DRONACHARYA
GROUP OF INSTITUTIONS

LABORATORY MANUAL

MEASUREMENT & METROLOGY LAB

SUBJECT CODE: KME-751

B.TECH. (ME) SEMESTER -VII

Academic Session: 2023-24, ODD Semester

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List of Experiments mapped with COs

S. No	Aim of the Experiment	COs
1.	Measurement of effective diameter of a screw thread using 3 wire method.	CO1
2.	Measurement of angle using sine bar & slip gauges.	CO4
3.	Study of limit gauges.	CO1
4.	Study & angular measurement using Bevel protector.	CO2
5.	Study of different types of Comparators.	CO3
6.	Study of important parameters of surface finish.	CO3
7.	Study of principle and operation of coordinate-measuring machine (CMM).	CO4
8.	Use of dial indicator and V Block to check the circularity and plot the polar Graph.	CO5
9.	Study and understanding of limits, fits & tolerances in assembly of machine components.	CO2
10.	Study and understanding of different methods of measurement of pressure.	
11.	Study and understanding of different methods of measurement of	

	temperature.	
12.	Study and understanding of measurement of strain using strain gauges.	
13.	Study and understanding of different methods of measurement of flow.	
14.	Study and understanding of different methods of measurement of vibration/power.	
15.	Study and understanding of measurement of displacement using LVDT.	

EXPERIMENT NO: - 01

Aim: - Linear Measurement Using Vernier Gauge & Micrometer

Apparatus :- Vernier Caliper, Micrometer. And Measuring Parts

Vernier Gauge

This is just as vernier caliper, equipped with special base block and other attachment which make the instrument suitable for height measurements. Along with the sliding jaw assembly, arrangement is provided to carry a removable clamp. The upper and lower surfaces of the measuring jaws are parallel to the base, so that it can be used for measurements over or under surface. The vernier height gauge is mainly used in the inspection of parts and work. With a scribing attachment in place of measuring part, this can be used to scribe lines at certain distance above the surface. However dial indicator can also be attached in the clamp and many useful measurements made as it exactly gives indication when dial tip just touching surface. For all these measurement, use of surface plate as datum surface is very essential.

PROCEDURE-

1. Take the material (sample) for which the value must be measured.
2. Check the vernier and main scale must coincide at 0
3. After checking the 0 mark put the sample piece and slowly leaves the measuring jaw over the piece
4. Tight the screw and measure the main scale also vernier scale reading
5. The line coincide with the main scale that the VSR
6. By adding MSR with VSR*L

