Linear and angular measurement

1. Introduction :-

Linear measurement applied to measurement of length, diameter, height and thickness includes external and internal measurement.

The dimension to be measured is aligned with the graduation of the scale. Linear measuring instrument are designed either for line (or) end measurment.

2. Classification of the instruments :-

The instruments used for the linear measurement are classified as

1. Direct — Graduated / Non graduated
2. Indirect

The graduated instrument includes rules, Vernier caliper, height gauge, depth gauge micrometers, dial gauge etc.

The Non graduated instruments includes Telescopic gauge, surface gauge, wire gauge etc.

They are also classified as,

a) Precision instrument (vernier, dial Gau

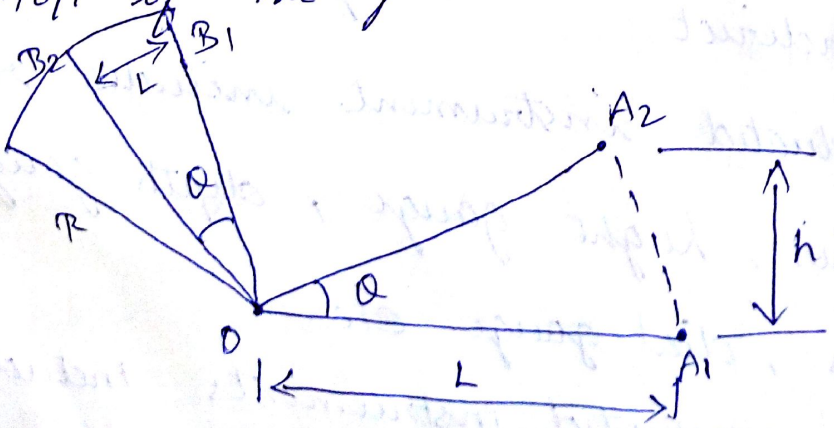
b) Non Precision instrument (steel rule)

3. Spirit level:-

Spirit level are used for

1. Measuring small angle (or) inclination
2. To determine the position of surface
3. To establish a horizontal datum.

The spirit level consist of a sealed glass tube mounted on a base. The inside surface of the tube is ground to a convex barrel shape having large radius. The precision of the level depend on the accuracy of this radius of the tube. A scale is engraved on the top of the glass tube.



The tube is nearly filled with either (or) alcohol except a small bubble of vapour in the form of a bubble.

Principle:-

The bubble always tries to remains at the highest point of the tube. If the base of the spirit level is horizontal, the centre point is the highest point of the tube.

If the base of the level is tilted through a small angle, the bubble will move relative to the tube, a distance along its radius corresponding to the angle. (OA_1 & OA_2) are two position of the base of the level. (B_1 & B_2) are the bubble positions.

Let l be the distance travelled by the bubble along the tube and "h" the difference in height between the end of the base,

$l = R\theta$ and $h = L\theta$

$\theta = l/R = h/L$

$R \rightarrow$ Radius of curvature

$L \rightarrow$ Length of base

4. Sine bar:-

Sine bar is a precision inst
used along with slip gauge for mea
of angle. Sine bar is used to measu
the angle very accurately and it
used to locate the work to a gi
angle with in very close limits.

It consist of a steel bar a
two roller. The sine bar is made
high carbon and high chromium
corrosion resistant steel, suitable hardn
The roller are of accurate and eq
diameter. They are attached to bar
at two end. The axis of the
roller is 100 mm, 200 mm (or) 300 mm

When the roller are brought
in contact with a flat surface, the
top of the bar is parallel to the
surface. The various parts are harden
and stabilized before grinding and
lapping.

Sine bar are graded as A Grade (or) B grade sine bar. A grade sine bar are made with an accuracy of 0.01 mm/m of length and B grade sine bar with an accuracy of 0.02 mm/m of length

Type of Sine bar:-

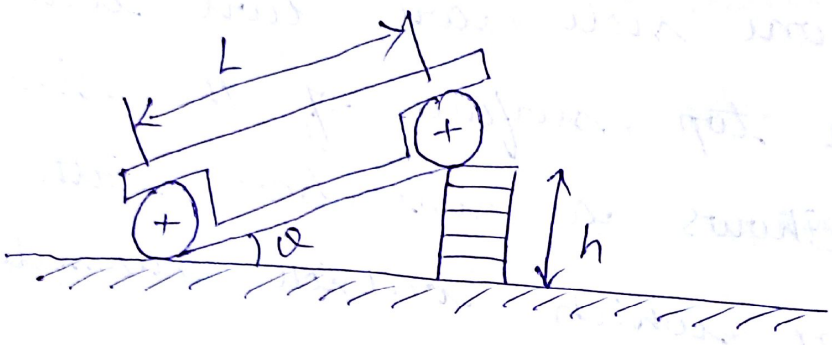
a) Form in which the roller are so arranged that their outer surface on one side are level with the plane top surface of the sine bar.

