero reading on the illuminated scale. The angle gauge build up is then removed and replaced by the component under test.

Usually a straightedge being used to ensure that there is no change in lateral positions. The new position of the reflected scale with respect to the fixed scale gives the angular tilt of the component from the set angle.

Checking the slope angle of a V-block

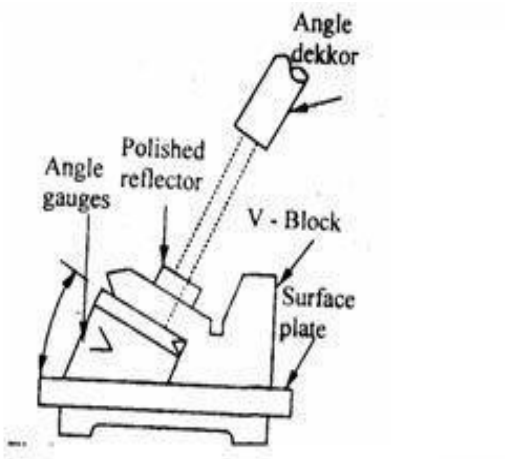


Figure shows the setup for checking the sloping angle of V block. Initially, a polished reflector or slip gauge is attached in close contact with the work surface. By using angle gauge zero reading is obtained in the angle dekkor. Then the angle may be calculated by comparing the reading obtained from the angle dekkor and angle gauge.

To measure the angle of cone or Taper gauge

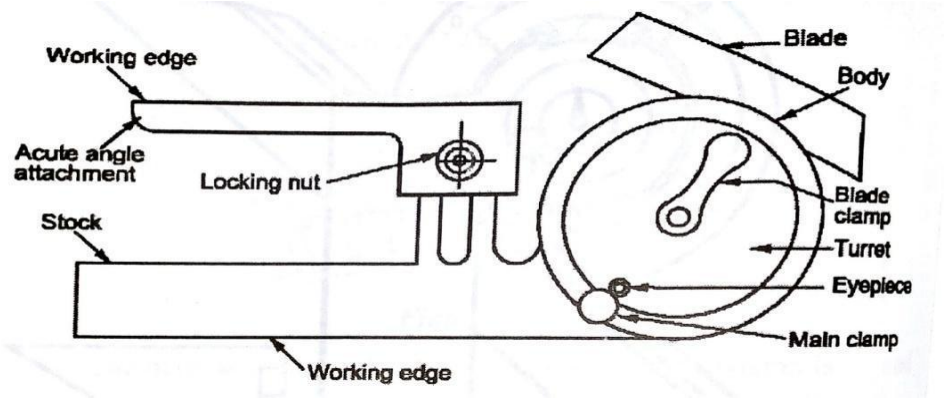
Initially, the angle dekkor is set for the nominal angle of cone by using angle gauge or sine bar. The cone is then placed in position with its base resting on the surface plate. A slip gauge or reflector is attached on the cone since no reflection can be obtained from the curved surface. Any deviation from the set angle will be noted by the angle dekkor in the eye piece and indicated by the shifting of the image of illuminated scale.

OPTICAL BENVEL PROTRACTOR

Working Principle

The value can be measured to an accuracy of 2 min by using this type of bevel protractor .The values are obtained against an index line or vernier by means of an optical magnifying system .The optical magnifying system is attached with the bevel protractor itself.

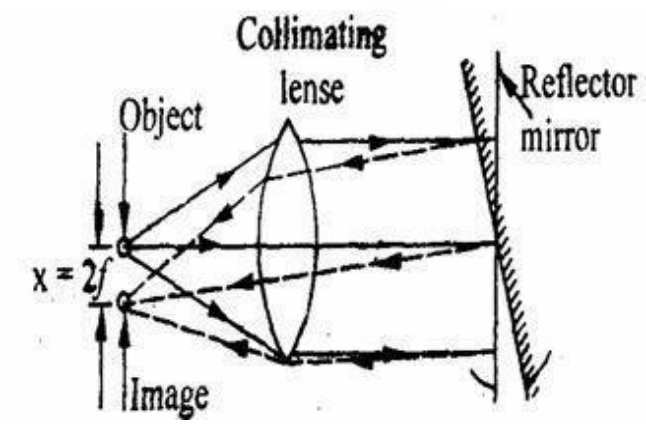
A separate arrangement is provided for adjusting the focus of the system for the normal variation of eye sight .The vernier scale are arranged always in focus of the optical system.



15. Explain the working principle of autocollimator and briefly explain its application. NOV/DEC 2010,(APR/MAY 2017)

AUTO- COLLIMATOR

Auto-collimator is an optical instrument used for the measurement of small angular differences, changes or deflection, plane surface inspection etc. For smallangular measurements, autocollimator provides a very sensitive and accurate approach. An auto-collimator is essentially an infinity telescope and a collimator combined into one instrument.



