

**Metrology**  
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**Lecture – 27**  
**Angle Measurement-1**

I welcome you all for the series of lectures on metrology. Now we will start the module 8 in this module, we will learn about the taper measurement, tilt measurement, angle measurement and the radius measurement.

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**Topics covered**

- Introduction to taper, tilt and angle
- Combination set
- Vernier bevel protractor
- Optical bevel protractor
- Sine bar
- Sine center
- Sine table

In a first lecture, we will be covering about The introduction to taper tilt and angle. what is the meaning of these terminologies and then what are the various instruments used for the measurement of taper tilt and angle. We will study about the instruments like combination set vernier bevel protractor, optical bevel the protractor, sin bar, sin center and sin table in between we will also conduct some experiments to understand that the measurement of these taper tilt and angle.

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## Introduction to taper, tilt and angle

**Taper:** To become narrower towards one end



**Tilt:** A sloping position or movement



**Angle:** The space between two intersecting lines or surfaces at or close to the point where they meet.



Now let us start the introduction to taper tilt and angle in our daily life we come across with these terminologies tapered it means to become narrower towards one end you can see here there is a component here the length of this particular portion of the component is 40 millimeter and from here to here the diameter is 40 millimeter.

Now it is the towards one end towards other end the diameter is the reducing at this particular location the diameter is the 30 millimeter that means the size is getting narrowed towards the one end such components are called tapered components. We can see one example here a tapered roller bearings and then we will tilt a sloping position our moment so one simple example is shown here.

We have a solar panel its inclination is change with the tilt or the orientation of the solar panel is change that means this position sloping position our sloping moment is known as tilt and then we have the turn angle it is a space between 2 intersecting lines or surfaces at or close to the point where they meet that means if you take the 2 lines OA and OB. These 2 lines are there getting intersected at this point O.

Now this space is known as angle similarly we can have 2 surfaces. So we have 1 surface like this and another surface. So this space between these 2 the surfaces is called angle. You can see

some examples here, we have machine tool the guide way, this is slide and it is a guide way we have the sloping surface here the inclination between these 2 surfaces is the angle.

Similarly we can have a have a sloping surface here and we have a flat surface so the inclination between these 2 surfaces is there is some angle and this angle tilt and taper.

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- There are two commonly used units of measurement for angle/taper/tilt. The more familiar unit is **degrees**. A circle is divided into 360 equal degrees, so that a right angle is  $90^\circ$
- Degrees may be further divided into minutes and seconds. Each degree is divided into 60 equal parts called minutes. So seven and a half degrees can be called 7 degrees and 30 minutes, written  $7^\circ 30'$ . Each minute is further divided into 60 equal parts called seconds, and, for instance, 2 degrees 5 minutes 30 seconds is written  $2^\circ 5' 30''$
- Parts of a degree are now usually referred to decimally. For instance seven and a half degrees is now usually written  $7.5^\circ$

They are normally measured in terms of degrees or radians that means there are 2 commonly used units of measurement for angle or taper or tilt the more familiar unit is degrees a circle is divided into 360 equal degrees, so that a right angle is 90 degree. Degrees may further be divided into minutes and seconds each degree is divided into 60 equal parts each part is called a minute.

So seven and a half degree can be called 7 degrees 30 minutes written as 7 degree 30 minutes each minute is for well divided into 60 equal parts each small part is called 1 second, so for instance 2 degrees 5 minutes and 30 seconds is written as shown here. Now parts of a degree are now usually referred to decimally. For instance 7 and a half degree is now usually written as 7.5 degrees, so this indicates that it is 7 degree 30 minutes.

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- The other common measurement for angles is **radians**. For this measurement, consider the unit circle (a circle of radius 1) whose center is the vertex of the angle in question. Then the angle cuts off an arc of the circle, and the length of that arc is the radian measure of the angle. It is easy to convert between degree measurement and radian measurement. The circumference of the entire circle is  $2\pi$ , so that  $360^\circ$  equals  $2\pi$  radians. Hence,  $1^\circ$  equals  $\pi/180$  radians



Now the other common measurement of angle is radius for this measurement consider a unit circle a circle of radius 1 unit whose center is the vertex of the angle in question if you see this diagram this is a vertex and will be circle with 1 unit radius then the angle cuts off an arc of the circle and the length of that arc is the radian measure of the angle .Now you can see here we have a line here we have another line here these 2 lines they cut the circle.

