**Metrology**
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**Lecture – 24**
**Measurement of Screw Thread Element**

I welcome you all for the module 6 lecture 2, in this lecture we will be covering the following topics.

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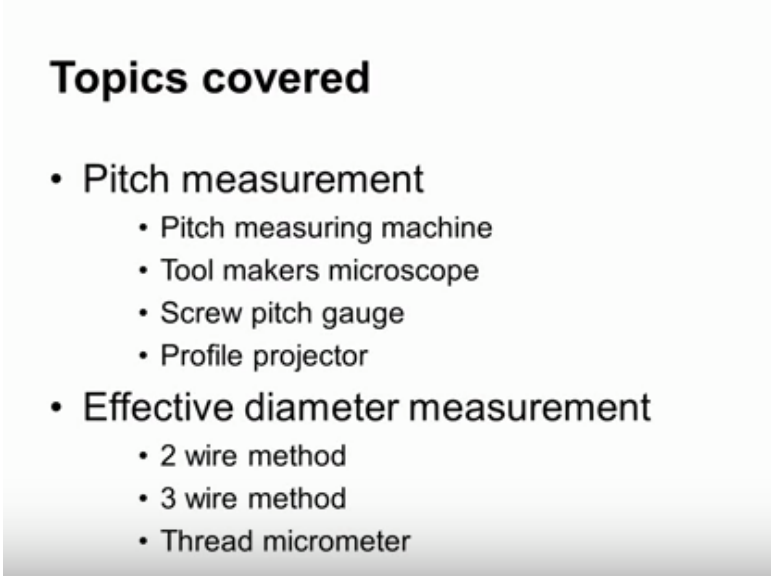


The measurement of pitch, wherein we will be discussing the use of pitch measuring machine and use of toolmakers microscope, screw pitch gauge and profile projector and then we will move to measurement of effective diameter, wherein we will be discussing about 2 wire method, 3 wire method and the use of thread micrometer.

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## Pitch measurement

The most commonly used methods for measuring the pitch are

1. Pitch measuring machine
2. Tool makers microscope
3. Screw pitch gauge
4. Profile projector

Now we will start the measurement of screw thread pitch. The most commonly used methods for making a pitch are pitch measurement using the pitch measuring machine use of tools makers microscope user use of screw pitch gauge and then use of profile projector.

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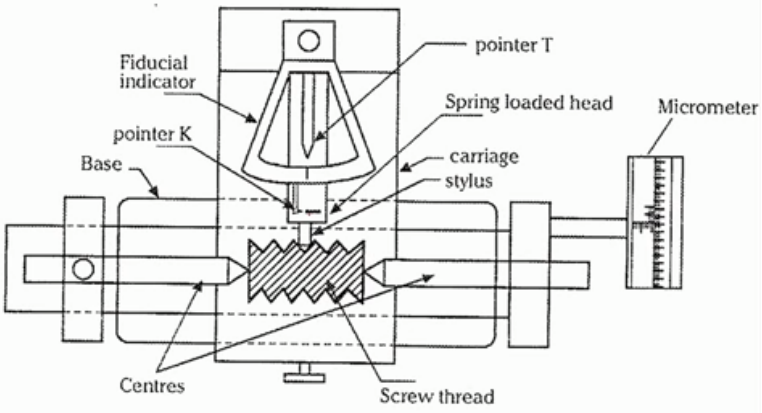
## Pitch measuring machine




A set of stylii is supplied along with the machine along with selection guideline

Now this diagram shows the pitch measuring machine, so we have the base made of cast iron very sturdy base and then they have Center 2 centers are provided for mounting the screw thread and then there is a carriage which will move parallel to the axis and then in the carriage. There is a stylus mounted on spring-loaded head and then they have 2 indicators 1 is fiducial indicator to ensure that same pressure is maintained throughout the pitch measuring.

Then there is another indicator K to indicate that stylus is in proper location and then we have a micrometer using the this micrometer when we rotate the micrometer the head measuring head will move because of when the measuring head moves parallel to the axis. The stylus will move in against the spring pressure and then when the carriage furthermost it will move down into the groove and it gets seated in the next groove.

The distance moved from the first position to the next position will give us the pitch of the screw thread. A set of stylus is supplied along with the machine along with a selection guideline so depending upon the type of thread and pitch of thread etc. We have to select the appropriate stylus and then we have to mount the stylus in the head.