Basic principle

If a light source is placed in the flows of a collimating lens, it is projected as a parallel beam of light. If this beam is made to strike a plane reflector, kept normal to the optical axis, it is reflected back along its own path and is brought to the same focus. The reflector is tilted through a small angle '0'. Then the parallel beam is deflected twice the angle and is brought to focus in the same plane as the light source.

The distance of focus from the object is given

$$x = 2\theta \, . f$$

Where, f = Focal length of the lens

by θ = Fitted angle of reflecting mirror.

WORKING OF AUTO-COLLIMATOR:

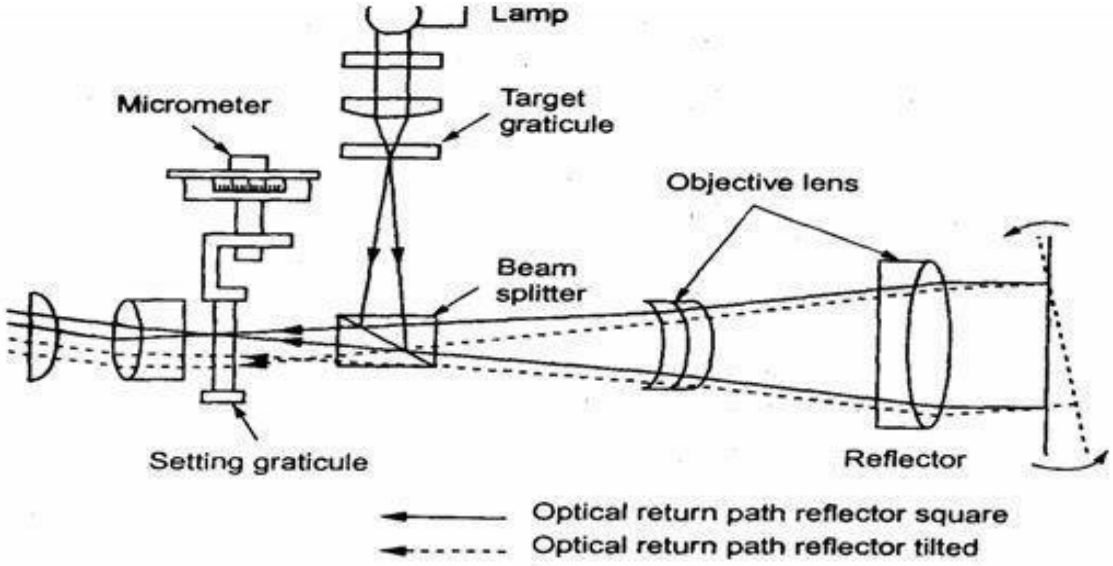
There are three main parts in auto-collimator.

1. Micro meter microscope.

2. Lighting unit and

3. Collimating lens.

Figure shows a line diagram of a modern auto - collimator. A target graticule is positioned perpendicular to the optical axis. When the target graticule is illuminated by a lamp, rays of light diverging from the intersection point reach the objective lens via beam splitter. From objective, the light rays are projected as a parallel rays to the reflector.



A flat reflector placed in front of the objective and exactly normal to the optical axis reflects the parallel rays of light back along their original paths. They are then brought to the target graticule and exactly coincide with its intersection. A portion of the returned light passes through the beam splitter and is visible through the eyepiece. If the reflector is tilted through a smallangle, the reflected beam will be changed its path at twice the angle. It can also be brought to target graticule but linearly displaced from the actual target by the amount 2θxf. Linear displacement of the graticule image in the linear displacement of the graticule image in the plane tilted angle of eye piece is directly proportional to the reflector. This can be measured by optical micrometer. The photo electric auto-collimator is particularly suitable for calibrating polygons, for checking angular indexing and for checking small linear displacements.

APPLICATIONSOFAUTO-COLLIMATOR

Auto-collimators are used for

1) Measuring the difference in height of length standards.

2) Checking the flatness and straightness of surfaces.

3) Checking squareness of two surfaces.

5) Precise angular indexing in conjunction with polygons.Checking alignment or parallelism.

6) Comparative measurement using master angles.

7) Measurement of small linear dimensions.

8) For machine tool adjustment testing.

Part C

1. Explain the working principle of SINE BAR (APR/MAY 2017)

Sine bars are always used along with slip gauges as a device for the measurement of angles very precisely.