So this length of arc is the radian, radian. It is easy to convert between the degree measurement and Radian measurement the circumference of the entire circle is  $2\pi$  the circumference to the entire circle is  $2\pi$  so that  $360$  degree equals  $2\pi$  radians and  $1$  degree equals  $\pi/180$ .

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- **Cone angle** is an included angle between generatrixes as measured in the axial plane section



The method of dimensioning and tolerancing conical surfaces on drawings is covered in ISO 3040:1990

Now there is another term cone angle which is frequently used it is an included angle between generic tricks as measured in the axial plane section. Now you can see here we have a conical part here we have multiple generators we can have multiple generators like this. Now the included angle between 2 generators is called corner angle, which is measured in the axial plane section.

The method of dimensioning and tolerancing conical surfaces on drawings is covered in the ISO 304:1990 standard.

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### Combination set



Now various instruments are used for measurement of angle or tilt or taper now we have a combination set we can see here we have a steel rule and then we have a centre head and then we have a square head and then as this is the protractor part. We have a body so this is the body blade which is a which can be rotated and we have the scale here rotary scale here this is a simple protractor varying there is no vernier it can see the details of a simple protractor we have a rotary scale we can see the markings with 0 to 90,100,110 up to 180.

The least count of the simple protractor is 1 degree we have a reference mark here. You can see 0 is marked here. This is a reference and there is a clamp to clamp the blade on the screen rule at any of orientation, now what we have to do is we have to insert the work piece whose angle is to be measure.

For example this is the work piece this angle between this particular surface and this particular surface we want to measure now the work piece is placed between the steel rule and the blade and then there should be intimate contact between the work piece surfaces and the blade surfaces and then, what is the reading of the protractor?

So this 0 is a reference with respect to this what is the angle indicated as shown by the protractor that we have to see that indicates the inclination in this particular case it is showing 4045 degree that means the angle between this particular surface and this particular surface is 45 degrees now we shall conduct a simple experiment to show how to use a combination set for the measurement of angle.

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Now we can see I am trying to measure this yeah this is the guide way the slight slide of the RAM of a shaper. I am trying to measure the inclination and angle between this particular surface and this particular surface. So I am using a simple protractor for measurement of the angle between these 2 processes.

We should the case steel rule should the intimately contact this particular surface and the blade of the protractor should contact intimately with this particular surface and then we can read this scale okay with reference to this particular reference mark. Now you can see the reading it is showing 0 degree, 10 degree, 20 30 40 50 and 55 degree so inclination between the 2 surfaces of the slide he is 55 degrees.

Yeah, can see reading 55 degree so a clamp is provided here we can clamp the steel rule with the protractor and we can remove and then we can read the protractor.

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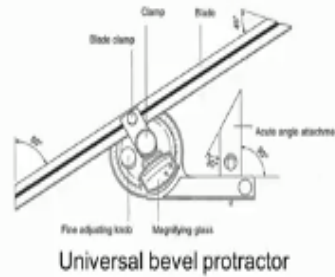
## Vernier Bevel Protractor

Measures angle between two faces of component.

Sliding blade length = 150 to 300 mm

LC = 5 minutes

Digital display



So now that you normally use the instrument for measurement of angle is vernier bevel protractor in the previous case we saw a simple protractor wherein there was no vernier, but here we have a vernier this is a rotary scale which reads 0-360 degree. So these count of this particular rotary scale is the one degree and then we have a vernier, so this is the 0 reference towards 1 side it did she show 60 minutes and the other side it shows the 60 minutes.

Now least count for this particular vernier is 5 minutes that means 5 minutes, 10 minutes, 15 minutes, 20,25,30 minutes like this each degree is divided into 12 parts. So each part representing the 5 minutes now this is the body which contains rotary scale as well as the vernier and then there is a clamp to clamp the blade at any desired angle.

