DHANALAKSHMI COLLEGE OF ENGINEERING

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Department of Mechanical Engineering

ME6513 - METROLOGY AND MEASUREMENT LAB

LABORATORY MANUAL

Name : ………………………………………

Register No. : ………………………………………

Branch : ………………………………………

Year & Semester : ………………………………………

CONTENTS

Ex No:

CALIBRATION OF OUTSIDE MICROMETER

Date :

Aim:

To calibrate the outside micrometer using slip gauge

Instruments Required:

1. Micrometer stand
2. outside Micrometer
3. Slip gauge

Specifications:

1. Outside micrometer

   Range =0 - 25mm

   Graduations=0.01mm

Description:

Outside Micrometer

It is used for checking the thickness of the square Rectangular and circular round balls. It is consists of various parts such as anvil spindle frame thimble ratchet.

Procedure:

1. The micrometer is checked for zero error.
2. The given slip gauge is held between the faces of the anvil and spindle.
3. The spindle is moved by rotating the thimble until the anvil and spindle touches the surface of the component.
4. Fine adjustment is made by ratchet. The main scale reading and thimble scale reading are noted.
5. Two are more reading are taken at different places of the component.
6. The readings are tabulated and calculated.

Tabulation:

Least count=0.01mm Range = 0 - 25mm

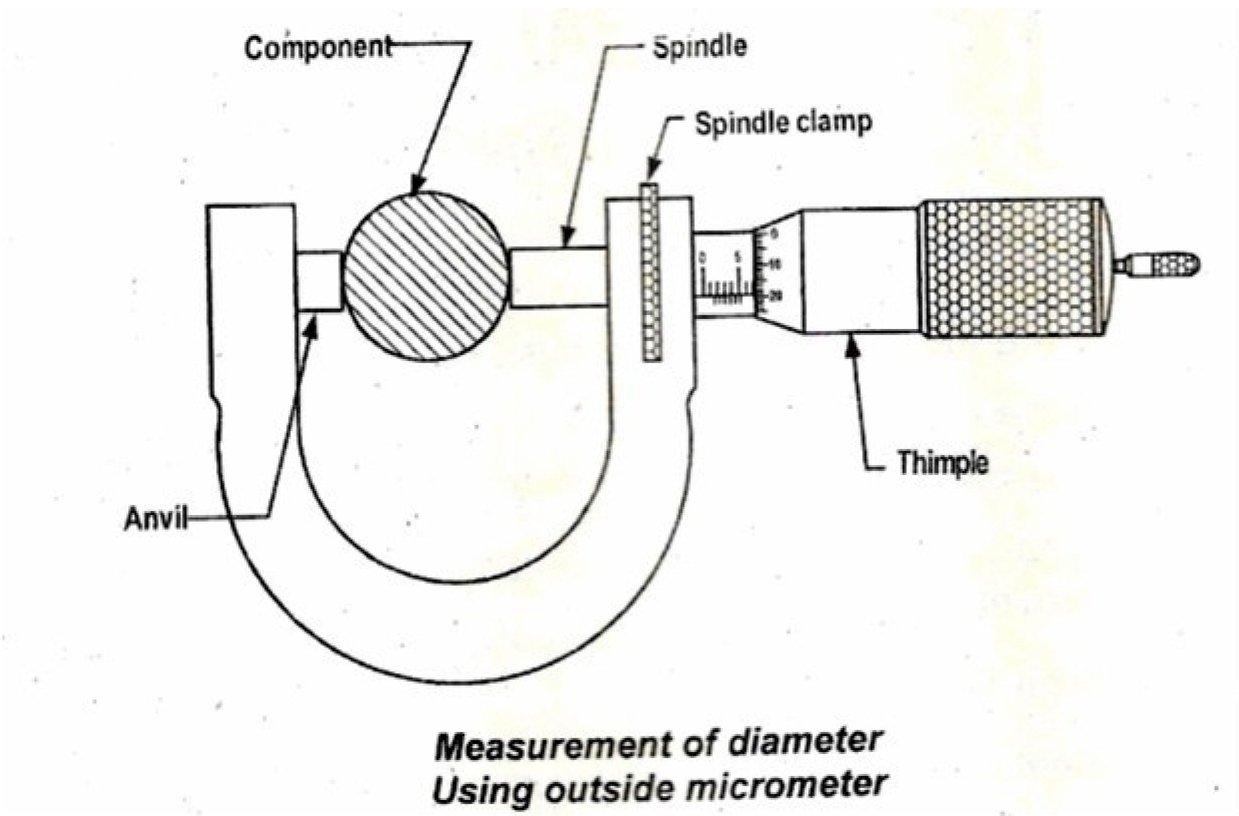
TR = MSR+ (TSC x L.C)

S.NO	MICROMETER READINGS				SLIP GAUGE READINGS (mm)	ERROR (mm)
	MSR (mm)	TSV	TSR (mm)	TR (mm)		

Model Calculation:

Main scale reading = mm
Thimble scale coincides =
Total reading = MSR+ (VSCXLC)

Error= Measured value – True value



Results:

Thus the outside micrometer using slip gauge was calibrated.

Ex No:

CALIBRATION OF VERNIER HEIGHT GAUGE USING SLIP GAUGE

Date :

Aim:

To calculate the Vernier height gauge using slip gauges

Instruments Required

1. Vernier height gauge
2. Slip gauge

Formula Used:

TR = MSR+ (VSCXLC)

Where, TR-Total Reading
MSR-Main Scale Reading
VSC-Vernier Scale Coincide
LC-Least Count

Description:

Vernier height gauge consists of a special base block and other attachment .The whole assembly is made such a way to measure height of parts to be measured. A removable clamp is attached b/w measuring jaws and Vernier both the upper and lower end of measuring jaws and Vernier are parallel to the base of Vernier height gauge. A scribing attachment is fitted to mark scribe line on the parts where is required sometimes measuring jaws of Vernier caliper are replaced by a dial gauge according to the type of measurement.

Procedure:

- Vernier height gauge is cleaned with a cloth.
- The clamping screws are loosened.
- The given component is fixed in both the two jaws.
- The component should be perfectly holded.
- The height is measured with the external jaws.
- The height of the component is measured by adjusting the movable jaws.

- The procedure is repeated for all the components.
- At least three readings should be taken and then average will give the accurate measurement.