OBSERVATION TABLE FOR VERNIER GAUGE

Sr No	MSR	VSR	LC	TSR
1				
2				
3				

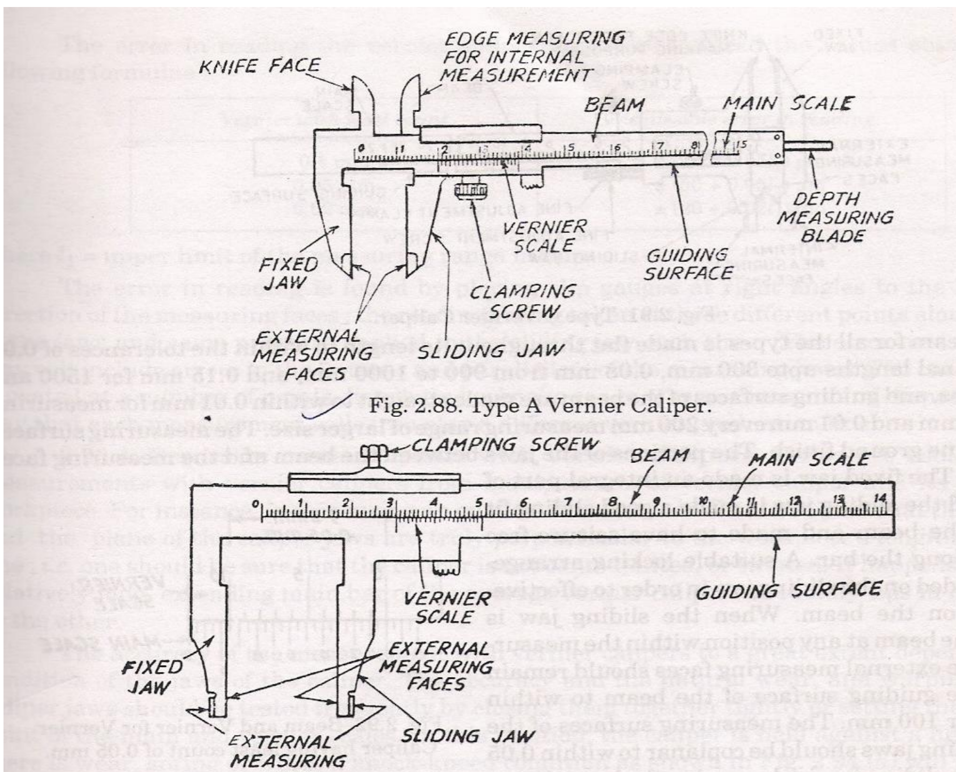


Fig. 01: Vernier Calipers

MICROMETER

The end of the screw forms one measuring tip and the other measuring tip is constituted by a stationary anvil in the base of the frame. The screw is threaded for certain length and is plan afterwards. The plain portion is called sleeve and its end is the measuring surface. The spindle is advanced by turning thimble connected to the spindle. The spindle is aside fit over the barre land barrel is the fixed part attached with frame. The barrel is graduated in unit of 0.05cm.i.e.20division per cm, which is the lead of the screw for one complete revolution. The thimble has got 25 divisions around its periphery on circular portion. Thus it sub-divides each revolution of the screw in 25 equal parts; i.e.each division corresponds to 0.002cm.

PROCEDURE

1. The whole movable jaw assembly is adjusted so that the two measuring tip just touch two parts to be measured.
2. Then lock nut is tightened.
3. Final adjustment depending upon the sense of correct feel is made by the adjusting screw.
4. Measuer the main scale readings i.e. the line coincide with o mark of vernier scale and noted down the reading.
5. The measuring tip is so designed as to measure inside as well as outside dimension.
6. Calculate MSR, VSR and TSR

OBSERVATION TABLE FOR SCREW GAUGE

Sr No	MSR	VSR	LC	TSR
1				
2				
3				

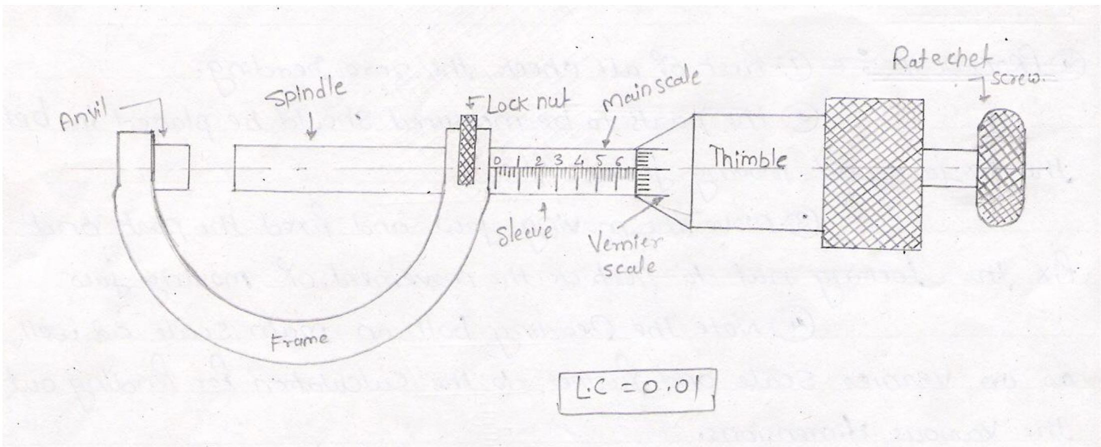


Fig.2: Micrometer

EXPERIMENT NO 2

Aim: – Angular measurement is using Sine Bar.

Apparatus: – Sine Bar and Measuring Parts.

Theory

SINE BAR

The sine principle uses the ratio of the length of two sides of a right triangle in deriving a given angle. It may be noted that devices operating on sine principal are capable of self generation. The measurement is usually limited to 45 degree from loss of accuracy point of view. The accuracy with which the sine principle can be put to use is dependent in practice, on some from linear measurement. The sine bar itself is not complete measuring instrument. Another datum such as surface plate is needed, as well as other auxiliary instrument, notably slip gauge, and indicating device to make measurements.

Checking of Unknown Angles: - Many a times, angle of component to be checked is unknown. In such a case it is necessary to first find the angle approximately with the help of a sin bar. Let the angle θ. The sine bar is set at an angle θ and clamped to an angle plate. Next the work is placed on sine bar and clamped to angle plate. Slip –gauges are so arranged (according to deviation) that the sprit level is at center (the air bubble)

If the deviation is noted down by the spirit level is h over a length 'l' of work, then height of slip gauges by which it should be adjusted is equal to = h 1

Precaution in Sine Bars:-

(a) A Compound angle should not be formed by miss dignity of w/p with the sine bar.