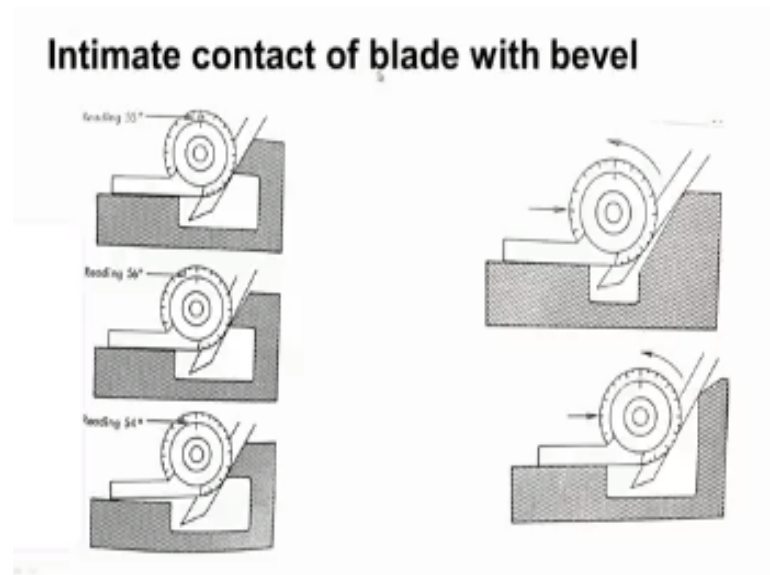
Now the shows the full view of the bevel protractor. Now it measured angle between 2 faces of a component there, there will be one blade which is fixed to the body you can see here this is the body to which the circular scale is fixed and as well as vernier is also fixed but is on the blade which is slide which moves.

So of sliding blade length it varies from 150-300 millimeter least count of this vernier protractor is normally 5 minutes here it is the mechanical displays is there scale is there are bevel protractor with a digital display also. Now you can see there are some attachments to the basic bevel protractor there is an acute angle measurement this is the 90 degree and this angle is 30 degree

and we have a sliding blade so this is again beveled at 45 degree and this shows this angle is 60 degree.

We can use these ends of the blade to check 45 degree and 60 degrees there is a magnifying lens for easy reading and there is a fine adjustment knob for proper adjustment of the blades and use a clamp to clamp the blade to the body. So with these additional attachments the simple dual protractor is called Universal bevel protractor.

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Now other important thing when we use protractor is intimate there should be a intimate contact between blade with the beveled surfaces. You can see here this is the sliding the blade and this is a blade, which is fixed to the body the surface of the fixed blade and the sliding the blade should contact the surface of the work piece intimately. Then only the proper reading can be taken we can see here in the picture deep, We have intimate contact here but there is no proper contact at this place.

So the reading shown is  $>$  the actual angle here. It is showing 55 degree which is a correct angle here it is showing more than 55 degree because of this error so sometimes the 1 blade sliding blade is in contact with the work piece but here fixed blade is not in contact its actually the protractor is climbing on the work piece so there is no contact here so the angle shown is 54 degree which is  $<$  the actual angle.



So again see when we 1 blade should come in contact with 1 perfect to the work piece and then we should the slide the protractor like this till the other blade comes in contact with the beveled surface and then further we should push the instrument so that there is the proper contact at this place then we should take the reading we should clamp for the blade and then we should take out then we can read the instrument.

If you if we further push the instrument you can see here when we push there will be a proper contact like this and if we try to push further again the sliding bit further rotate and then there will be the there will be error in the reading such things should not be there. So while the using direct the bevel protractor the surfaces of the work piece should be properly clean and surface of the blades of the protractor bevel protractor should be properly clean and then we should carefully use the instrument.

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Now we will conduct a simple experiment to learn how to use a protractor now you can see here I am using a bevel protractor with vernier and this will be work piece B block and I want to measure the inclination angle between this particular surface and this surface you can see how to keep the blades we should see that 1 blade is in contact with this particular surface and the other blade should properly contact the other surface.

I can see the proper contact, so if necessary we can take a piece of paper or a feeler gauge and we should try to insert here to see whether there is proper contact or not between the work surface and the blade. So now you can see the contact on this particular place. Yeah, now we can read the instrument now please be circular the scale and then we have the vernier here.