They are used to

- Measure angles very accurately.
- Locate the work piece to a given angle with very high precision.

sinebars are made from high carbon, high chromium ,and corrosion resistant steel. These materials are highly hardened, ground and stabilized. Insinebars, two cylinders of equal diameter are attached at lie ends with its axes are mutually parallel toeachother.Theyarealsoatequaldistancefromtheuppersurfaceofthesinebar mostly the distance between the axes of two cylinders is 100mm, 200mm or 300mm.The working surfaces of the rollers are finished to 0.2μmR value. The cylindrical lholes are provided to reduce the weight of the sinebar

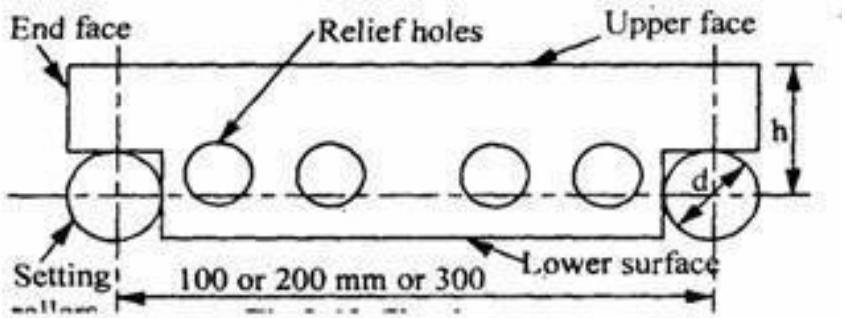


Fig 2.21 Sine Bar

Working principle of sinebar

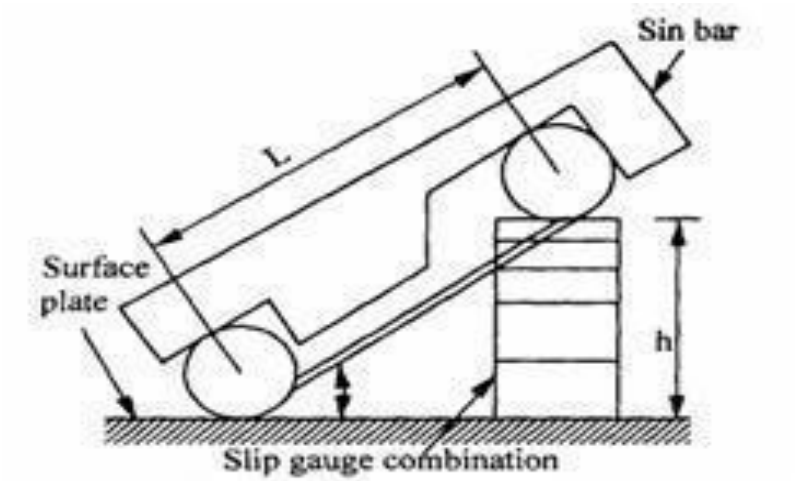


Fig 2.22 Principle of Sine bar

The working o fsinebar is based on**trigonometryprinciple**.Tomeasurethe angle of a given specimen,one roller of the sinebar is placed on the surface plate and another one roller is placed over the surface of slip gauges. Now, 'h' be the height of the slip gauges and 'L' be the distance between roller centers,

$$\text{Sin}\theta = \frac{h}{L}$$

$$\therefore \theta = Sin^{-1}(h/L)$$

UNIT 3

FORM MEASUREMENT

Part-A

1.Mention the purpose of Goniometric heads in tool makers microscope? (May 12)

Goniometric head in tool makers microscope is used to measure circular divisions .for example, the flank angle of the gears may be measured using Tool makers microscope with a goniometric head.

2. What is meant by 'Best size wire' in screw thread measurement?(May 16)

Best size of wire is a wire of such diameter that it makes contact with flanks of the thread on the pitch line.

3. What are the factors affecting surface roughness?(May 16,Nov 16)

(a) Vibration

(b) Material of the work piece

(c)Tool

(d)Machining type.

4.Define degree of fullness and degree of emptiness in form factor.(Dec 13)

Degree of fullness is the ratio of area of metal considered to the area of enveloping the rectangle.

Degree of emptiness is the ratio between the difference of the area of metal considered to the area of enveloping the rectangle and area of enveloping the rectangle.

5. Define straightness of line in two planes?(MAY/JUNE 14)

A line is said to be straight over a given length of the variation of the distance of its points from two planes perpendicular to each other and parallel to the direction of a line remaining within the specified tolerance limits.

6. Define roundness and name the four measurements of roundness?(Dec 14)

It is a surface of the revolution where all surfaces are inserted by any plane perpendicular to a common axis in case of cylinder and cone.

a. Heart square circle

b. Minimum radial separation circle

c. Maximum inscribed circle

d. Minimum circumscribed circle.

7. What is gear run out?(Dec 12)

It means eccentricity in the pitch circle. It will produce periodic vibration during each revolution of the gear. It will give the tooth failure in gears.

8.List the reasons for the occurrence of progressive pitch errors in screw threads?

(Dec 12)

a. In correct linear and angular velocity ratio

b. In correct gear train and lead screw

c. Saddle fault

9. Define Lead?(Dec 13)

It is defined as the distance at which a thread advances for one rotation. Lead=No. of starts ×Pitch

10. Define lead angle?(Dec 13)

It is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

11.What are the various methods used for measuring the gear tooth thickness?(May 14)

a. Gear tooth vernier

b. Constant chord method

c. Base tangent method

d. Measurement over pins.

12.Define constant chord?(May 12)

Constant chord is the chord joining points or opposite faces of the tooth.