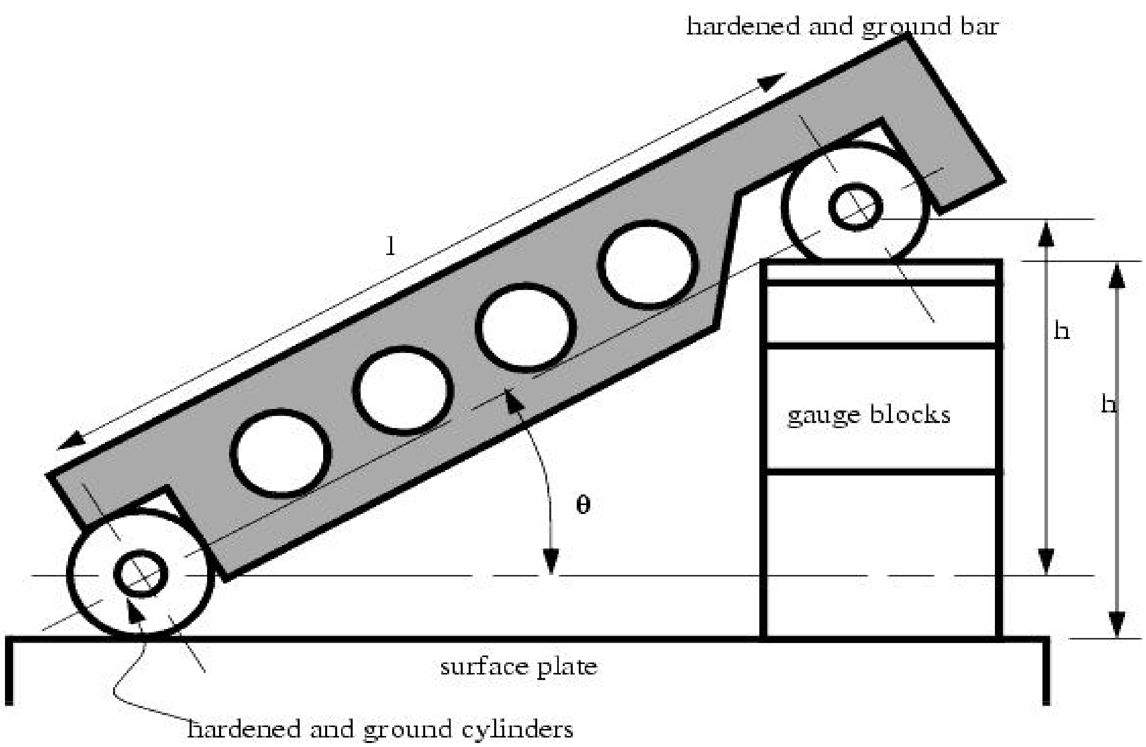
This can be avoided by attaching the sine brand work against an angle plate.

(b) Accuracy of sine bar should be ensured.

(c) As far as possible longer sine bar should be used since4 many errors are reduced by using longer sine bar.

Result:-

To perform angular measurement using sine bare with slip gauge.



l = distance between centres of ground cylinders (typically 5" or 10")
h = height of the gauge blocks
θ = the angle of the plate

$$\theta = \operatorname{asin}\left(\frac{h}{l}\right)$$

Fig.3: Sin Bar

EXPERIMENT NO 3

Aim: – Angular measurement is using Bevel Protractor.

Apparatus: – Bevel Protector and Measuring Part

BEVEL PROTECTOR

It is use for measuring &lying out of angles accurately and precisely within 5 minutes. The protector dial is slotted to hold a blade which can be rotated with dial to the required angle and also independently adjusted to any desired length. The blade can be locked in any position.

Checking of Unknown Angles: – Many a times, angle of component to be checked is unknown. In such a case it is necessary to first find the angle approximately with the help of a bevel protractor which is set at any angle and clamped to an angle plate. Next the work is placed on sine bar and clamped to Angle plate as shown Slip –gauges are so arranged (according to deviation) that the sprit level is at center (the air bubble)
If the deviation is noted down by the spirit level is h over a length 'l' of work , then height of slip gauges by which it should be adjusted is equal to = h 1

Precaution in Bevel Protector:-

1. Angle of instrument must coincide with the angular scale
2. Gripped the instrument to the measuring face exactly
3. A Compound angle should not be formed by miss dignity of w/p with the Bevel Protector.

This can be avoided by attaching the brand work against an angle plate.