Now you can see the pressure the read from one end the reading is 20 degree, 30 degree 40 degree, okay 40 degree and then we should see which mark is coinciding with the main scale main scale reading is 40, 41 degree, 42 degree, 43 degree, 44 degree main scale reading is 44 degree and then we should see the coinciding division in the same direction that is you can see here.

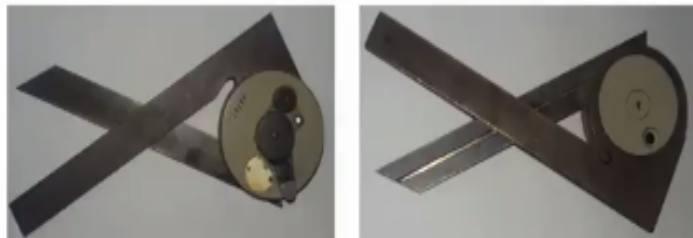
This particular mark on the vernier is coinciding with this 50 degree line. So the vernier reading is 5 minutes, 10 minutes, 50 minutes, so the angle is 44 degrees and 15 minutes. So that is a angle.

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### Optical bevel protractor

Glass circular scale, range 0 – 360 deg. LC 5 minutes



So another variation of bevel protractor instrument is optical bevel protractor here we can see there is a body which houses a circular glass scale which leads from 0-360 degrees again least count in this particular case is 5 minutes. You can see the peeping hole here so we have to keep the work piece between these 2 blades so this is the work piece and we want to measure this angle between these 2 surfaces.

So this surface should contact with displayed and the other surface should contact the other blade and then we should establish intimate contact between the surfaces and then by operating this lever we can clamp it we can flap the blades and then we can remove the protractor from the work piece and then by peeping through this peeping hole or we can read a scale inside. There is a glass circular scale so like this so which reads 0 degree, 10 degree ,20 degree like this and then with a 1 degree marks.

So this is 5 degree again 6,7,8,9,10 this and then there will be a vernier there will be vernier so with 5 minutes 5 minutes least count, so with reference to this 0 on the vernier which we should

take the main scale reading as well as the vernier reading and then where we can note down the inclination their angle.

So this is the back side view of for the bevel protractor you can see a groove here so we can move inside is inside the body there is a projection and over that this movable slide blade slide so at any desired position we can clamp the blade.

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Now this picture shows the full set we have the body clamp peeping holes and then sliding blade with the 60 degree bevel on one side and 45 degree bevel on the other side and this is the blade which is fixed to the body and blade, which is slide. There is a spare a longer blade is provided so wherever necessary we can remove this smaller removal blade and we can insert this blade and we can use it.

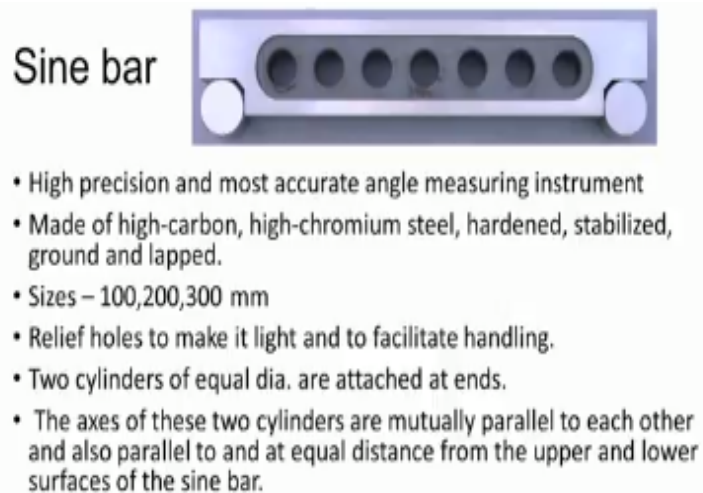
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Now we will see we will conduct an experiment to show how to use the optical protractor now you can see how this milling table I am trying to measure the inclination so this is the guide way we have the top surface of the guide way and then we have an incline surface of the guide way I am trying to measure the inclination between these 2 surfaces using is optical bevel protractor, so we have this slide blade and the blade this is the body clamp for clamping the blade and peeping hole.