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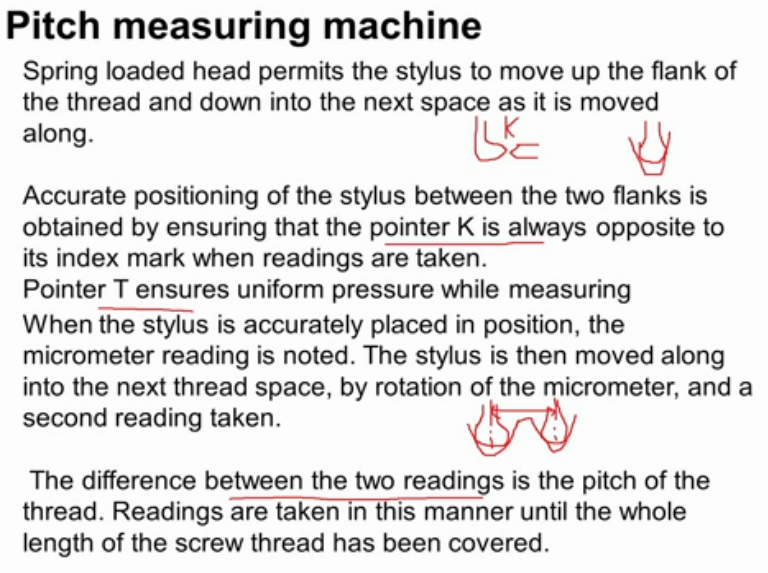


So accurate positioning of the stylus between the 2 flanks is obtained by ensuring that the pointer K is always opposite to its the index mark when reading are taken that means, When this stylus is in a proper position, when the stylus is placed like this between flanks the pointer K will indicate whether the pointed K should be just against the reference mark.

So this is the pointer K stylus of this the pointer should be against its reference so this indicates that the location of the stylus in the thread group is proper and the pointer T that is fiducial indicator ensures the uniform of pressure. The difference between the 2 readings that means

either the stylus is the place in the first thread groove then the micrometer is the reading is taken and then it is the moved to the next groove.

So the distance moved by the stylus from the first position to the next position gives the pitch. Now this pitch measurement can be carried out for 5,6 or more than for all these thread grooves and an average pitch value can be calculated.

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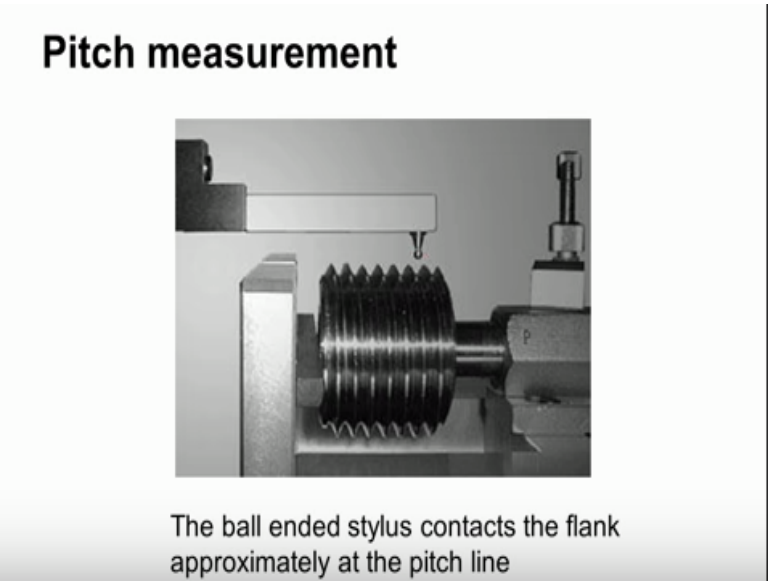


Now this picture shows the arrangement of pitch measurement we can see we have a center on which the screw thread is mounted and we have a ball which carries the stylus. The stylus will move from 1 thread to the next thread and get seated into the thread groove and then the micrometer reading is taken and then it is moved to the next thread so like this we can measure the pitch and the stylus others contact the flank approximately at the pitch line.