b) Shows a sine bar with hollow roller which outside diameter equal to the width of sine bar. It is useful in instance where the width of the inter into calculate of work hight

c) Shows a sine bar with pins on both side. This is used where the ordinary sine bar cannot be used on the top surface due to interruption.

Principle of sine bar:-

The principle of operation of sine bar is based on the laws of trigonometry. To set a given angle, one roller of the bar is placed on the surface plate and the combination of slip gauge is inserted under the second roller.



h → Height

L → Distance b/w roller

$$\sin\theta = \frac{h}{L} \quad (or) \quad \theta = \sin^{-1}\left(\frac{h}{L}\right)$$

Thus the angle to be measured or to be set is determined by indirect method as a function of sine for this reason, the device is called "sine bar".

Angle Gauge:-

The Angle gauge enable any angle to be set to the nearest 3". These are pairs of hardened and stainless steel. The measuring faces are lapping and polished to a high degree of accuracy and flatness.

They are 75 mm long and 15mm wide and are available in two sets. One set consists of 12 pairs and a square block in three series of value of angle.

1°, 3°, 9°, 27° and 41°

1', 3', 9' and 27'

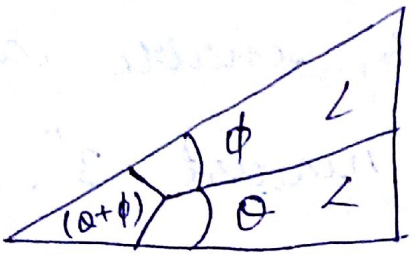
6', 8", and 30"

Another set contain 13 pairs

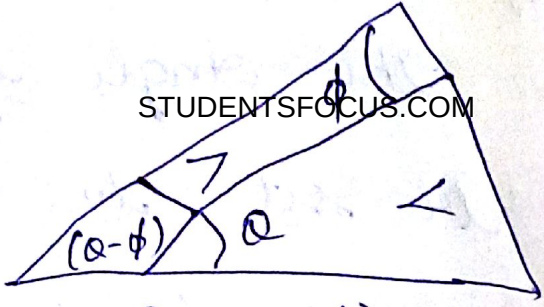
1°, 3°, 9°, 27° and 41°

1', 3', 9' and 27'

3", 6", 13" and 30"



Addition



Substraction

Each angle gauge is accurate to which one second and is marked with engraved "V" which indicate the direction of indicated angle.

These gauge together with a square block can be so wrong that any angle between 0° to 360° can be set.

Each angle gauge is a wedge thus two gauge with their narrow ends together provide an angle which is the sum of the angle of the individual gauges. Subtraction of angle is obtained when the narrow end are opposed.

Clinometer :-

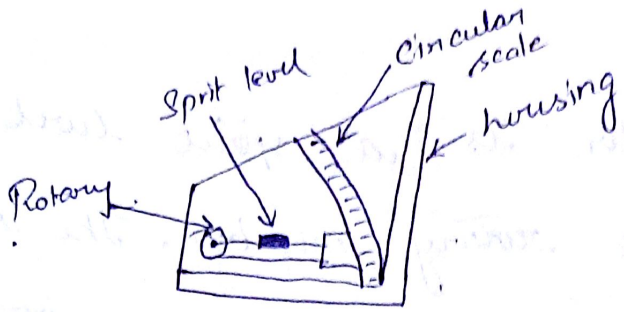
A Clinometer is a spirit level mounted on a rotary member. The angle of inclination of the rotary member relative to its base can be measured by circular scale.