So which we can take the readings the back side view of the optical protector, now you can see the one blade one blade should come in contact with the top surface of the guide way and the other blade should contact this sloping surface ,so intimate contact is very essential to get the proper readings now you can see the contact intimate contact between the surfaces and the blade surfaces.

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Another very common instrument used for measurement of angles and tapers is a sine bar this photograph shows a sine bar with the body of the sign box and we have 2 rollers very precise very precisely measuring the rotor fixed to the 2 ends of the sign bar and we have the circular holes here to reduce the weight of the sign bar.

So this is a very high precision and most accurate angle measuring the instrument we can measure the angles even to an accuracy of a few seconds, so these sine bars are they are made of high carbon high chromium steel they are hardened stabilized and ground under lab they are available in various size of 100 millimeter length, 200 millimeter length and 300 millimeter length.

This length means the distance between centre of this roller and this Center the distance between the Centers of the roller is the size of sine bar so these relief holes are provided to make it light and for easy handling the diameters of these 2 cylinders are rollers attached to the 2 ends.

Diameters are equal, equal diameter rollers the axis of these 2 cylinders are rollers are mutually parallel to each other and also parallel to and at equal distance on the upper and lower surfaces facing but that means the axis of this roller and access objects roller should be parallel to each other should be parallel to the top surface resign bar under parallel to the bottom surface will be sine bar.

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## Sine bar

-Sine bar is used in combination with slip gauges for precise angular measurement.

-It is used either to measure angle very accurately or to locate any work to a given angle.

-Accuracy up to 0.01mm /m length of sine bar can be obtained.

-IS: 5359-1969

Now sine bar it is used in combination with slip gauges for precise angular measurement. It is used either to measure angle very accurately or to locate any work piece to a given angle accuracy up to 0.01 millimeter per meter length of sine bar can be obtained these sine bars are made as per Indian Standards 5359-1969.

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Accuracy requirement and tolerance specified by IS: 5359-1969 for a 100 mm sine bar are as follows:

1. Flatness of upper and lower surfaces = 0.001 mm
2. Flatness of side faces = 0.005 mm
3. Squareness of side faces to upper surface = 0.003/25 mm
4. Squareness of end faces to upper faces = 0.003/25 mm
5. Straightness and circularity of rollers = 0.002 mm
6. Variation in distance between roller axis = +/- 0.003 mm

Now accuracy requirement and tolerance is specified in Indian Standard 5359-1969 for a 100 millimeter sine bar as follows: Flatness of upper and lower surfaces should be 0.001 millimeter and the flatness of side faces should be 0.005 millimeter, squareness of size faces to upper surface that means if this is the very sine bar squareness of the side surfaces to the upper surface should be within this 0.003/25 millimeter.

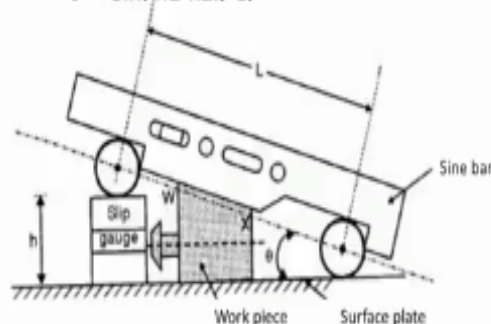
Similarly squareness of end faces to upper faces surface should be within this 0.003/25mm and the straightness and circularity of rollers should be < 0.002 millimeter, variation in distance between roller axis should be less than +/-0.003 millimeter.

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- The sine bar should not be used for angle greater than 60 degrees.
- To measure unknown angles (taper) of small work pieces

$$\sin \theta = (h_1 - h_2) / L$$

$$\theta = \sin^{-1}((h_1 - h_2) / L)$$



Now these were sine bar should not be used for angles  $> 60$  degrees for smaller angles these can be used to get the precise the angular value to measure unknown angles or tapers of small work pieces these are preferred these sine bars are preferred and you can see the arrangement how we can use a sine bar for measurement of taper angle you can see here this is the work piece and we need to measure the taper or the angle between this surface and this surface.