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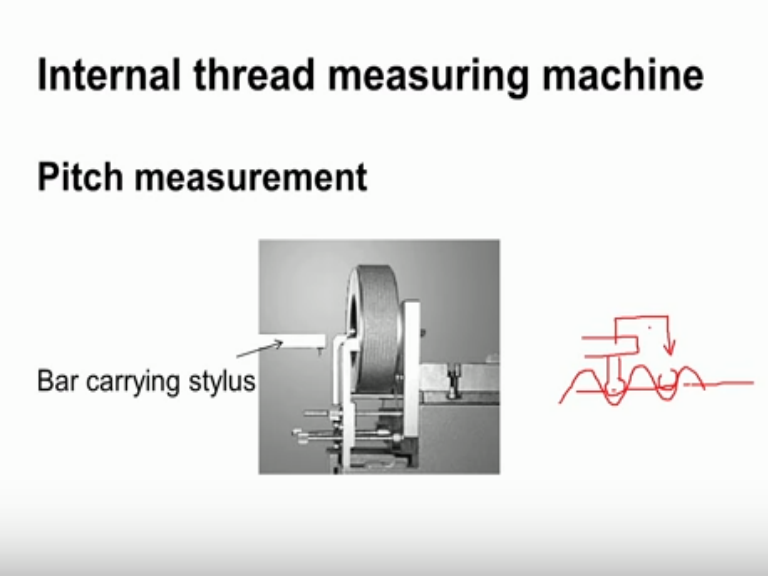


Now internal thread the measuring machine and how do we check the pitch of internal thread. You can see here the arrangement is we have a bar which carries the ball ended stylus and there is an arrangement to mount the work piece with the internal thread the bar the bar along with the stylus will move in and it gets seated integrally thread like this, so will be having the screw thread like this so this bar with the stylus will move into the work piece having the screw thread.

So this is a bar and this is the stylus the ball and stylus and this is the pitch line but this ball end be seated in the groove approximately at the pitch line and then the micrometer reading is taken and then it is the withdrawn and the bar is the withdrawn and it then it goes to the next position again it gets seated ball is seated like this and again other reading is taken, so the difference in reading gives a pitch of for internal the thread.

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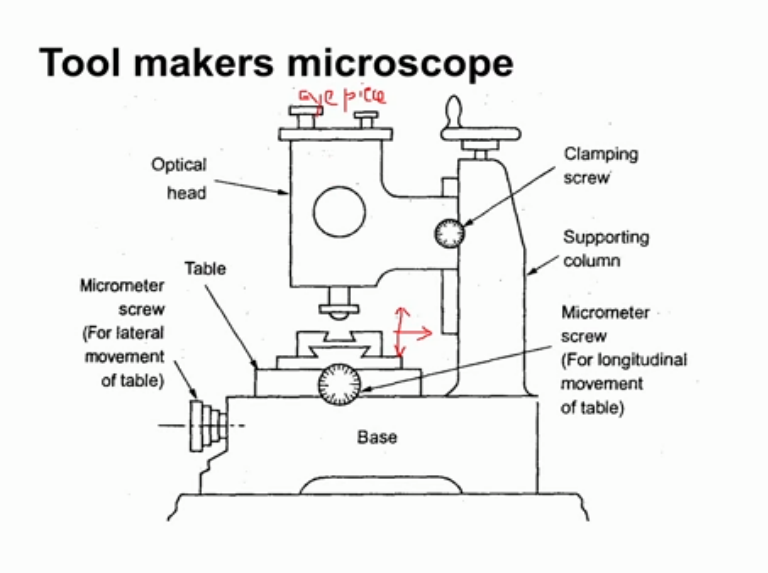


Now tool makers for microscope can also be used for the measurement of pitch the construction of the tool maker microscope is shown in this schematic diagram. We have a sturdy cast iron base and there is a column the work table, work table is mounted on the base the work table can be moved in X and Y direction that is it can be moved perpendicular to the column like this and it can be moved parallel to the column.

So for moving the table you can see the micrometer screws are provided and then the table carries a glass plate the work piece should be placed on the glass plate and the light will move pass through the work piece and the shadow image a will be obtained there on the screen which can be observed through the eye piece.

So this is a eye piece to which we can observe the shadow and then this is the optical head which carries all the collimating lens and an eye piece and this is the objective the magnification can be selected depending upon the requirement like the objective may be some 3X magnification similarly eye piece magnification can be selected this optical head can be moved up and down for focusing purpose.

We can see there are great guide ways are provided for a moment of optical head and there is a wheel which can be used to move the head up and down and it can be clamped and is a clamping screw after focusing the head this clamp and this is the wheel for moving the head up and down.