Tabulation:

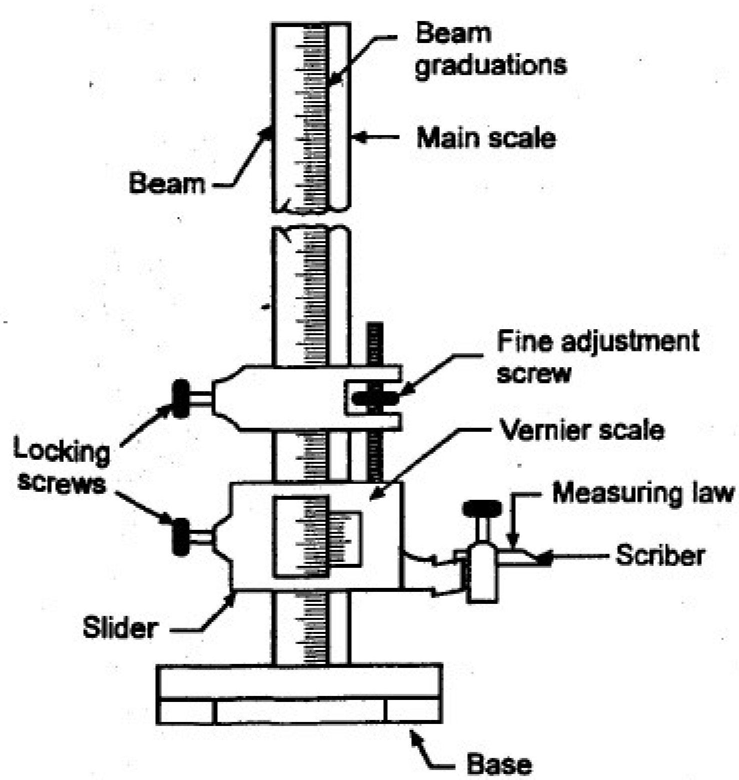
Least count = 0.02 mm

S.NO	VERNIER HEIGHT GAUGE READING (mm)				SLIP GAUGE READINGS (mm)	ERROR (mm)
	MSR (mm)	VSC	VSR (mm)	TR (mm)		

Model Calculation:

Main scale reading = mm
Vernier scale coincides =
Total reading = MSR+ (VSCXLC)

Error = Measured value – True value



Result:

Thus the Vernier height gauge was calculated using slip gauge.

Ex No:

CALIBRATION OF DIAL GAUGE

Date :

Aim:

To calibrate the dial gauge by using dial tester

Instruments Required:

1. Dial gauge
2. Dial tester

Description:

Dial test indicator are used for checking surface of parallelism of rods and bars. They are also used for measurement of linear dimensions of jobs which regulate easy readability of moderate precision.

It has two pointers which are actuate by rock and pinion arrangement which acts as spindle. The spindle is made to come in contact in work piece. The linear displacement is calculated.

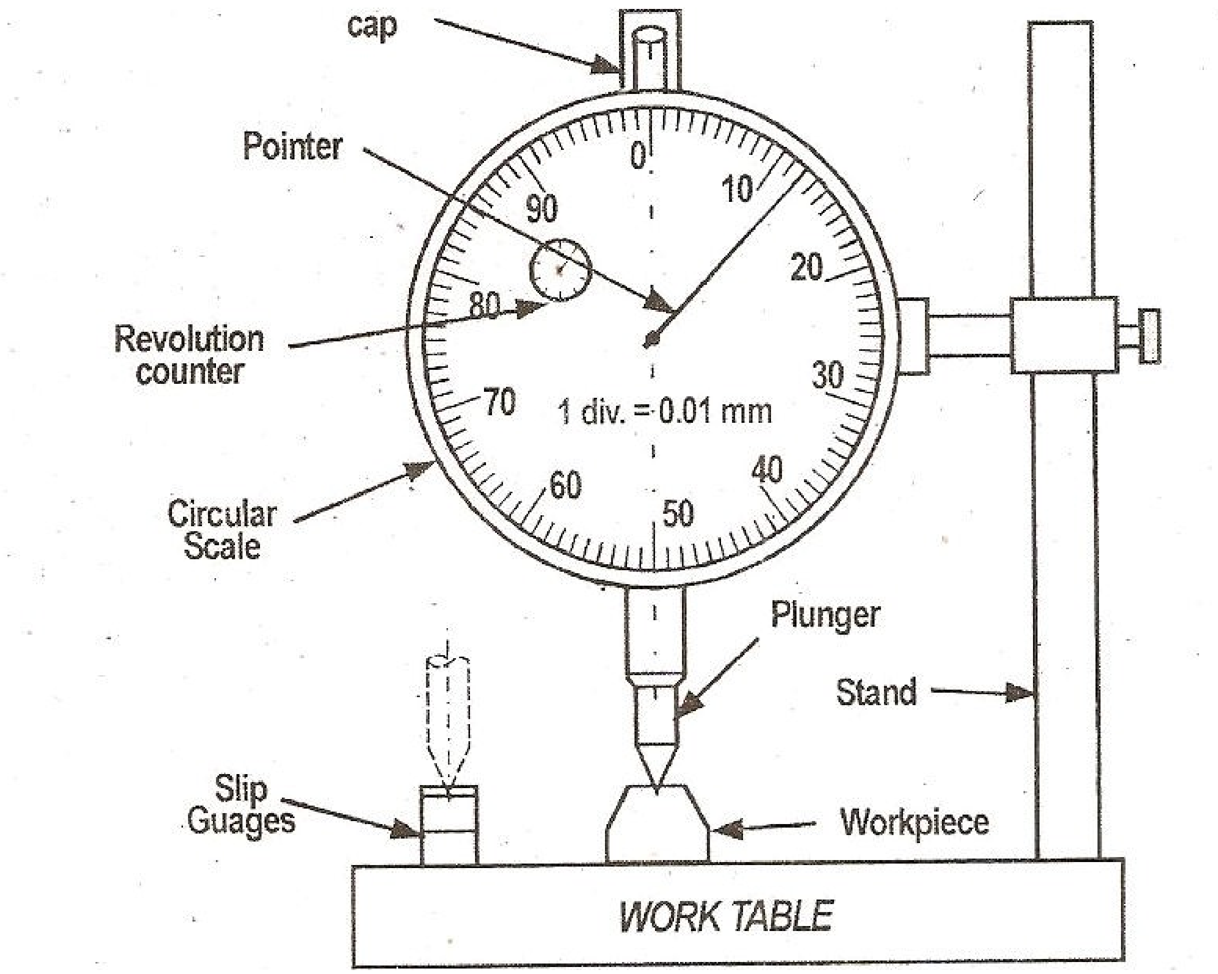
Procedure:

1. The slip gauges are built up to the given weight of the component.
2. Dial gauge with stand is placed on the surface plate.
3. The built up gauge is placed under the plunger.
4. The indicator is set to zero.
5. The built up gauge is removed.
6. The given machined component is placed under the plunger.
7. The variation in the height of the component is noted from the reading of the dial.