So this is angle that is to be measured we have to keep the work piece on there to clean the surface of the work piece and we should keep the work piece on the clean the surface plate and then over that we have to mount the sine bar as shown in picture we can take the help of may be the angle plate or magnetic stand to mount the sine bar over the work piece.

Now you can see here one roller is in contact with a surface plate and then the gap between the roller under the surface plate is filled with the slip gauge which indicates an height of  $H$  and the distance between the Centers of rollers is  $L$  this is the length of sine bar. Now by knowing the value of  $H$  and knowing the value of  $L$  they can find out the angle  $\theta$  using this relationship  $\sin \theta = (h_1 - h_2)/L$  where in this case  $h_2$  is 0 and this is the  $h_1$ .

If we have the arrangement like this so this is the surface plate and then this is the component the taper of which is to be measured and then we have 2 mounted a sine bar like this and now this is a roller and we have another roller here. So in this case we have to fill this gap between roller and surface plate using slip gauges, so in this case this is  $h_1$  and here it is  $h_2$  and this is  $L$  so now this  $\theta$  is  $\theta$  can be calculated using relationship so  $\theta = \sin^{-1}((h_1 - h_2)/L)$ .

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Now we will conduct a simple experiment to learn how to measure the angle using the sine bar. Now you can see the arrangement for the measurement of taper angle of this particular tapered component, now we have the surface plate we have to clean the surface of the surface plate and then we have to keep the cleaned work piece on the surface plate.

We can take the help of an angle plate for proper mounting of the sine bar this the sine bar these are the relief holes and we have 2 rollers of equal diameter 2 cylinders of equal diameter fixed to

the sine bar and then this is the magnetic stand and then we have the slip gauge box to fill the gap between roller and the surface plate.

You can see the close view of the tapered component is dead center of plate. Yeah this taper or cone angle we want to measure angle plate the tops surface of sine bar and then side surface of sine bar until a relief hole they have the slip gauge box. Now we have to mount the sine bar on the work piece that is tapered component and then we have to keep the magnetic stand in front of the sine bar.

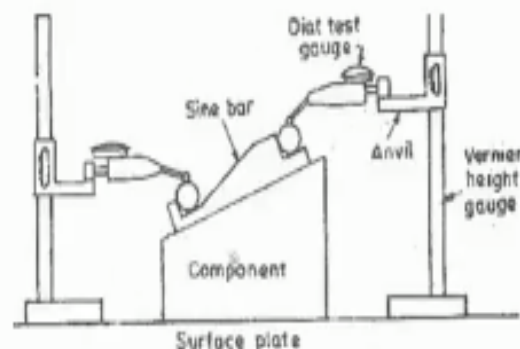
So that it will not fall the backside on the other side. We have the angle plate and from the front side we have magnetic stand to support the sine bar and then magnetic stand is switched on now you can see the component taper component below the sine bar and then this gap, gap between the cylinder and the surface plate should be filled using slip gauges.

So that will give  $h_1$  height  $h_1$  and the other side also we should fill the gap between this cylinder and the surface plate using slip gauge slip gauges so that will give  $h_2$  knowing the values of  $h_1, h_2$  and  $L$ . We can find out the taper angle  $\theta$  that  $\theta = \sin^{-1}((h_1 - h_2)/L)$ .

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- Checking of unknown angles of heavy component
- Use of sine bar and vernier height gauges





Sometimes the work piece will be very heavy so checking of unknown angles of heavy component in that case how do we use the sine bar so we can place the sine bar as shown here you can see the top surface is in contact with the component heavy component in cylinder are on the other side now we can use the vernier height gauges to check where the  $h_1$  and  $h_2$ .

So we can always use vernier height gauge to check this height  $h_1$  and here this height is  $h_2$  and then  $L$  is the length of the sine bar knowing  $h_1$   $h_2$  and  $L$  we can find out the angle  $\theta$  this angle  $\theta$  using the relationship  $\sin \theta = \frac{h_2 - h_1}{L}$  so using this relationship we can find the tip taper angle of the in component.