Types of clinometer

1. Vernier
2. Micrometer
3. Dial
4. Optical

Vernier Clinometer :-

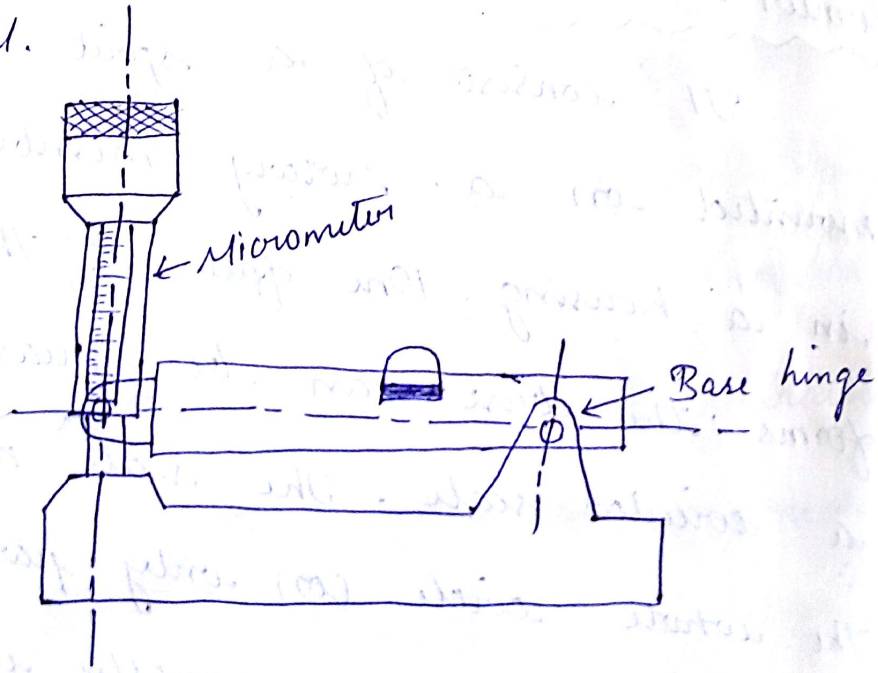
It consist of a spirit level mounted on a rotary member carried in a housing. One face of the housing forms the base can be measured by a circular scale. The scale may cover the whole circle (or) only part of it. Clinometer are generally used to determined the angle included between two adjacent face of a workpieces.



$$\alpha = 180 - (\theta - \phi)$$

Micrometer clinometer :-

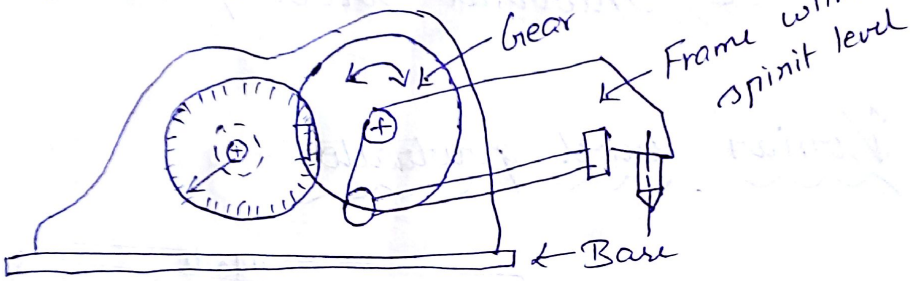
In this type spirit level is attached at one end of the beam of a micrometer. The other end of the spirit level is hinged on the base. The base is placed on the surface whose inclined is to be measured.



The micrometer is adjusted till the level is horizontal. This type of clinometer is used for measuring small angle.

Dial clinometer :-

The dial clinometer is similar in principle to the bird protractor. The spirit level is attached in a gear and a dial gauge. The whole angle can be observed through an opening in the dial on the circular scale on the gear and the fraction of the angle can be read on the dial gauge.



Optical Clinometer :-

It consist of rotatable turret which is mounted on a base. Spirit level is provided in the turret. The reading are taken by measuring microscope on a graduated scale provided on a fixed circular glass disc concentric with the turret. (1' can be measured.)