Tabulation:

Least Count: Dial gauge = 0.01mm

S.NO	SLIP GAUGE READING (mm)	UNKNOWN READING (mm)	ERROR (mm)



Result:

Thus the dial gauge is calibrated using dial tester

Ex No:

CALIBRATION OF VERNIER CALIPER

Date :

Aim:

To calibrate the Vernier caliper by using slip gauge

Instruments Required:

1. Vernier Caliper
2. Slip gauge

Description:

Vernier Caliper:

Vernier caliper has two sides' namely main scale and vernier scale which moves along the main scale vernier are used to measure both internal and external dimension.

Procedure:

1. Vernier caliper is cleaned with a cloth.
2. The clamping screws are loosened.
3. The given component is fixed in both the two jaws.
4. The component should be perfectly holded.
5. The thickness is measured with the external jaws.
6. The length of the component is measured by adjusting the movable jaws.
7. The procedure is repeated for all the components. At least three readings should be taken and then average will give the accurate measurement

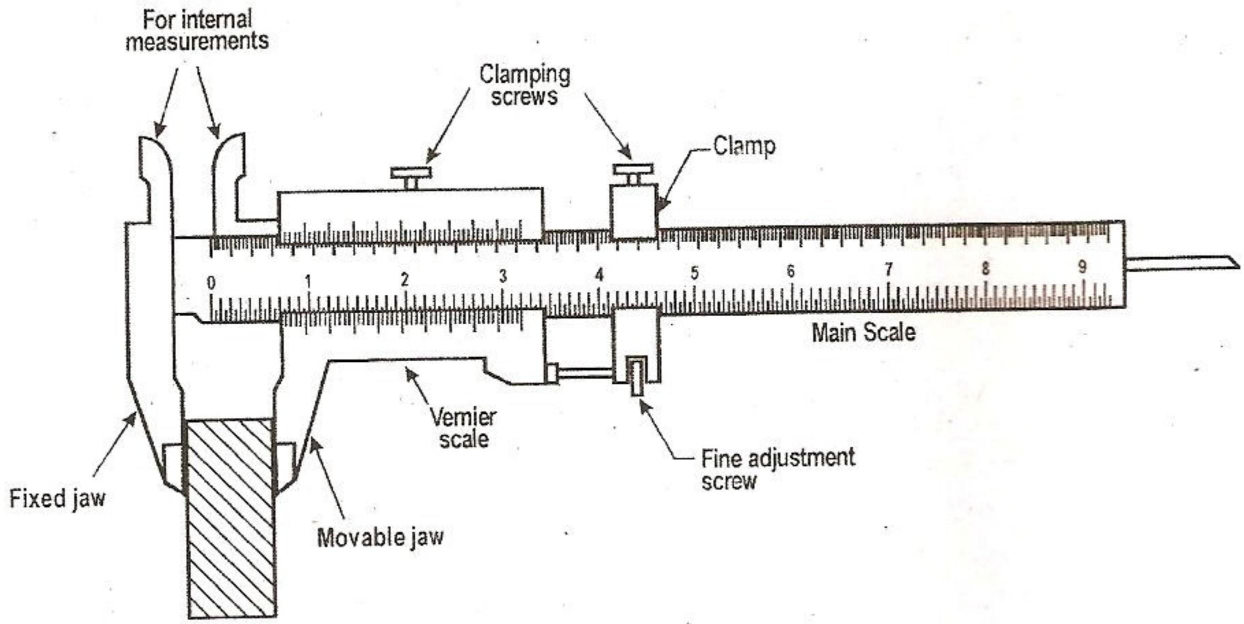
Tabulation:

Least count=0.02mm

S.NO	VERNIER READING (mm)			SLIP GAUGE READINGS (mm)	ERROR (mm)
	MSR (mm)	VSR	TR (mm)		

Model Calculation:

Main scale reading = mm
Vernier scale coincides =
Total reading = MSR + (VSCXLC)



Measurement of thickness of plate Using Vernier Caliper

Result:

Thus the vernier caliper has calibrated using slip gauge

Ex No:

ANGLE OF TAPER BLOCK BY SINE BAR

Date :

Aim:

To measure the angle of the given taper block by using sine bar.

Instruments Required:

1. Sine bar
2. Slip gauge
3. Taper block

Formula:

$$\text{Sin } Ø = h / L$$

Where,

H - Height of the slip gauge
L - Distance between the centers
Ø - Inclined angle of the specimen

Description:

A Sine bar consist of an accurately ground bar since on which two accurately ground cylinder of the same diameter are mounted at an exact distance apart. The axis of the Cylinder on the plane that is parallel to the upper or working surface of the sine bar .The axis of the cylinder are parallel to each other . The upper surface has high degree of feathers.

The principal used in the measurement angle is that the sine of the given angle is the ratio of the opposite side of the angle to the hypotenuse of the right angled triangle.

Procedure:

1. The given component is placed on the surface plate.
2. One roller of sine bar is placed on surface plate and bottom surface of sine bar is seated on the taper surface of the component.
3. The combination of slip gauges is inserted between the second roller of sine bar and the surface plate.

4. The angle of the component is then calculated by the formula given above.

Tabulation:

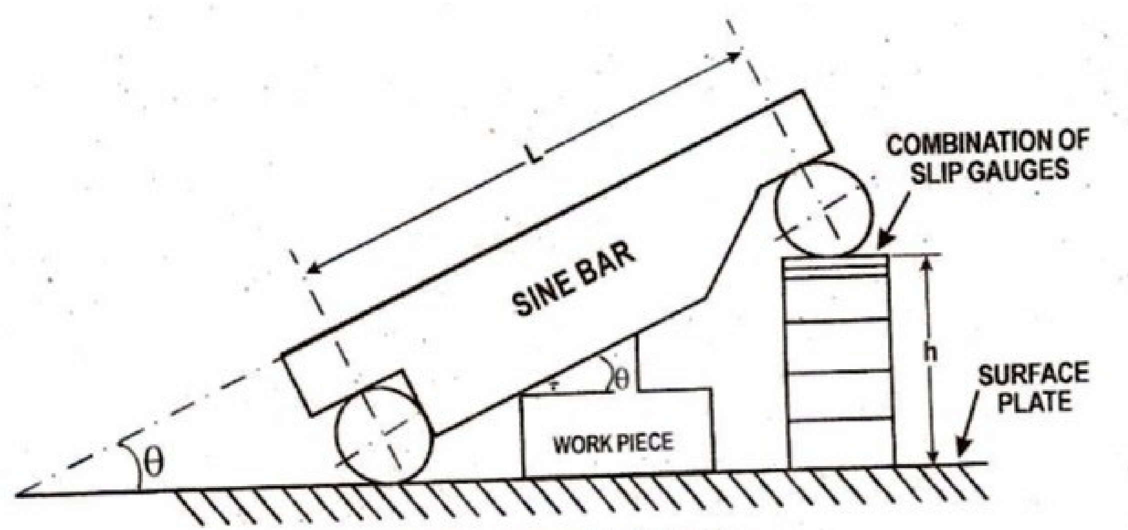
LENGTH OF THE BAR CENTER (L) (mm)	**h1 (mm)**	**h2 (mm)**	**h1- h2 (mm)**	**ANGLE OF INCLINATION OF SINE BAR**