13. Define straightness of a line in two planes?(May 14)

A line is said to be straight over a given length of the variation of the distance of its points from two planes perpendicular to each other and parallel to the direction of a line remaining within the specified tolerance limits.

14. Define drunken thread

A condition in which the crest of a thread or threads wavers or is uneven

15. What are the various factors affecting surface roughness of the machined components?

- Vibration of the machine tool
- In proper clamping of work piece
- Over depth of cut /feed rate

16. Is assessment length greater/ lesser than traverse length in surface finish measurement? Why?

The assessment length or evaluation length is the length of data that will be used for analysis. Commonly one sampling length is discarded from each end of the measurement length.

The measurement length is dictated by the numerical value of the cut-off, which itself is dictated by the type of surface inspection.Typically, a measurement may consist of a traverse of 6-7 times the cut-off selected. For example, 7 cut-offs at 0.8mm = 5.6mm. One of two cut-offs will then be removed according to the filter type and the remaining cut-offs used for assessment. This only applies when measuring roughness.

Part-B

1. Explain in detail the various methods used for checking the profile of a spur gear Profile checking.

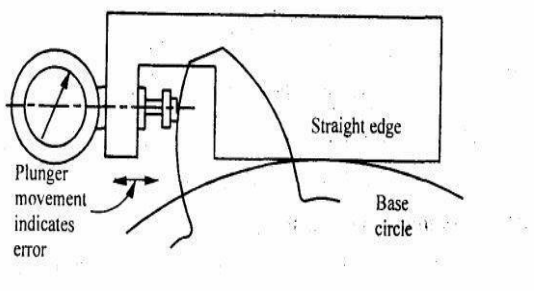
The methods used for profile checking is

- Optical projection method.
- In volute measuring machine.

Optical projection method:

The profile of the gear projected on the screen by optical lens and then projected value is compared with master profile.

In volute measuring machine:



InvoluteMeasuringMachine

In this method the gear is held on a mandrel and circular disc of same diameter as the base circle of gear for the measurement is fixed on the mandrel. After fixing the gear in the mandrel, the straight edge of the instrument is brought in contact with the base circle of the disc. Now, the gear and discare rotated and the edge moves over the disc without sleep. The stylus moves over the tooth profile and the error is indicated on the dial gauge.

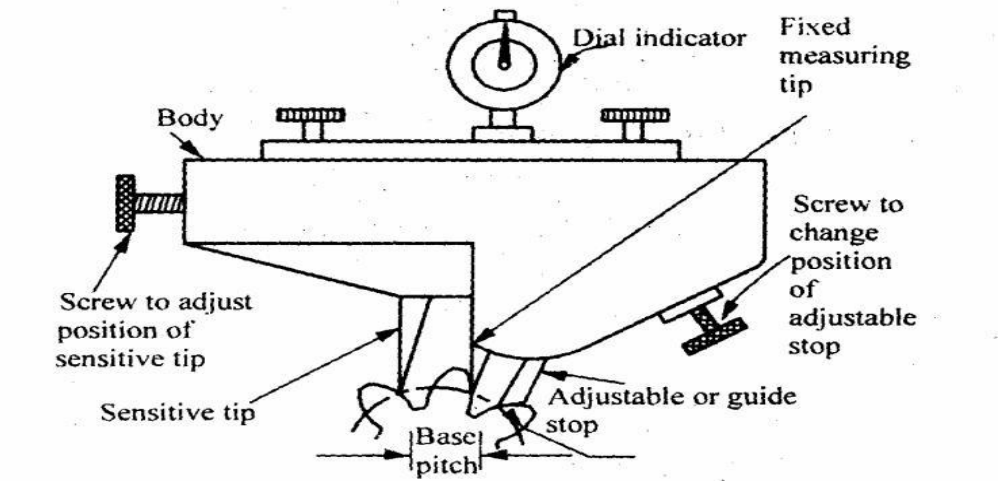
2.Explain in detail the various methods used to measure the pitch of a spur gear

Pitch measurement:

There are two ways for measuring the pitch.

- Point to point measurement (i.e.One tooth point to next toot point)
- Direct angular measurement

Tooth to Tooth measurement



The instrument has three tips. One is fixed measuring tip and the second is sensitive tip, whose position can be adjusted by a screw and the third tip is adjustable or guide stop. The distance between the fixed and sensitive tip is equivalent to base pitch of the gear. All the three tips are contact the tooth by setting the instrument and the reading on the dial indicator is the error in the base pitch.

Direct Angular Measurement

It is the simplest method for measuring the error by using set dial gauge against a tooth. In this method the position of a suitable point on a tooth is measured after the gear has been indexed by a suitable angle. If the gear is not indexed through the angular pitch the reading differs from the original reading. The difference between these is the cumulative pitch error.