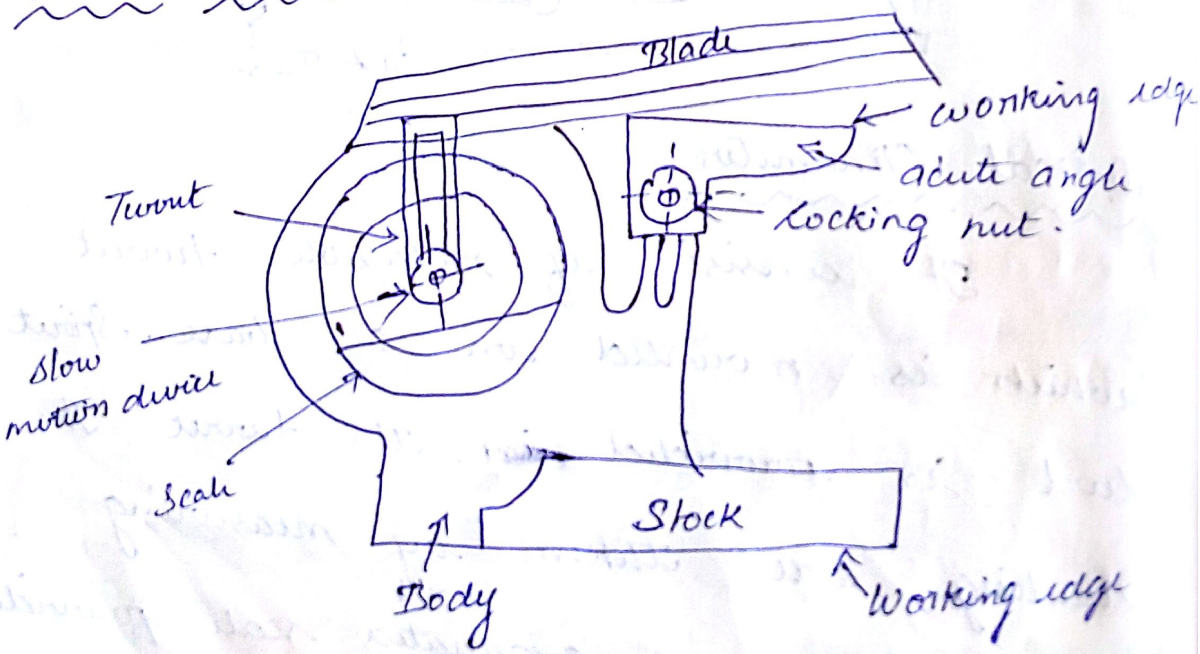
7. Angular Measurements:

To obtain these for high precision work, use is made of sine bar, angle gauge and optical instrument. The spirit level and the dividing head are also employed.

8. Bevel Protector:-

a) Vernier bevel protractor
b) Optical bevel protractor
c) Universal bevel protractor

Vernier bevel protractor:-



The bevel protractor are used to find the flatness, squareness, parallelism, etc

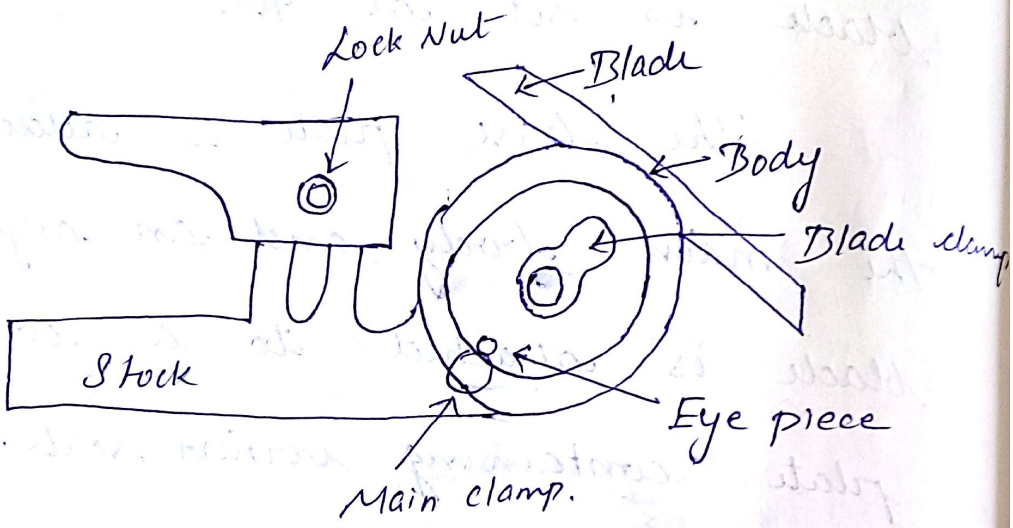
The Vernier bevel protractor with acute angle attachement. The body of V bevel protractor is designed is such a way that is back is flat and there are no projections beyond its back The features of the body is tested by checking the squarness of blade with respect to base plate when the blade is set at 90°.

The base plate is attached to the main body and an adjustable blade is attached to a circular plate containing vernier scale. The main scale graduated in degree is provided on the main scale.