Model Calculation:

For measuring the angle of the given taper block by using the Sine bar

$\sin \Phi = h1-h2/ L$

$\Phi = \sin^{-1} (h1-h2 /L)$



Measurement of angle
Using Sine bar

Result:

Thus the angle of the given taper block is measured by using the Sine bar

Taper angle of the given block by using sine bar =

Ex No:

ANGLE OF TAPER ROD BY SINE CENTER

Date :

Aim:

To measure the angle of the given taper block by using sine center and slip gauge.

Instruments Required:

1. Sine center
2. Slip gauge
3. Dial gauge

Description:

It is a sine center with block holding center which can be adjusted and reading clamped in any position. A one center connection with slip gauge consists of case fuel device for pressure measurement of conical between the centers. There are made from high carbon chromium corrosive resistant steel hardened cylinders of equal diameter are attached at ends then to each other and also parallel to equal distance from the super surface of the sine center. The distance between the center of two cylinder of the given sine center exactly 100mm.

Procedure:

1. To check and measure the angle the sine center is plane over the surface plate.
2. The two center are clamped tightly place slip gauge below are one end to other along the work rod and zero readings.
3. It is not added to few slip gauges in steps till the dial gauge move along the work for the center and entire length of the taper readings is zero.
4. The angle is given by

$$\text{Sin } \Phi = h1\text{-}h2 / L$$

Where,

Φ =Height of the slip gauge

h = Height between the cylinder

L = Length of the sine bar

Tabulation:

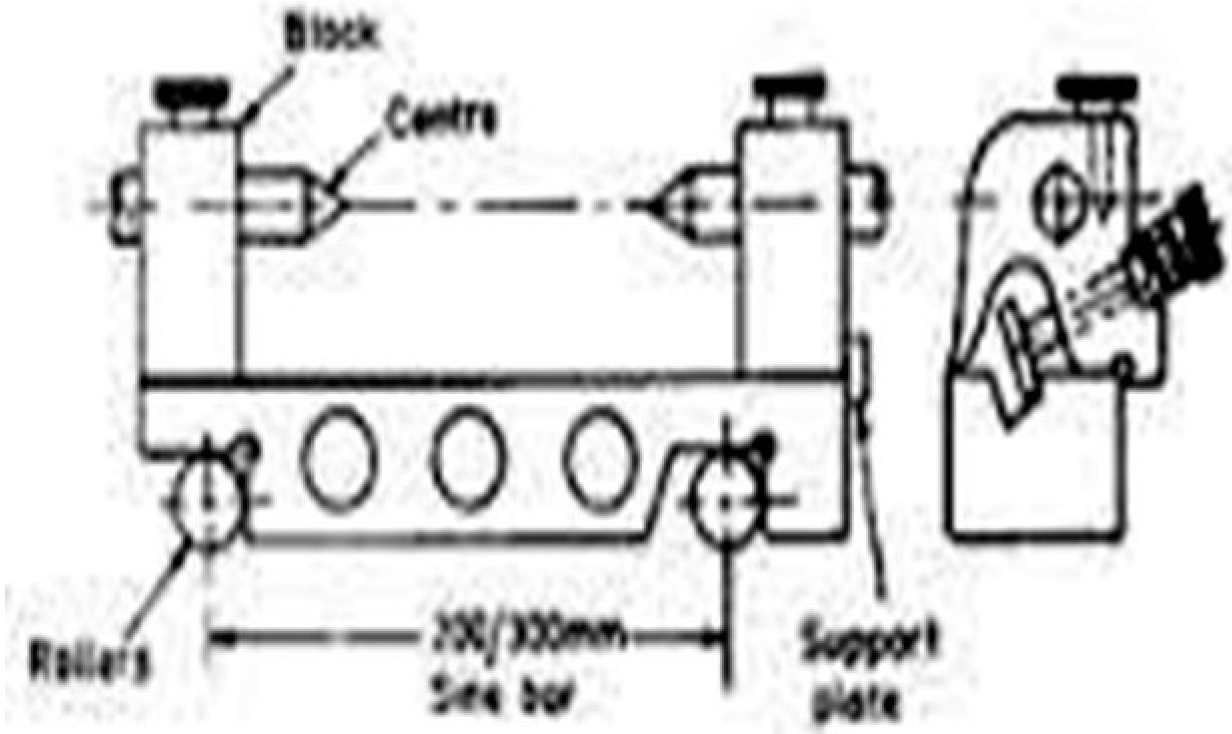
S.NO	DISTANCE BETWEEN ROLLERS "r" (mm)	SLIP GAUGES		h mm	HALF ANGLE
		h1 mm	h2 mm		

Model Calculation:

For measuring the angle of the given taper rod by using the Sine center

$$\sin \Phi = h/L,$$

$$\Phi = \sin^{-1}(h/L)$$



Result:

Thus the angle of the given taper rod is measured by using the Sine center.
Taper angle of the given rod by using sine angle=

Ex No:

ANGLE OF V-BLOCK BY VERNIER BEVEL PROTRACTOR

Date :

Aim:

To measure the angle of V-block component by using vernier bevel protractor.

Instruments Required:

1. Vernier bevel protector
2. V-block

Description:

Protector is an instrument used to measure and layout the angles with an optical level protector. It is possible to read to an extent of Z. The blades present in the protractor slides in its clamps. The unusual available blade lengths are 150mm and 300mm. inside the body protector there is a glass side. The stock and the body are attached to each other such that the body are attached to each other such that the outlet edges of the stock its tangential to the outside diameter of the body

The blades are clamped to the inner rotating member of the body. The inner rotating member of the body carries a small eye piece. It is possible to view the circle graduation against a fixed index circle.