4. Accuracy of Bevel Protector should be ensured.

5. As far as possible longer *Bevel Protector* should be used since many errors are reduced by using longer *Bevel Protector* then taken in the similar manner on the second face of work piece. The included angle between the faces is then the difference between the two readings

Result:-

To perform angular measurement using bevel protractor is successfully completed.

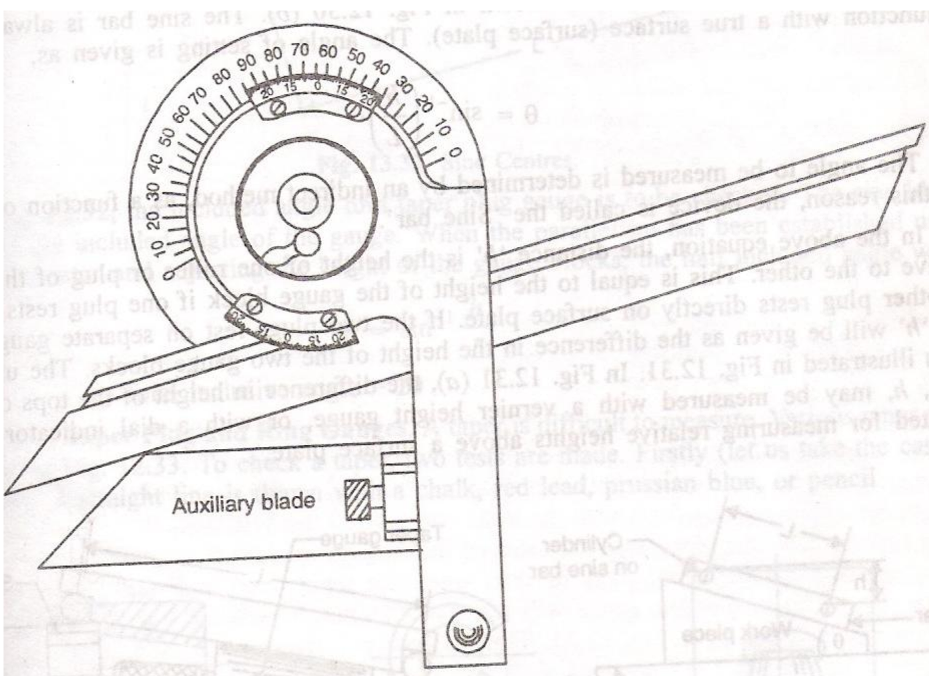


Fig.4: Bevel Protector

EXPERIMENT NO: - 04

AIM: – Measurement of Screw Thread Diameter Using the Floating flat form measuring machine.

Apparatus: – Floating platform device screwed or threaded specimen.

FLOAING CARRIAGE MEASURING MACHINE:

Measuring machine consists of three main units. First base casting carries a pair of centers on which a threaded work piece is mounted. Another carriage called as lower late is mounted on base which is exactly at 90 degree to base but capable of moving parallel with the axis of thread. On this lower slide is provided with another. Carriage called as top slide and capable of moving towards the center (i.e. 90 degree to the thread axis) on the one and f top slide there is one head having a large thimble inability to read up to 0.002 mm and on the other and just opposite to it is a fixed anvil which is spring loaded and its zero position is indicated dry dial indicator. On this top slide two supports one provides for supporting were and viz pieces for measurement of minor dial and effect diameter.

WORKING:-

Place the standard cylinder (gauge) whose diameter is approximately equal or nearer to the major diameter of extend thread which can be adjust between two center of fixed carriage or base.

The distance between centers can be adjust with the help of jigs provide. After this move the lower Slide parallel to axis of cylinder so as take the leadings at correct position. Now stop moving lower slide and operate the thimble of micrometer by engaging viz pieces over flat anvils to get a constant reading of financial indicates of top slide. When you see that indicate is set a fixed-point note down the reading (h) of micrometer. Take the reading for the standard gauge of fixed dimension which will be indicated as R1.

R1 = M.S.R. + (VSR 1 * L.C 1) + (VSR2 * LC2) ------------------ [1]

Replace the standard cylinder with threaded work piece and repeat the same procedure and see to it that the fiducially indicator is showing the same reading as it was in earlier case. If it is so stop moving the thimble considering constant pressure is applied in both the case. Note down the reading.

R2 = M.S.R. + (VSR1 * L.C 1) + (VSR2 * LC2) ------------------ [2]

Major diameter = D + (R2-R1) if R2 > R1

= D - (R1-R2) if R2 < R1

Where D is dial of setting standard cylinder. Same procedure is again repeated by inserting wire of given diameter in the consecutive threads of the given job by keeping the entire dial indicator setting as constant and take that reading as R3.