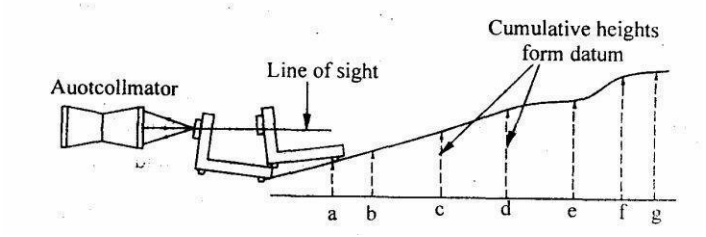
3. Explain how straightness is measured using the following instruments

The straightness of any surface could be determined by either of these instruments by measuring the relative angular positions of number of adjacent sections of the surface to be tested. First straight line is drawn on the surface then it is divided into a number of sections the length of each section being equal to the

length of sprit level base or the plane reflector's base in case of auto collimator. The bases of the spirit level block or reflector are fitted with two feet so that only feet have line contact with the surface and the surface of base does not touch the surface to be tested.

The angular division obtained is between the specified two points. Length of each section must be equal to distance between the center lines of two feet. The special level can be used only for the measurement of straightness of horizontal surfaces while auto-collimator can be used on surfaces are any plane.

In case of spirit level, the block is moved along the line equal to the pitch distance between the center line of the feet and the angular variation of the direction of block. Angular variation can be determined in terms of the difference of height between two points by knowing the least count of level and length of the base.



Straightness using Auto-Collimator

In case of auto collimator the instrument is placed at a distance of 0.5 to 0.75m from the surface to be tested. The parallel beam from the instrument is projected along the length of the surface to be tested. A block fixed on two feet and fitted with a plane vertical reflector is placed on the surface and the reflector face is facing the instrument.

The image of the cross wires of the collimator appears nearer the center of the field and for the complete movement of reflector along the surface straight line the image of cross wires will appear in the field of eyepiece. The reflector is then moved to the other end of the surface in steps equal to. The center distance between the feet and the tilt of the reflector is noted down in second from the eye piece.

4. Explain the following direct methods of surface finish measurements. (NOV/DEC 2015)

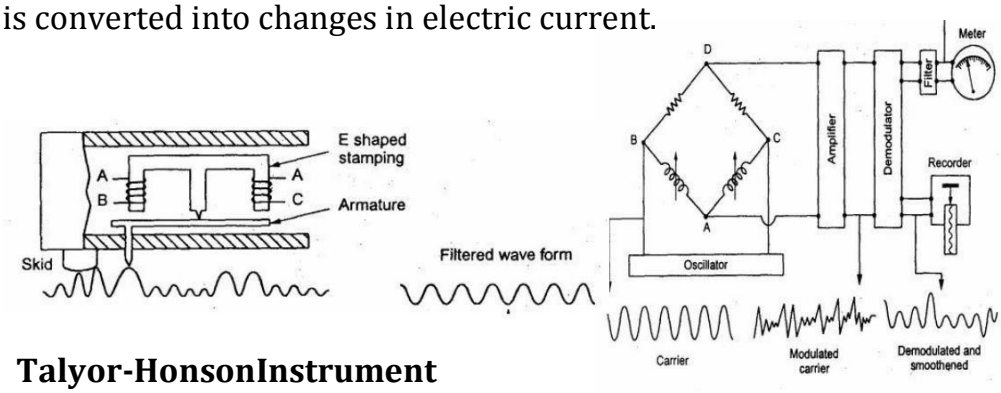
i) Taylor Hobson Talysurf

Talyor-Hobson-Talysurf

It is working a carrier modulating principle and it is an accurate method comparing with the other methods. The main parts of this instrument is diamond stylus (0.002mm radius) and skid

Principle

The irregularities of the surface are traced by the stylus and the movement of the stylus is converted into changes in electric current.



Talyor-HonsonInstrument

Working

On two legs of the E- shaped stamping there are coils for carrying an A.C. current and these coils form an oscillator. As the armature is pivoted about the central leg the movement of the stylus causes the air gap to vary and thus the amplitude is modulated. This modulation is again demodulated for the vertical displacement of the stylus. So this demodulated output is move the pen recorder to produce a numerical record and to make a direct numerical assessment.

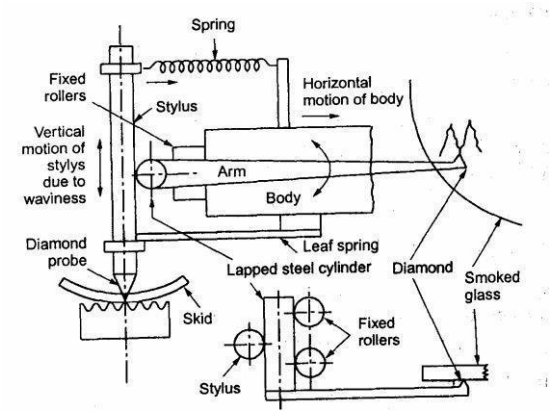
Tomlinson Surface meter

This instrument uses mechanical-cum-optical means for magnification.