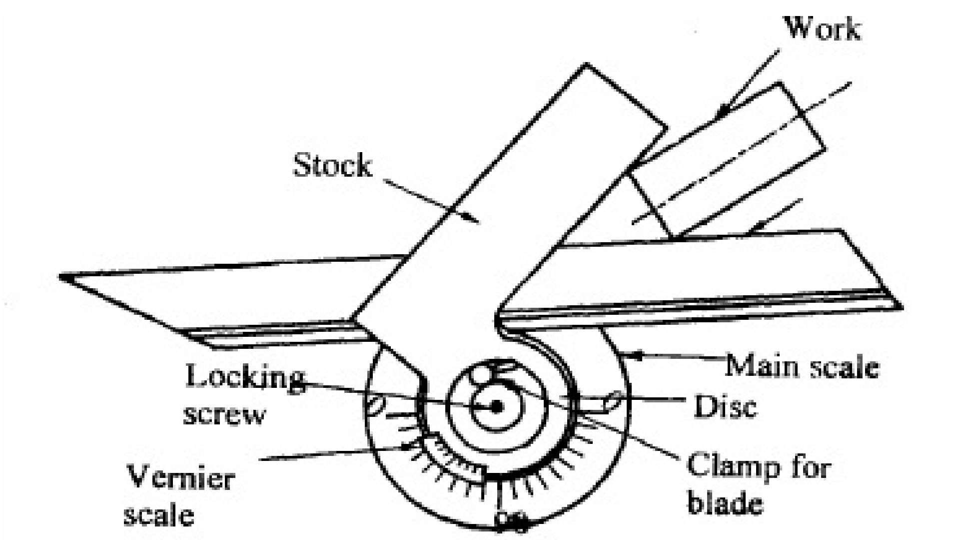
Procedure:

1. For measuring the angle of V blocks the number of whole degree on the main scale up to vernier center zero mark is noted in the vernier optical bevel protector.
2. The mark in the main scale is found and this is added to the number of whole degree to obtain the reading provision is made to adjust the focus of the optical magnifying systems.
3. It is being adjusted in order to make accommodation of normal variation in eye sight

Tabulation:

Least Count = 5’

S.No.	MSR	VSC	VSR	TR	‘V’ Block angle	Error



Result:

Thus the angle of the given taper block is measured by using the optical protector.

(i) Angle of V-blocks =
(ii) Angle of V-blocks =

Ex No:

MEASUREMENT OF SPUR GEAR TOOTH DIMENSIONS

Date :

Aim:

To measure gear parameter by using gear tooth vernier.

Instruments Required:

1. Gear tooth Vernier

2. Gear specimen.

Formula Used:

1. Depth, d = (Nm/2) (1+2/Z-COS(90/Z)
2. Width, w =Nm x sin (90/Z)
3. Outer diameter of gear, D =(Z+2)m
4. Module, m =D/(N+2)

Where,

w = Chordal width of tooth in mm

d = Chordal addendum of gear in mm

M = Module of gear in mm

N = NO. Of teeth

D = outside Dia in gear in mm

Procedure:

1. Find the zero error in the horizontal scale and vertical scale of the given gear toot vernier.
2. Find outer diameter of the given gear by using vernier caliper.
3. Count the no of tooth on the given gear.
4. Calculate the depth of pitch circle from the top circle.
5. Calculate the module (m) of the gear.
6. Similarly calculate the theoretical width by substituting and no of gear tooth in the formula.
7. The vertical gear tooth vernier is made of point to calculate the depth value.
8. Now the gear tooth, i.e. kept in between in the two jaws of the gear tooth vernier.
9. Observe the main scale reading and vernier scale coincidence of the horizontal scale.
10. Repeat the observation of different position of the same tooth and calculate the average.

Tabulation:

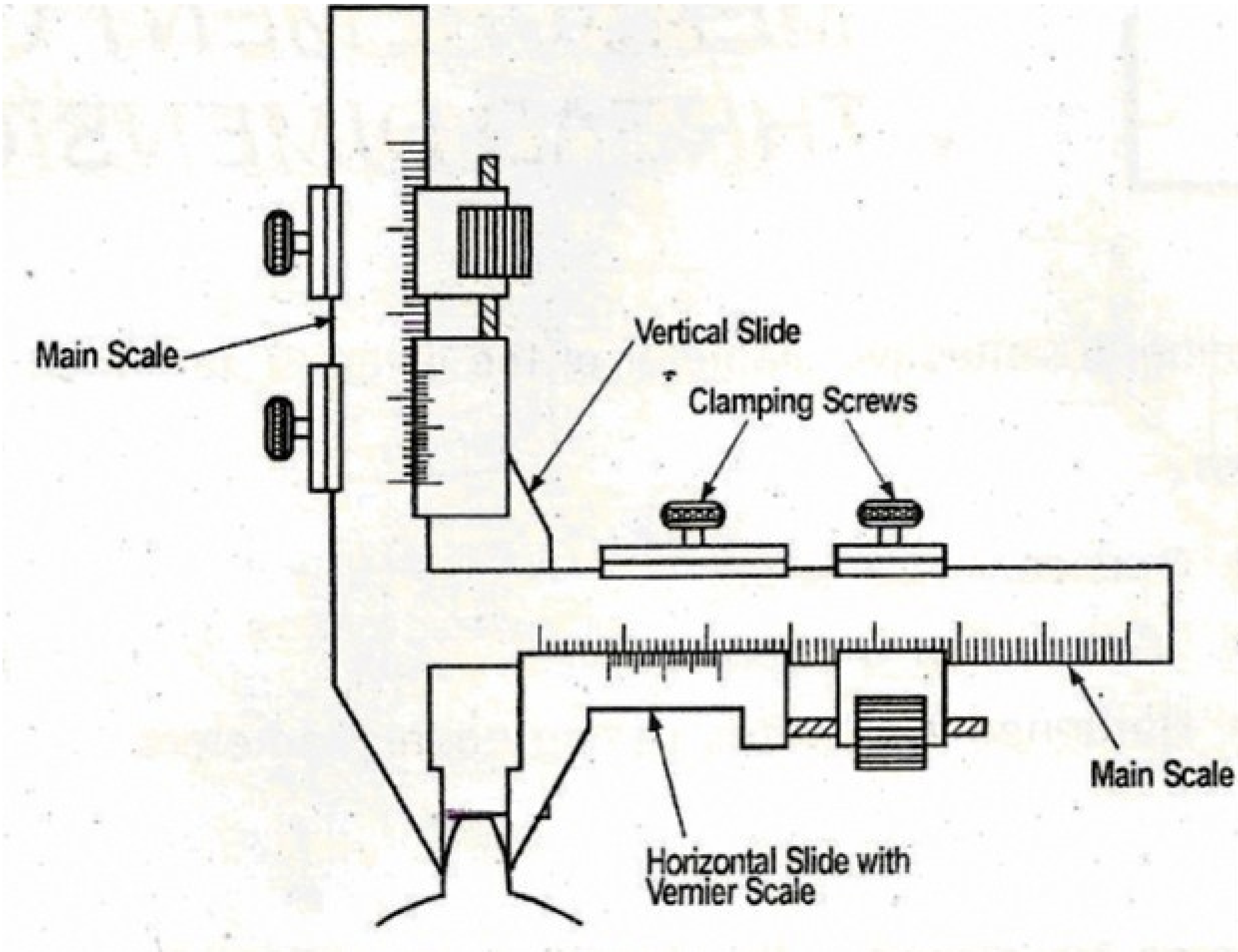
Least count: Horizontal Scale = 0.02 mm

Vertical Scale = 0.02 mm

Measurement of Addendum and Chordal Width

S.No.	**Chordal addendum (d)**				**Chordal width (w)**			
	MSR (mm)	**VSC**	**VSR (mm)**	**TR (mm)**	**MSR (mm)**	**VSC**	**VSR (mm)**	**TR (mm)**