R3 = M.S.R. + (VSR1 * L.C.1) + (VSR2 * LC2) -------------- [3]

Let M is the diameter with wire then.

M = 25 - (R3 - R1) if R3 > R1 -------------------------------- [4]

= 25 + (R1 - R3) if R3 < R1 -------------------------------- [5]

Floating carriage micrometer is the best method to determine the affective diameter of up to four decimal place. This method is divided into two types according to no. Of wires:-

1) Two wire method

2) Three wire method

For, two wire method the wire diameter'd' and content pitch are calculated as

BM = 1/2 BC = 1/2 {p/2} = p/4

Let, M = distance over wire

E = effective diameter

D = diameter of wire

X = angle of threads

P = pitch of threads

T = dimension under wire = M - 2 D

Sin x/2 = OE/OP = D/2/OP

OP=D/2 * 1/SIN X/2 = D/2 cosec X/2---------------------- [3]

PA = OP - DA= d/2 cosec x/2-d/2= d/2 {cosec x/2-1}V PQC,Cot x/2 = PQ/QCPQ = QC*

COT x/2AQ = PQ – PA =QC Cot x/2 - d/2 (cosec x/2 -1) =1/2 PP =2 AQ =2[QC Cot x2 -d2 (Cosec x/2-1)]=2[P/4 Cot x/2 - d/2 (cosec x/2 - 1)] P = [P/2 COST X/2 - D/2 Cosec (x/2-1)]

X---:- valor of thread angle

For with ward thread value of angle x = 55

P = [p/2 cot 55/2 - d cosec (55/2 - 1)] pitch = 1.5 mm,

P = 0.9605 P - 1.1657 d ------------- [4]

For matrix thread X = 60

P = 0.866 p - 1.031 ------------- [5]

For effective dial (E)

E = T+P

= (M - 2D) + eq 4 or eq 5

E = Effective dia of wire

T = dia under wire

P = Const from equation 4 or 5

T = M - 2D

M = dia with wire

RESULT: – thus screw thread diameter were calculated using floating platform diameter

Measuring machine is 23.324 mm

PRECAUTION: –

1) Do not over tighten the anvil
2) Move vernier screw gently.
3) Do not over tighten the specimen to prevent its damage.

EXPERIMENT NO - 5

Aim: - *Study of* Linear Measurement Using Dial Indicator.

Apparatus: - Dial Gauge Indicator.

Theory:-

The different component of dial gauge indicator. It consists of plunger, removable contact pt, stem a transparent glass cover, calibrated dial pointer, bezel camp or bezel locking nut.

Revolution counter in order to counter in order to count the no of revolution of a pointer, dust proof cap etc. It consists of a plunger which slides in bearing and carries a rack with it. The rack is meshed with pinion (P1) again pinion (P2) and gear (G2) are on same spindle [because of which magnification is taking place]. The gear (G1) is meshed with (P1) again pinion (P2) and gear (G2) are on spindle basically gear (G2) is meshed with pinion (P3) on whose spindle pointer is attached. The pinion (P3) is meshed with gear (G3) on which a light is here spring is attached in order to guide the movement of plunger a rack guide is provided and to bring the plunger to its initial position a light coil spring is attached to plunger. Any linear displacement given causes rack to move upward during this upward movement as rack is meshed with pinion (P1) and gear (G1) rotate by some amount but as the no of teeth on gear (G1) is more compared to that of pinion (P2) which is meshed with it rotate more time. Let us say if there is 100 teeth on gear G1 and 10 teeth on pinion P2 the 1st stage of magnification is 100/10=10 times again.

Therefore overall magnification can be calculated,

(G1XG2)/ (P2XP3)

EG: (100x100/10x10) = 100

In this way dial indicator works you can take diff readings by keeping standard and object. Then comparison can be made. The magnification is about 250-1000.