Construction

In this the diamond stylus on the surface finish recorder is held by spring pressure against the surface of a lapped cylinder. The lapped cylinder is supported one side by probe and other side by rollers. The stylus is also attached to the body of the instrument by a leaf spring and its height is adjustable to enable the diamond to be positioned and the light spring steel arm is attached to the

lapped cylinder. The spring arm has a diamond scriber at the end and smoked glass is rest on the arm.



Tomlinson Surface meter

Working

When measuring surface finish the body of the instrument is moved across the surface by a screw rotation. The vertical movement of the probe caused by the surface irregularities makes the horizontal lapped cylinder to roll. This rolling of lapped cylinder causes the movement of the arm. So this movement is induces the diamond scriber on smoked glass. Finally the movement of scriber together with horizontal movement produces a trace on the smoked glass plate and this trace is magnified by an optical projector.

5.Explain the tooth thickness measurement for the following methods(APRIL/MAY 2016,2017)(NOV/DEC2016)

Tooth thickness is generally measured at pitch circle and also in most cases the chordal thickness measurement is carried out i.e. the chord joining the intersection of the tooth profile with the pitch circle.

The methods which are used for measuring the gear tooth thickness is

a) Gear tooth vernier caliper method (Chordal thickness method)
b) Base tangent method.
c) Constant chord method.
d) Measurement over pins or balls.

Gear tooth vernier method

In gear tooth vernier method the thickness is measured at the pitch line. Gear tooth thickness varies from the tip of the base circle of the tooth, and the

instrument is capable of measuring the thickness at a specified position on the tooth. The tooth vernier caliper consists of vernier scale and two perpendicular arms. In the two perpendicular arms one arm is used to measure the thickness and other arm is used to measure the depth. Horizontal vernier scale reading gives chordal thickness (W) and vertical vernier scale gives the chordal addendum. Finally the two values compared.

The theoretical values of W and d can be found out by considering one tooth in the gear and it can be verified. In fig noted that w is a chord ADB and tooth thickness is specified by AEB. The distance d is noted and adjusted on instrument and it is slightly greater than addendum CE.

$\therefore$ 'W' is chordal thickness and 'd' is named as chordal addendum.

So, $W = AB = 2AD$

And angle, $AOD = \theta = \frac{360}{4n}$

Where, n = Number of teeth.

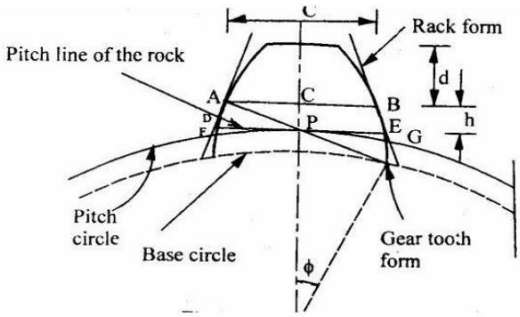
$W = 2AD = 2 \times AO \, Sin\theta$

$= 2R \, Sin \, 360/4n$ .....