S.No.	**Chordal addendum (d)**		**Chordal width (w)**	
	Actual value	Theoretical value	Actual value	Theoretical value



Result:

Thus the chordal thickness and addendum of gear are measured using gear tooth Vernier.

Ex No:

MEASUEMENT OF SCREW THREAD USING PROFILE PROJECTOR

Date :

Aim:

To determine the major and minor diameter, pitch and flank angle of a screw tread using profile projector.

Instruments Required:

Profile projector

Screw thread

Description:

Profile Projector:

Profile projections are highly sophisticated and versatile designed as per international standards. This comprehensive range covers all conceivable application its ideal for the rapid inspection and measurement (linear and angular) of small to medium size components such as watch parts, tools, rubber components, miniature electronic assemblies and so on. It's best quality high resolution optics provides accurate, bright, clear and sharp images. The special front and back surface mirror are highly polished and lobbied distortion and reproduction. Three element condenser system and high intensity halogen lamps provides brilliant images even in day light condition commitment to quality insure that offer the highest level of precision, quality, reliability and performance.
Two types profile projectors are,

- Vertical floor model, ideal for the rapid inspection
- Horizontal floor model, ideal for the tracing for projected images

Procedure:

Measurement of Major Diameter:

The given material thread is placed horizontal plan plate of material profile projector and transmitted light is switched on the vertical measurement known is located fill of thread is on screen the difference of reading is major diameter

Measurement:

The wire is made to coincide with and touch the line on one side of thread and micrometer reading are noted the cross wire is coinciding to touch level on other side.

The crosswire is to coincide on to root of one side of thread. The horizontal Knob is adjusted to coincide on next root on same side.

The cross wire is made to coincide the root of v-groove of thread and the angle of project is noted. The other side of V-groove is made to coincide with wires of adjusting the projector. The difference is reading is twice the flank angle.

Tabulation:

MAJOR DIAMETER

S.NO	Micrometer reading I (R1)				Micrometer reading II (R2)				Difference R1—R2 (mm)
	MSR	VSR	VR	TR	MSR	VSR	VR	TR	

MAJOR DIAMETER

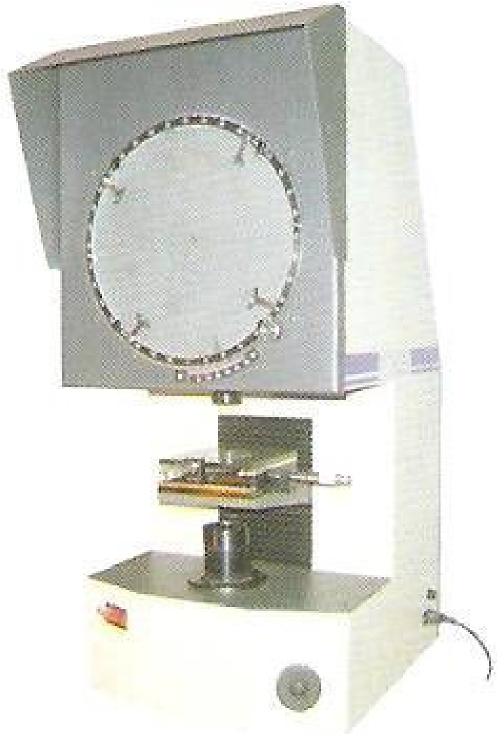
S.NO	Micrometer reading I (R1)				Micrometer reading II (R2)				Difference R1—R2 (mm)
	MSR	VSR	VR	TR	MSR	VSR	VR	TR	

PITCH

S.NO	Micrometer reading I (R1)				Micrometer reading II (R2)				Difference R1—R2 (mm)
	MSR	VSR	VR	TR	MSR	VSR	VR	TR	

To Measure Flank Angle

S.NO	Angle of the left side	Angle of the right side	Induced angle



Model 300T

RESULT

Thus using the profile projector the depth pitch and flank angle major and minor diameter or given screw thread are measured.

Major diameter of given thread -
Pitch of given thread -
Minor diameter of given thread -

Flank angle of given thread -

Ex No:

MEASUREMENT OF DISPLACEMENT USING LVDT

Date :

Aim:

To measure the displacement in terms of microns or mm using LVDT system

Description:

The instruments is equipped with internal calibration setting which enables the operator to calibrate only LVDT with the instrument provided the output of the transducer for rated display is accurately known with the suitable extension units the channels occupies can be increased and multipoint can be made faster response a compared to the moving coil meter

Specification:

(i) LVDT displacement transducer

Voltage: 1-30 v
Frequency: 2 KHz
Sensitivity: (0.2-1)mv/v10 micron
Operating temperature:5-55ºC
Linearity elevation: 1%max

(ii) Displacement meter:

Transducer – LVDT
Range: 1999 micron/1.99 m
Frequency: 2 KHz
Frequency display: 3.5 digits LED display
Working temperature: 10-45ºC
Power requirement: 230V, 50 Hz, 1Φ

Procedure:

Null Balance:

LVDT transducer consists of primary coil and secondary coil round on a cyclic bobbin. When the soft iron wire is put exactly in the middle and primary windings is exited equal voltage are induced in secondary windings. The differential voltage is proportional to the displacement of wire form centre. This voltage is complicated phase directed and fed to the display. The null circuit is used to reduce the finite output to minimum. Now the core is slightly moved so that further reduction in value is got. By alternatively adjusting the core position and null ball potentiometer. A minimum possible null voltage will be loss than 1mv rms

Zero Adjustment

After adjusting the null through zero control potentiometer on the barrel is adjusted so that display range zero.