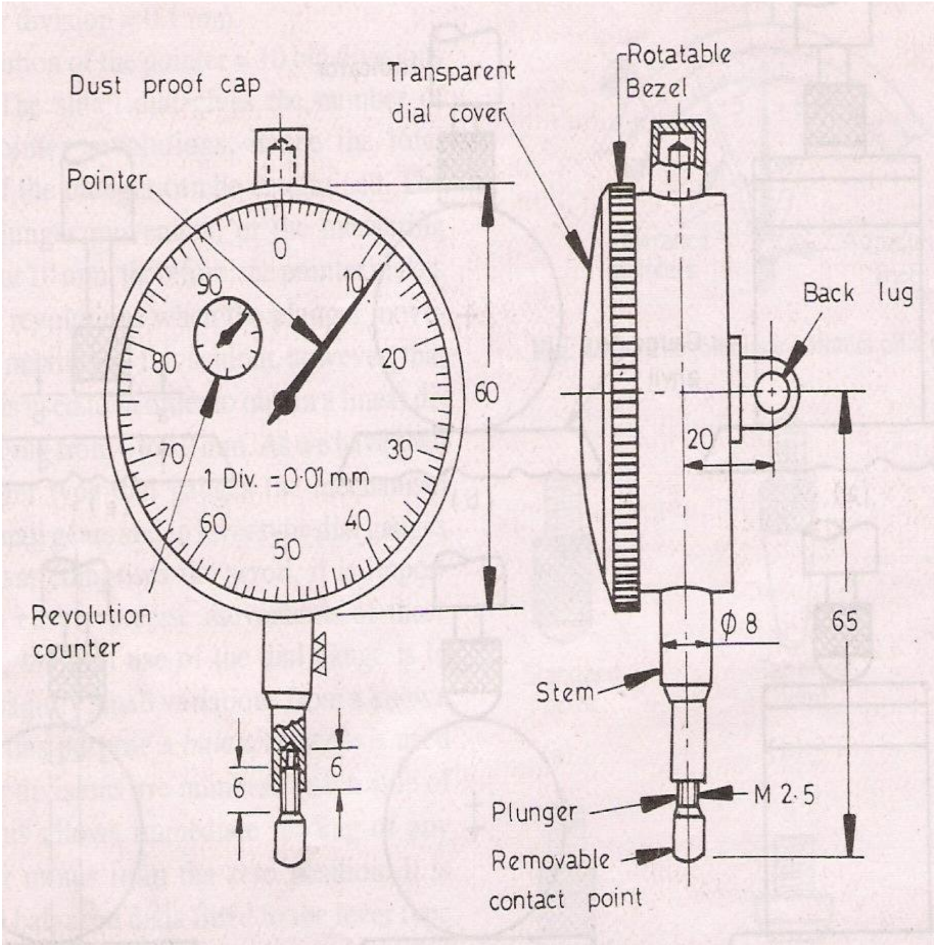


Fig .6 : Dial Indicator

Working of Dial Indicator gauge-

Dial indicator has been used with several auxiliary devices for a wide variety of length measurement. Obviously dial indicator can be used for carrying the needed complimentary function, resulting in a single tool, it is known as indicator gauge. It must be remembered that indicator gauge are always comparator type measuring instrument and require the use of a setting gauges for establishing the basic measuring position

EXPERIMENT NO - 6

Aim: - *Use of dial indicator to measure the measuring part.*

Apparatus: - Dial Gauge, Dial Gauge Indicator, Slip gauge.

Theory:-

The different component of dial gauge indicator. It consists of plunger, removable contact pt, stem a transparent glass cover, calibrated dial pointer, bezel camp or bezel locking nut. Revolution counter in order to counter in order to count the no of revolution of a pointer, dust proof cap etc. It consists of a plunger which slides in bearing and carries a rack with it. The rack is meshed with pinion (P1) again pinion (P2) and gear (G2) are on same spindle [because of which magnification is taking place]. The gear (G1) is meshed with (P1) again pinion (P2) and gear (G2) are on spindle basically gear (G2) is meshed with pinion (P3) on whose spindle pointer is attached. The pinion (P3) is meshed with gear (G3) on which a light is here spring is attached in order to guide the movement of plunger a rack guide is provided and to bring the plunger to its initial position a light coil spring is attached to plunger. Any linear displacement given causes rack to move upward during this upward movement as rack is meshed with pinion (P1) and gear (G1) rotate by some amount but as the no of teeth on gear (G1) is more compared to that of pinion (P2) which is meshed with it rotate more time. Let us say if there is 100 teeth on gear G1 and 10 teeth on pinion P2 the 1st stage of magnification is 100/10=10 times again.

Therefore overall magnification can be calculated,

(G1XG2)/ (P2XP3)

EG: (100x100/10x10) = 100

In this way dial indicator works you can take diff readings by keeping standard and object. Then comparison can be made. The magnification is about 250-1000.

Dial gauge -

Dial gauges divided in two categories, type 1 & type 2 for general engineering purpose depending upon the movement of the plunger. These are manufactured in two grades, grade a and grade b, with total plunger movement or lift of 3,5 and 10mm. Type1 dial gauge has the plunger movement parallel tip the plane of dial and type 2 has the plunger movement perpendicular to the plane of dial

Indicator gauge-

Dial indicator has been used with several auxiliary devices for a wide variety of length measurement. Obviously dial indicator can be used for carrying the needed complimentary function, resulting in a single tool, it is known as indicator gauge.