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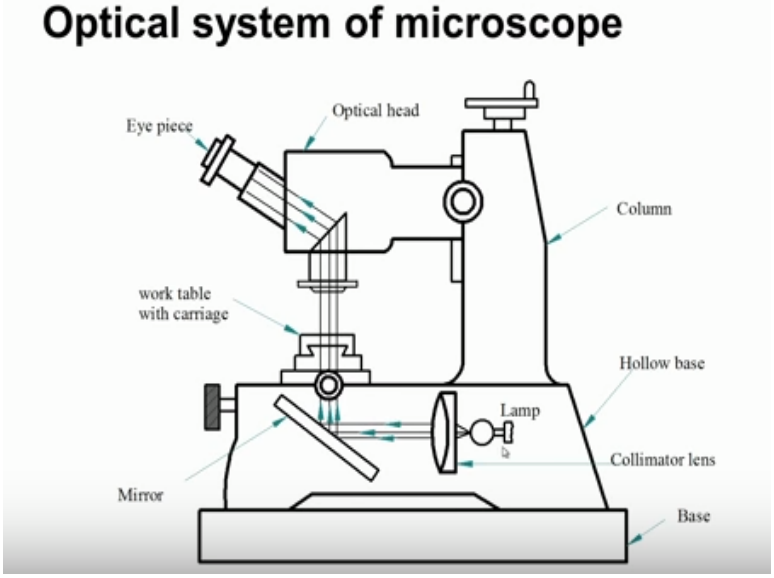


This is the optical system of microscope you can see the body has a lamp normally a tungsten filament lamp is used and they are set of lenses collimating lenses to get parallel beam of light and there is a mirror so using which the light beam is diverted and we have a glass plate here over which we can place the work piece, work piece should be placed here. For example we want to measure the pitch displaced on the glass plate light will pass through the work piece and value we get the image which we can observe through the eye piece.

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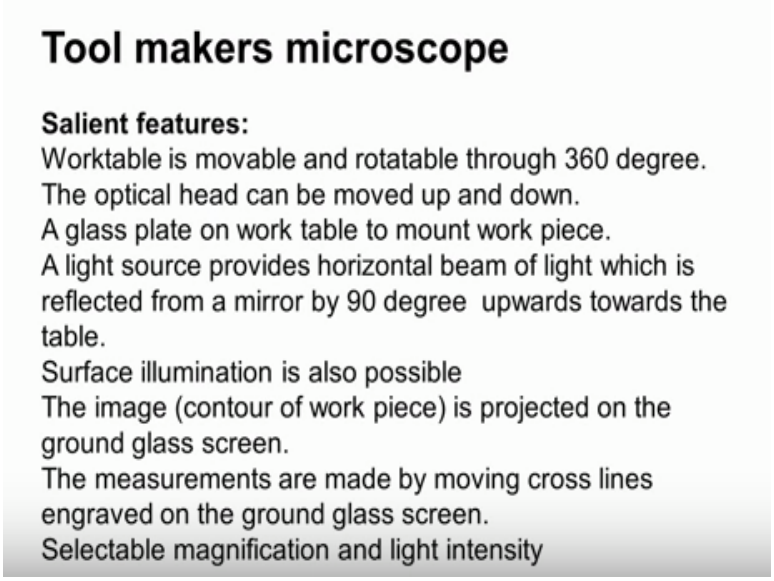


Now but these the toolmakers microscope they have movable and rotatable tables. The table can be moved in the X and Y direction. So that we can take the measurement and it can be rotated

also so this will be very useful while measuring the thread angle of work piece. The optical head can be moved up and down for focusing the purpose and there is a glass plate on work table to mount the work piece.

So that the light will pass through the glass plate and will pass through the work piece and we get the shadow image light sources are provided which will give us a horizontal beam of light which is deflected by mirror by 90 degrees upwards the table surface illumination is also possible whenever they want to measure the surface characteristic of work pieces.

If the surface illumination can be used the image that is the contour of the work piece is projected on the ground the glass screen which has the scale which is rotary scale as it has cross shape using which you can take the measurement the measurements are made by moving the cross lines engraved on the ground glass screen the magnification can be selected depending upon the size of the work piece.

If it is very small then higher magnification can be used and similarly light intensity you can also be selected, so now what we shall see a tool makers microscope and we will understand the construction and how it works.

**(Video starts: 13:19)**

You can see the tool maker microscope the construction. This is the work table this can be rotated also you can see the grooves are provided for fixing the fixture work piece fixture and then the table can be moved parallel to the column this is the column of tool makers microscope table can be moved parallel to the column and perpendicular to the column using these the micrometer wheels these micrometers.

They have a very fine accuracy the least count of this these micrometers is the 1 micron you can see the column and you can see the rack also and we have a wheel here for moving the optical head up and down for focusing purpose and you can see the eyepiece and then this is the objective the lenses of objective and eyepieces can be changed to get the required magnification and in below this table we have a light source through which we get the beam of light for surface illumination purpose.