Where, R = Pitch circle radius

Module, $m = \frac{P.C.D}{No.\,of\,teeth} = \frac{2R}{n}$

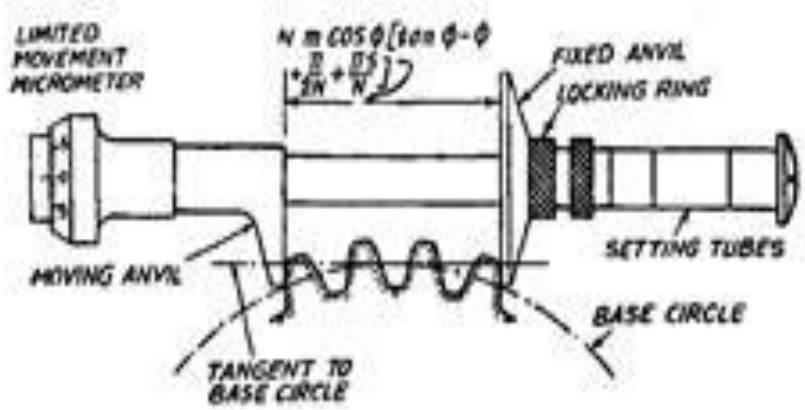
$\therefore R = \frac{nm}{2}$

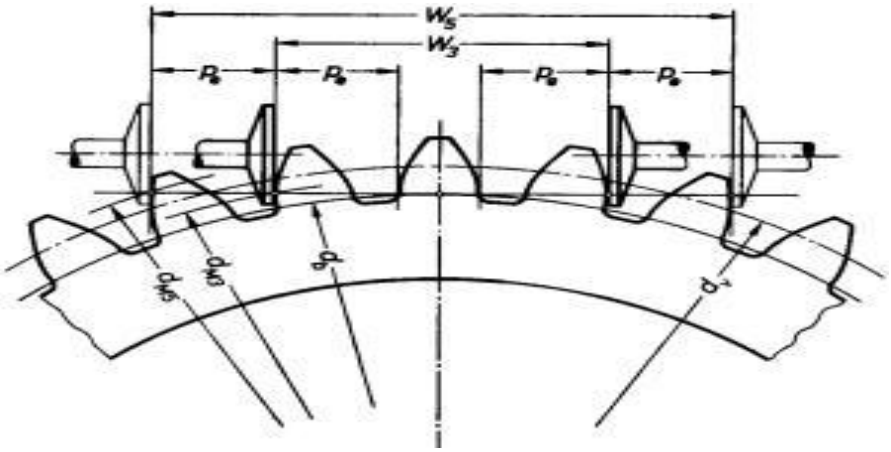


And $OD = R \, Cos\theta = \frac{nm}{2} Cos\left(\frac{90}{n}\right)$

$$\boxed{OD = \frac{nm}{2} Cos\left(\frac{90}{n}\right)}$$

The Base Tangent Method





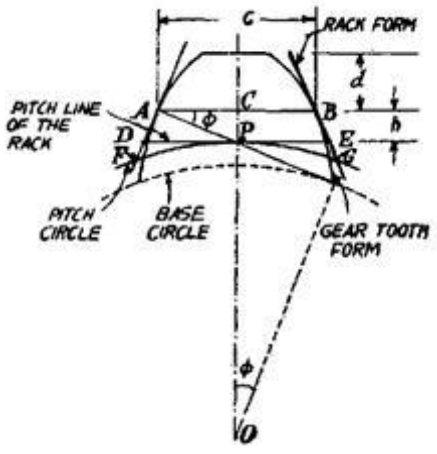
In this method, the span of a convenient number of teeth is measured with the help of the tangent comparator. This uses a single verniercalliper and has, therefore, the following advantages over gear tooth vernier which used two vernierscales

(i) The measurements do not depend on two vernier readings, each being functionoftheother.

(ii) The measurement is not made with an edge of the measuring jaw with the face. Consider a straight generator (edge) ABC being rolled back and forth along a base circle.

Thus the measurements made across these opposed involutes by span gauging will be constant and equal to the arc length of the base circle between the origins of involutes. The value of the distance between two opposed involutes, or the dimension over parallel faces is equal to the distance round the base circle between the points where the corresponding tooth flanks

Constant chord method



. Constant chord of a gear is measured where the tooth flanks touch the flanks of the basic rack. The teeth of the rack are straight and inclined to their centre lines at the pressure angle Also the pitch line of the rack is tangential to the pitch circle of the gear, the tooth thickness of the rack along this line is equal to the arc tooth thickness of the gear round its pitch circle. Now, since the gear tooth and rack space are in contact in the symmetrical position at the points of contact of the flanks, the chord is constant at this position irrespective of the gear of the system in mesh with the rack.

Part C

6. Explain the following methods to measure the major, minor and effective diameter of a screw 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

Measurement of major diameter:

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

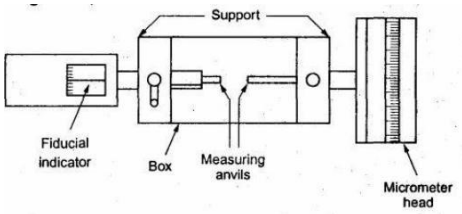
- Ordinary micrometer
- Bench micrometer.

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 0.002 mm. 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.



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.

BenchMicrometer

$\therefore$ 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

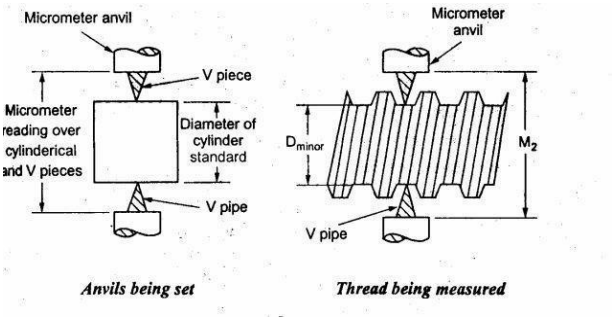
R_1 = Micrometer reading on setting cylinder.

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,

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.



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.

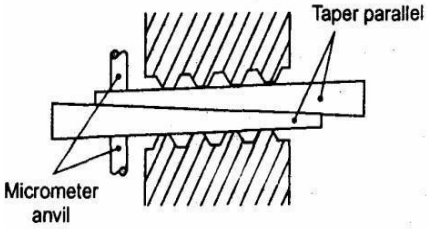
Measurement of Minor diameter of Internal threads

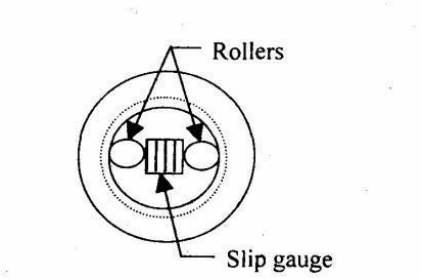
The Minor diameter of Internal threads are measured by

- Using taper parallels
- Using Rollers.