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### Lathe setting for taper turning



Now you can see the another application of sine bar this is the setting of lathe for taper turning you can see the work piece in which we have to cut the taper we want to maintain some well to cut some taper and now the tile stock can be also be tile stock quill can be moved. You can see the sign bar and this is the reference bar sign bar and between the cylinder, cylinder of the sign bar and reference surface we have filled with the slip gauge.

So like this knowing the value of  $h_1$  difference  $h_2$   $h_1 - h_2$  and length of the sign bar can find out the  $\theta$  or if we know what is the angle that is required we can find out what is a height of slip gauge and then we can arrange the lathe for taper turning in this fashion.

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## Sine center

These are used in situations where it is difficult to mount the sine bar on the component



Now another variation of sine bar is a sine center you can see here we have the body of the sine center these are the relief holes and then we have cylinders fixed to the body of the sine center and then here we have 2 centers these are the centers they are slidable you can see the slot here we can loosen the clamp and then we can move the centers axially like this to accommodate the work piece of a different length.

So this sliding arrangement is provided so these sine centers they are used in situations where it is difficult to mount the sine bar on the component so what they can do is we can mount the work piece between the centers like this and then using a dial indicator we have to keep the slip gauges here so this is a surface plate so this is  $h_1$  and this is the  $h_2$  okay.

Now we should find what should be the value of  $h_2 - h_1$  okay  $h_2 - h_1$   $h_2 - h_1 / L$ . We know what is the size of the sine bar and say we have a tapered component so we should place the tapered component here between centers and then we should adjust this height  $h_1$ -,  $h_2 - h_1$  the difference height we should adjust till the dial indicator reads 0 so we can always change this  $\theta$  by varying this height difference.

So that the dial indicator we have to move the dial indicator on the generator of the tapered component okay when they move the dial indicator on the generator of the work piece this should reach 0 like that we should adjust this inclination so when it reads 0 then there will be a

particular value of theta so that is the cone angle of the tapered component so like this we can use the sine center for measurement of angles taper angles.

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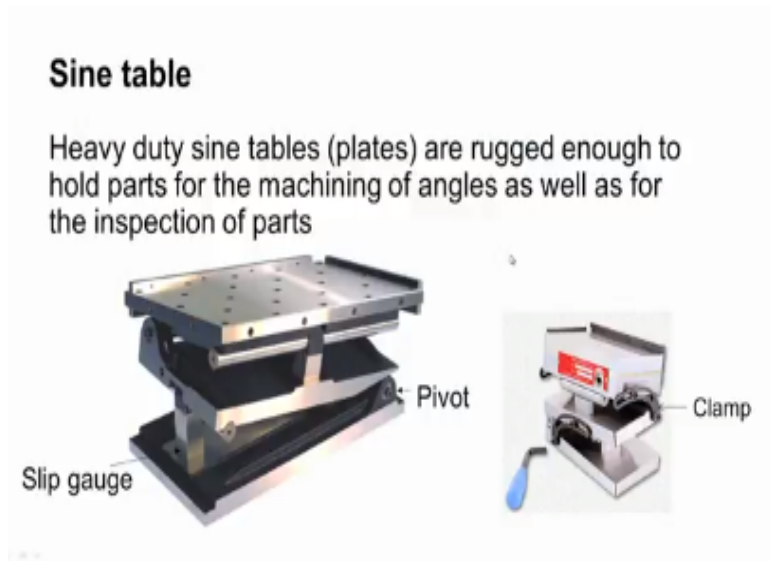
Now you can see and advance the sine center this is the base and then this is the sine table so it is pivot here okay. So this sine table can be tilted in this fashion. We can tilt the table and we can place here there is a roller and this is a surface design table, so here after lifting it after tilting it we have to fill this gap using the slip gauges.

You can see in this picture the slip gauges are placed so we should calculate the measures the slip gauge height till the dial indicator reads 0 we have to mount the tapered component between the centre can see the centers now the body which contains the centre can be moved horizontally like this to accommodate this also can be slid to accommodate the work piece of different then these 2 can be slid.

You can see yet the type of component is mounted between center and then there is an attachment here there is a arrangement for mounting the dial indicator you can see the dial indicator is mounted and this head can be moved up and down, you can see the guide base here so this head can be moved up and down again that accommodate the work pieces of different sizes so then the dial indicator is moved horizontally ok till it reads 0 throughout.