The blade can be moved along throughout its length and can also be reversed. It is about 150 (or) 300 m long, 13mm wide and 2 mm thick. Its ends are bevelled at an angle of 45° and 60°.

Optical bevel protractor:-

Optical bevel protractor is a recent development of the vernier bevel protractor. By using this instrument it is possible to take reading upto approximately 2 mins of an arc. The internal circular scale is graduated in division of 10 mins of arc.



Reading are taken against a fixed index line (or) Vernier by means of optical magnifying system which is integral with the instrument.

The scale is graduated as a full circle marked 0-90-0-90. The zero position corresponding to the condition, when the blade is parallel to stroke.

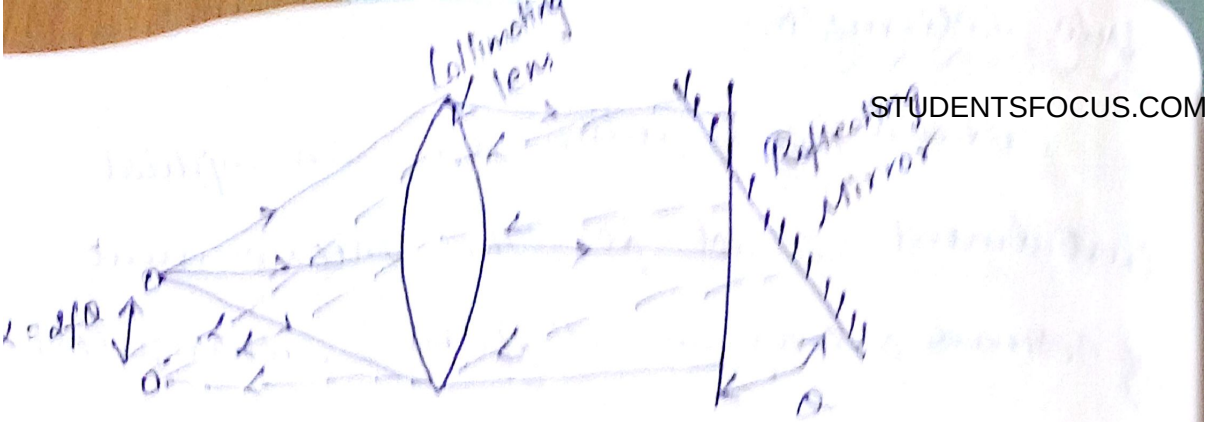
Auto collimator:-

Auto collimator is an optical instrument used for the measurement of small angular deflection, changes (or) deflection, plane surface inspection etc.

Principle:-

If a light source is placed in the focus 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 optical axis, it is reflected back along its own path and its brought to the same focus. If the reflection is tilted to the small angle θ the parallel beam is deflected twice that angle and is brought to a focus in the same plane as the light source, but a one side at a distance $x = 2f\theta$

where, f = focus length of lens
θ = Angle of inclination (Reflecting Mirror)



The image seen after reflection in the external reflector whose angular variation are being measured formed by the light from the objective lens. This light passes through the beam splitter and the image is picked up by the microscope

Application :-

1. Measurement of straightness and flatness of surface
2. Precise angular indexing
3. Comparative measuring using master angle.
4. Assessment of squareness, & II^{el}
5. Small linear dimension measuring
6. Machine tool adjustment setting

Limit gauge:-

The main requirement of any interchangeability in the manufacturing component is to attain the close achieved value.

Types:-

Plug gauge

Ring gauge

Snap gauge

Position gauge

Application:-

→ Thread gauge

→ Form gauge

→ Screw Pitch gauge

→ Feeler gauge

→ Air gauge

→ Indicating gauge.

Device used for linear measurements

1. Vernier
2. Micrometer
3. Slip gauge
4. Comparators

Vernier caliper:-

→ Main scale
→ Vernier scale

Principle:-

Two scale of different size are used to measure dimension in high accuracy.

Steps:-

→ Check for zero error
→ Fine adjustment of movable jaw
→ Both jaw should touch the part
→ Final adjustment depend on experience

Type:-

1. Type A
2. Type B
3. Type C

Micrometer:-

1. Has an accurate screw
2. 10 to 40 threads
3. End of screw act as measuring tip
4. While measuring diminution the lock nut is secured.

Parts:-

→ Frame, Anvil, spindle, Ratchet, adjustment nut.