It must be remembered that indicator gauge are always comparator type measuring instrument and require the use of a setting gauges for establishing the basic measuring position

Slip gauge-

Slip gauges with three basic forms are commonly found. These are rectangular square with center hole, and square without center hole. Rectangular forms is the more widely used because rectangular block are less expensive to manufacture, and adopt themselves better to application where space is restricted or excess weight is to be provided. For certain application squarely gauges, through expensive, are preferred. Due to their large surface area, they wear longer and adhere better to each other when touch to high stack.

PROCEDURE:-

For calibration checking.

1. The slip gauge is used for the purpose of checking the calibration.

2. A known slip gauge is taken and placed on the surface; the indicator gauge which has the least count of instrument is calculated

3. The deflection of the pointer is noted and the final reading is obtained

4. For measuring the dimension of a given sample, a known slip gauge is matched with the given sample; the comparator is put on the surface without disturbing the reference setting

7. If the sample is greater than reference one, the pointer shows deflection which is measured and reading is calculated.

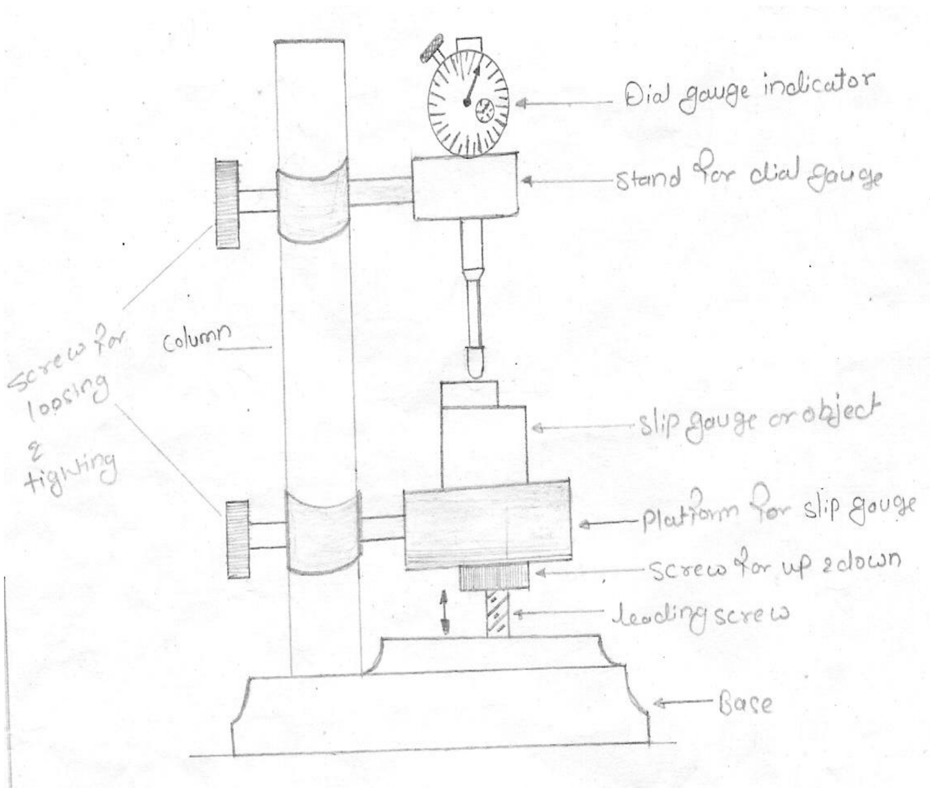


Fig.7: Dial Indicator

OBSERVATION:

Slip gauge

For linear measurement least count = (0.2/200)=0.001 mm/div

For standard dimension

For specimen

Main scale reading =MSR = -------

Circular scale reading =CSR= ---------

Total reading (TR) = MSR + (CSR * LC)

Total Height of specimen = -----------

Calculation of Dial Gauge:-

Slip Gauge Reading Dial Gauge Reading

= 50+ …… = 0.2 + …….

= 51.001 mm = 0.2 + ……

= 51.003 mm = 0.2 + …….

Difference for the both should be equal

Result

Thus we have completed the linear measurement using dial gauge and calibration of dial gauge.

EXPERIMENT NO – 7

Aim: – Study of limit, fit and tolerance

Theory:-

Nominal size: The size designation used for general identification. The nominal size of a shaft and a hole are the same. This value is often expressed as a fraction. Basic size: The exact theoretical size of a part. This is the value from which limit dimensions are computed. Basic size is a four decimal place equivalent to the nominal size. The number of significant digits implies the accuracy of the dimension.