So like that we should adjust slip gauge height and then the angle can be calculated that will be the angle of taper angle of the work piece.

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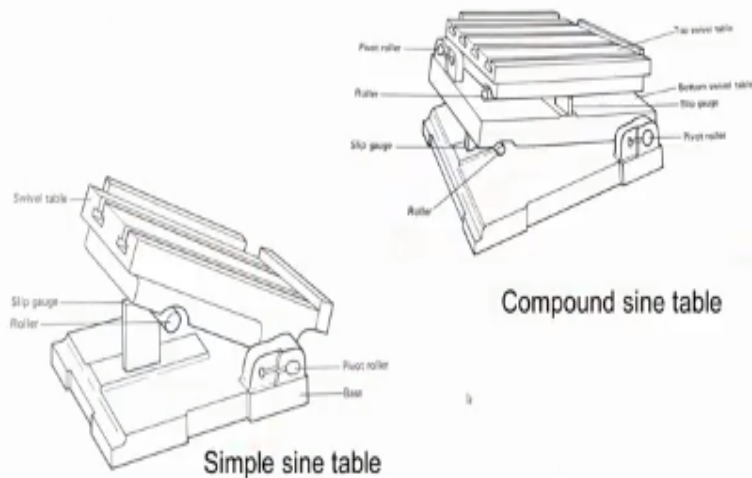


Now another variation of sine table sine center a variation of sine center we can see here. This is called the sign that table so this is the base of the sign table and you can see the table, table can be tilted so this table can be tilted we can see the pivot here a roller fixed sine table and between the roller and the base surface top surface we have to insert the slip gauge, so and there is another this is a basically a compound the sine table.

So this table can be tilted like this there is another table mounted over this table which can be tilted in this fashion. so in 2 planes we can tilt the plates these 2 plates again you can see the pivot here and there is a roller fixed to the bottom surface of this top plate so here we have to keep the slip gauge for adjusting they require the angle you can see the holes are provided for mounting the component on this particular table.

So these sine tables are heavy duty tables they are very rugged to hold the defaults for machining of for measurement of angle as well as for machining of angles work pieces can be mounted on this table and it can be machine you can see the clamp for the 2 plates or 2 tables okay using these clamps the tables, the angles can be rigidly clamped the tables can be clamped.

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Now these are the Schematic views of simple sine table here we have only one the availing the table pivot and roller which is fixed to the bottom of prevailing table and this is a reference surface on which slip gauge they should be placed, so between roller and the reference surface the slip gauge can be place and then required angle can be maintained and this is the schematic diagram of compound the sine table.

We have 2 plates here this is one plate which can be tilted there the change in this fashion and there is another table which can be tilted in this manner, so we have 1 the pivote for this filling the table and this is the pivot for another table you can see the T slots for mounting being for work pieces on the top of swivel table.

**(Video Starts: 51:25)**

So we will see a simple sine table you can see the top surface of the sine table. We can also see the T slots you can see the pivot work here pivot roller there is a provision to put a rod here using that rod we can tilt it so that required angle can be maintained I can clearly see the T slots here for mounting the work pieces and we can see the slots here for mounting this sine table on the table of machine, machine tools.

A rod can be placed here and then if this pivot work can be rotated to change the angle slots for mounting design table, machine table. Now this is the surface or bitch slip gauges should be a place we should clean the surface and then we should keep the work pieces ah slip gauges we

can also see the roller fix to the bottom surface of the swiveling plate so between the roller and this surface we should keep the slip gauges.

**(Video Ends: 53:43)**

We can also see the pivot out roller, so now let me summarize the topics covered in this lecture we discussed about the meanings of taper, tilt and angle we also learnt about the various instruments used for measurement of taper and angle we learnt about the combination set and then vernier beveled protector, optical bevel protractor. We also studied about the sine bar, sine center and sine table of different types that is the simple sine table and compound sine table.

We also conducted some experiments to learn about how to use these instruments, so we will stop the lecture at this point and we will continue this in the next lecture. Thank you.