Cal Adjustment

After carrying but the above two adjustment a known displacement is given to the shaft of transducer and by operating CAL potentiometer for display is set to read the given displacement for the adjustment it is necessary to use LVDT calibration figure. The shaft iron core is to be used with LVDT is to be served to shaft and the calibration. The shaft can be of any non material such as a cyclic shaft or non magnetic material stainless steel.

Tabulation:

S.NO	MICROMETER READING (mm)	LVDT READING (mm)	ERROR=LVDT READING-MICROMETER READING

Result:

Thus the displacement was determined by using LVDT and graph was plotted.

Ex No:

MEASUREMENT OF VIBRATION PARAMETERS USING VIBRATION SET UP

Date :

Aim:

To study the various parameters involved in the vibrations of a given system.

To plot the characteristic curves of the given specimen

Instruments Required:

1, Vibration exciter

2, Vibration pick-up

3, Vibration analyzer

4, Power amplifier

5, Oscillator

Description:

The mechanical vibration, if not within limits may cause damage to the materials, structures associated with it.

Vibration exciter is an electrodynamic device. It consists of a powerful magnet placed centrally surrounding which is suspended the exciter coil. This assembly is enclosed by a high permeability magnetic circuit.

When an electrical current is passed through the exciter coil, a magnetic field is created around the coil resulting in the upward or downward movement of the suspended coil depending upon the direction of the current flow in the coil. Thus controlling the frequency of the coil current, the frequency of vibration is controlled. Power amplifier is the control unit for the exciter.

Piezo – electric crystals produce an emf when they are deformed. This output emf may be measured to know the value of applied force and hence the pressure.

A piezo – electric material is one in which an electric potential appears across certain surfaces of a crystal of the dimensions of the crystal are charged by the application of a mechanical force. The effect is reversible.

Common piezo – electric materials include quartz, Rochelle salt, lithium sulphate etc.,

Caution:

Do not remove the fuse cap while power chord is connected to 230V AC mains

Procedure:

1. Connect power amplifier output to vibration exciter.
2. Place the vibration pick up on vibration exciter spindle.
3. Connect vibration pick up cable to vibration analyzer sensor socket.
4. Select the range 0-100 by two way switch.
5. Note down the displacement, velocity and acceleration from vibration analyzer.
6. Similarly noted above parameters in frequency range of 0-1000 Hz.

S.No	Frequency (Hz)	Displacement (mm)	Velocity (cm/sec)	Acceleration (m/sec^2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Result:

Various parameters of vibration such as displacement, velocity and acceleration are studied and the following characteristic curves were plotted.

1. Displacement Vs Frequency =
2. Velocity Vs Frequency =
3. Acceleration Vs Frequency =

Ex No:

MEASUREMENT OF STRAIGHTNESS AND FLATNESS USING TWO AXIS AUTO COLLIMATOR

Date :

Aim:

To measure the straightness and Flatness given specimen using two axis auto collimator.

Instruments required:

Collimator unit, Base, plain reflector, optical Scanner

Procedure:

1. Testing square with auto collimator.
2. Level auto collimator unit on a stand a table.
3. Straighten the light.
4. Observe measuring graphical through the eye below.
5. The smallest discussion of linear scale is measured.
6. Bring plain reflector in front of the auto collimator to get reflector.
7. Depending upon the verification in surface.
8. Using micrometer provided for eye piece we can measure the frequency up in lose.

Formulae:

Deviation = Sin θ (A-B)

Where angle θ in rad & Distance A-B in mm

Parallel to the Axis:

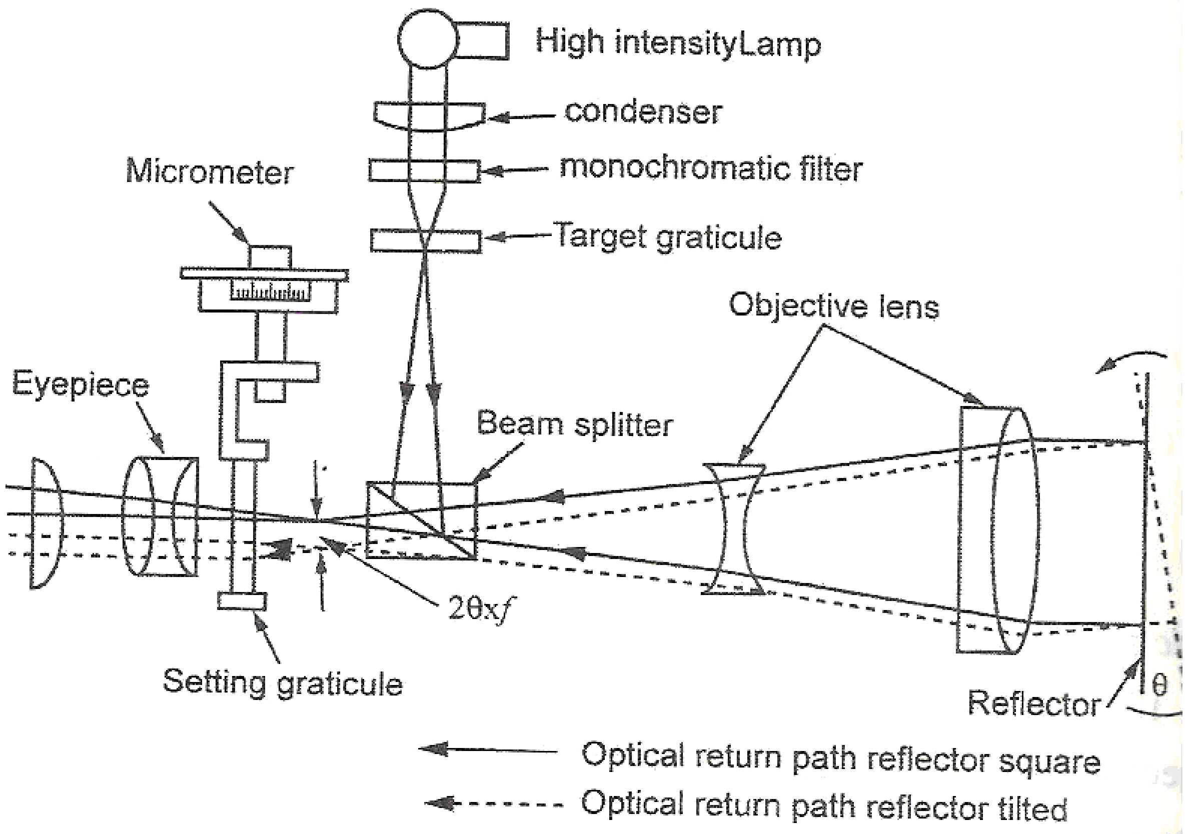
S.No.	Distance from ref A-B (mm)	MSR (Min)	Micrometer (Sec)	Result - θ degree	Deviations (mm)
1					

2					
3					
4					
5					
6					

Perpendicular to the Axis:

Sl.no	Distance from ref A-B (mm)	MSR (Min)	Micrometer (Sec)	Result - θ Degree	Deviations (mm)
1					
2					
3					
4					
5					
6					

Working of auto-collimator:



Result:

Thus the straightness and Flatness are determined using autocollimator.