Using taper parallels

For diameters less than 200 mm the use of Taper parallels and micro meter is very common. The taper parallels are pairs of wedges having reduced and parallel outer edges. The diameter across their outer edges can be changed by sliding them over each other





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.

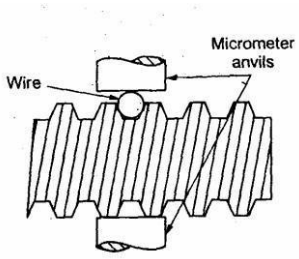
Measurement of effective diameter

Effective diameter measurement is carried out by following methods.

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

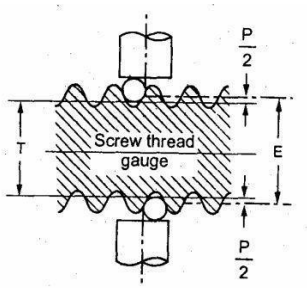
One wire method

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.



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 micro meter reading is taken and let it be R. Then the standard is replaced by the screw thread to be measured and the new reading



7. **Explain the various methods by which roundness is measured.(NOV/DEC2014,2016)**

Roundness is defined as a condition of a surface of revolution. Where all points of the surface intersected by any plane perpendicular to a common axis in case of cylinder and cone.

Devices used for measurement of roundness

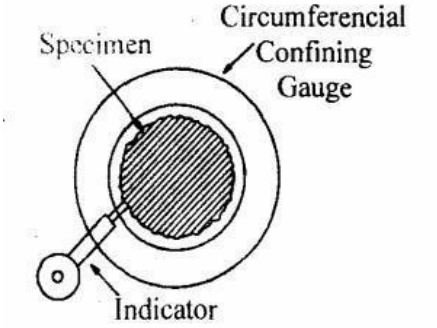
1) Diametral gauge.
2) Circumferential conferring gauge
3) Rotating on center
4) V-Block
5) Three-point probe.
6) Accurate spindle.

Diametral method

The measuring plungers are located 180° apart and the diameter is measured at several places. This method is suitable only when the specimen is elliptical or has an even number of lobes. Diametral check does not necessarily disclose effective size or roundness. This method is un reliable in determining roundness.

Circumferential confining gauge

Fig. shows the principle of this method. It is useful for inspection of roundness in production. This method requires highly accurate master for each size part to be measured. The clearance between part and gauge is critical to reliability. This technique does not allow for the measurement of other related geometric characteristics, such as concentricity, flatness of shoulders etc.



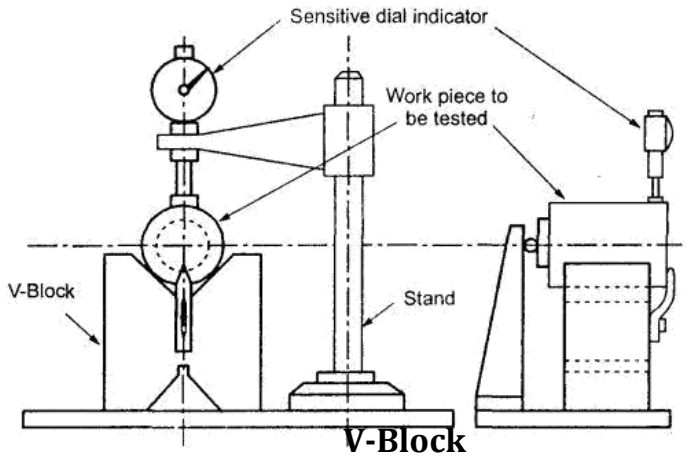
Confining Gauge

Rotating on centers

The shaft is inspected for roundness while mounted on center. In this case, reliability is dependent on many factors like angle of centers, alignment of centres, roundness and surface condition of the centres and centre holes and run out of piece. Out of straightness of the part will cause a doubling run out effect and appear to be roundness error.

V-Block

The set up employed for assessing the circularity error by using V Block is shown in fig. The V block is placed on surface plate and the work to be checked is placed up on it. A diameter indicator is fixed in a standand its feeler made to rest against the surface of the work.



V-Block

The work is rotated to measure the rise on fall of the work piece. For determining the number of lobes on the work piece, the work piece is first tested in a 60°V-Block and then in a 90° V-Block. The number of lobes is then equal to the number of times the indicator pointer deflects through 360° rotation of the work piece.

Limitations

- The circularity error is greatly by affected by the following factors.
- If the circularity error is i\e, then it is possible that the indicator shows no variation.

- Position of the instrument i.e. whether measured from top or bottom.
- Number of lobes on the rotating part.
- The instrument position should be in the same vertical plane as the point of contact of the part with the V-block.

- A leaf spring should always be kept below the indicator plunger and the surface of the part.

Three point probe

The fig. shows three probes with 120° spacing is very, useful for determining effective size they perform like a 60° V-block. 60° V-block will shown o error for 5 a 7 lobes magnify the error for 3 -lobed parts show partial error for randomly spaced lobes.