Example:

Nominal size = 1 ¼

Basic size = 1.2500 design size:

The ideal size for each component (shaft and hole) based upon a selected fit. The difference between the design size of the shaft and the design size of the hole is equal to the allowance of the fit. The design size of a part corresponds to the Maximum Material Condition (MMC). That is, the largest shaft permitted by the limits and the smallest hole. Emphasis is placed upon the design size in the writing of the actual limit dimension, so the design size is placed in the top position of the pair.

Tolerance: The total amount by which a dimension is allowed to vary. For fractional linear dimensions we have assumed a bilateral tolerance of 1/64 inch. For the fit of a shaft/hole combination, the tolerance is considered to be unilateral, that is, it is only applied in one direction from design size of the part.

Standards for limits and fits state that tolerances are applied such that the hole size can only vary larger from design size and the shaft size smaller.

Basic hole system: Most common system for limit dimensions. In this system the design size of the hole is taken to be equivalent to the basic size for the pair. This means that the lower (in size) limit of the hole dimension is equal to design size. The basic hole system is more frequently used since most hole generating devices are of fixed size (for example, drills, reams, etc.) When designing using purchased components with fixed outer diameters (bearings, bushings, etc.) a basic shaft system may be used.

Allowance: The allowance is the intended difference in the sizes of mating parts. This allowance may be: positive (indicated with a "+" symbol), which means there is intended clearance between parts; negative ("-"), for intentional interference: or "zero allowance" if the two parts are intended to be the "same size". This last case is common to selective assembly.

Example:

The example of a limit dimension for the shaft is shown in a shaft/hole assembly. The top number in the limit represents the design size of the shaft. The two values define a range of acceptable component sizes. The drawing is for a shaft/hole assembly of 3/4 inch nominal diameter. A standard Class RC3 fit is being used. The specifications for the fit are found in the fit tables in the appendix of your text. By finding the appropriate range for the nominal size in the left hand column of the table and reading under the RC3 fit heading we obtain the following values.

Hole	Shaft
+ 0.8	- 0.8
+ 0.0	- 1.3

These values are applied algebraically to the basic size for the in order to obtain the limit dimensions for each part. Note that the values are given in thousandths of an inch. Further note that one of the values for the hole is zero. This will make one limit for the hole the same as basic size, hence the basic hole system.

We now have the following:

Nominal size = ¾

Basic size = .7500

Limit dimension for the hole = .7500

.7508

Limit dimension for the shaft = .7492

.7487

Design size for the hole = .7500

Design size for the shaft =.7482

This means the for this standard fit, the allowance = +.0008

This is the difference between the design sizes of the parts, or, in other words, the largest shaft and the smallest hole. The allowance is positive since the shaft is always smaller than the hole and will assembly freely.

In most design situations the nominal size of the combination is chosen through engineering analysis of the problem. A standard fit is then selected based upon function. The fit tables include short descriptions of the applications for the specific fits. The limit dimensions for each part can be written using the previous procedure.

Unilateral tolerance:

This is an alternative form for the writing of fit dimensions. The information is the same as that for limit dimensions, just the format is different. In the unilateral tolerance format, the design size of the component is given and the tolerances on each part are list in an indented position. Example: limits unilateral tolerance

.7487 +.0000

EXPERIMENT NO - 8

Aim: - Study and adjustment of spark plug gap using feeler gauges.

Theory:- A **feeler gauge** is a tool used to measure gap widths. Feeler gauges are mostly used in engineering to measure the clearance between two parts. They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values. It is common to have two sets forimperial units (typically measured in thousandths of an inch) and metric (typically measured in hundredths of a millimetre) measurements.A similar device with wires of specific diameter instead of flat blades is used to set the gap inspark plugs to the correct size; this is done by increasing or decreasing the gap until the gauge of the correct size just fits inside the gap. The lengths of steel are sometimes called *blades*, although they have no sharp edge.

A taper feeler gauge is a feeler gauge of tapered, as opposed to parallel, shape. The blade of the gauge is of a constant thickness, and the two types of gauge are used in a similar way. A feeler gauge is a must-have tool for checking valve tolerances, point gaps and other critical measurements. Get quick and accurate measurements from 31 different steel blades etched with SAE and metric sizes. The compact steel frame fits into any tool bag and most pockets.

- Checks valve tolerances, point gaps and other critical measurements.
- Compact steel frame
- Flexible steel blades

Precaution in feeler gauge:-

1. Never use feeler gauges on operating machinery.
2. Feeler gauges are strips of hardened metal that have been ground or rolled to a precise thickness. They can be very thin and will cut through skin if not handled correctly.
3. Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

Fig.8 : Feeler Gauge

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