Graph:

Deviation Vs Distance from reference

Ex No:

FORCE MEASUREMENT

Date :

Aim:

To measure the force using load cell.

Instruments Required:

1. Proving Ring
2. Load cell
3. Force indicator
4. Screw jack
5. Dial gauge.
6. Capacity of proving Ring =2.5 KN.

Description:

Force is one of the major derived parameter having fundamental dimension of mass length and time. It is a vector quantity which, when applied result in a change of momentum in a body. Basically mechanical force is created due to variation of started potential energy.

This is different types of load cell like column type, shear type, s-type, and compression type. In this setup, s-type load cell is provided.

Procedure:

1. Ensure that proving ring along with load all is perfectly in vertical position.

2. Check and ensure that the axis of screw jacks perfectly aligned with load cell.

3. Ensure that load cell with socket is connected to the rear side of the load indicator.

4. Apply a small load without any slip in the system.

5. Note down the reading of dial gauge of force indicator.

Sl.no	Actual load applied (kg)	Deflection (div)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

1 division = 0.002mm

Result:

Thus the force measurement has been measured using load cell.

Graph: Deflection Vs Applied load

Ex No:

TEMPERATURE MEASUREMENT

Date :

Aim:

To measure the temperature using copper constantan thermo couple.

Instruments Required:

1. Thermo couple
2. Temperature measuring setup.
3. Ice cubes.

Procedure:

1. Connect the thermocouple supplied at the input terminal if copper constantan Thermocouple is used. Copper wire must be connected to the terminal and constantan wire to –ve terminal.

2. Immerse the junction of thermocouple in ice and adjust the meter reading at 0° C using potentiometer.

3. Immerse the junction of thermocouple in boiling at 98° C by using Potentiometer marked max.

4. Repeat the procedure for 2 to 3 times.

Sl.No	Actual temperature C°	Indicated temperature C°
1		
2		
3		
4		
5		

6		
7		
8		
9		
10		

Result:

Thus the temperature is measured using thermocouple.

Graph:

Indicated Temperature Vs Actual Temperature

Ex No:

MEASUREMENT OF DIMENSION OF GIVEN SPECIMEN USING TOOL MAKER'S MICROSCOPE

Date :

Aim:

To measure various dimension of a given specimen using Tool maker's microscope.

Instruments Required:

Tool maker's microscope, Specimen, Eyepiece.

Procedure:

1. To find the Major and Minor diameter:

One end of screw thread in made to coincide with cross wire & fixed. Reading is taken. The different between readings given linear measurement.

2. Measurement of pitch:

The contour is get so that the same it an screen. The reading of micrometer is noted. The reading of are subtracted & different is noted.

3. Measurement of thread angle:

The screw is rotated till linear cross wire coincides with flank of thread profile. The angle of screw rotation and than the same line coincides with flank thread.

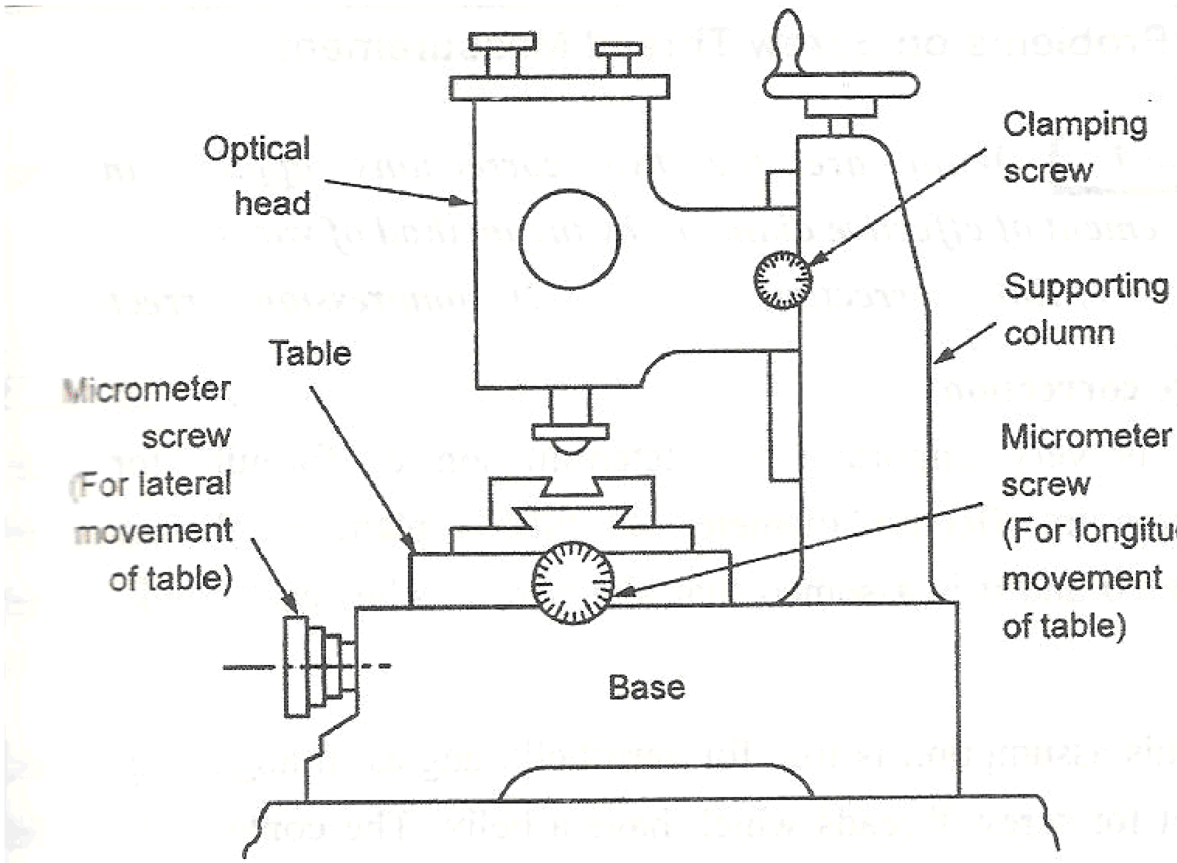


Fig. 3.20. Tool makers microscope.

Result:

The various parameters of the given specimen are measured.