We have another light source placed in the measuring head here is the eyepiece and you can see the objective now that is the 3X objective placed you can also see the rack which is used for a point on movement of the head so these are the micrometer, micrometer for a moment of table in X and Y direction that is parallel to column and perpendicular to column you can see the glass plate on which the work piece can be mounted here.

We can see remain switch and then 2 black rotary knobs are there so this one is used to get the surface the illumination you can see the light source light is reflected back so this surface illumination is used whenever we want to check the surface characteristics and this knob we have to use when we want to get the shadow images of the contour to contours of work pieces the least count of this micrometer is 0.001 millimeter.

Main switch surface illumination knob you can see the brightness can be adjusted this is off position brightness 1, 2, 3 brightness in different intensities we can have. So similarly this is the vertical illumination to get to get the contours of your pieces again brightness can be adjusted the through illumination using this tool maker microscope.

We can measure the various thread elements like pitch of the screw thread and then thread angle and a major diameter minor diameter so all the thread elements can be accurately measured so whenever the work piece of scooters are very, very small the we can get the magnified image and then the measurements can be obtained so whenever it is not possible to use other types of instruments like thread micrometer or outside micrometer then this tool makers microscope will be very useful.

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You now we will move on to the use of screw pitch gauge which is used to measure the pitch of screw thread, now in the this picture shows a set of leaves we can see here arranged in a handle and the what is the pitch value are marked on each leaf so by trial and error we can measure the pitch of the screw thread and a light source is needed to check the pitch that means we have to say this is the screw thread this 1 piece having the screw thread.

We have to select leave which will match with the this is the gauge pitch gauge and back side we should have a light source so we get the light and then we should observe in this direction if the light passes between the pitch gauge and work piece then the match is not perfect then we should change the gauge and this process we should continue till the light will not pass through the gap between pitch gauge and work piece like this we can measure this screw pitch gauge.

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We can measure the pitch using a screw pitch gauge now let us see how we can use a pitch gauge to measure the pitch we have a screw thread whose pitch is to be measured it is held in left hand and pitch gauge is held in the right hand. We should select the pitch gauge particularly a leaf should be selected and placed on the screw thread if the match is pakka which this combination should be viewed against a light source.

If the light does not pass between the gap then the matches and we can read the pitch value that is mentioned on the leaf.

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Now we can see 1.75 is mentioned on this leaf so the pitch of this screw thread is 1.75 millimeter.

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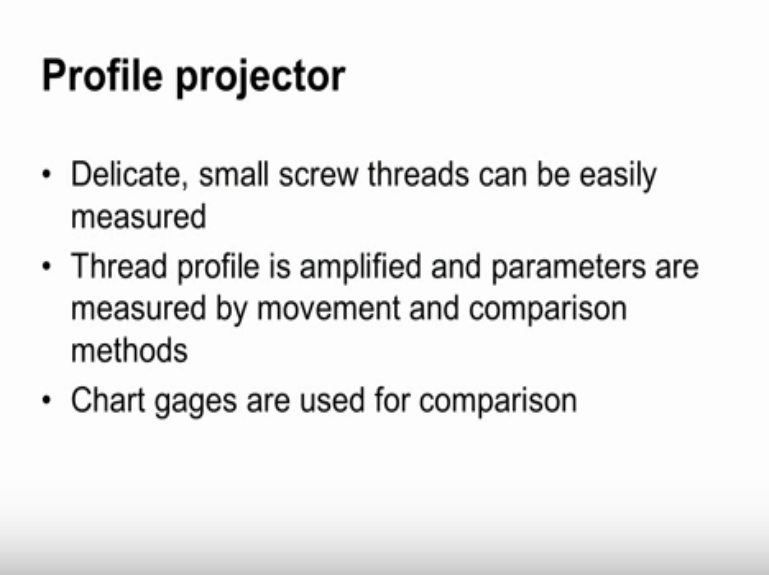


Now the profile projector is also used to check the pitch of the screw threads the working principle is similar to the working principle tool makers of the microscope when a profile projector the image of the work piece that is screw thread is obtained on the ground glass screen and then by moving the image against the reference cross lines we can measure the thread element like pitch thread angle etc

Those elements can be measured so very delicate and the small screw threads can be easily measured using profiler projector and the thread profile is amplified and parameters are measured by moment and comparison methods chart gauges are used for comparison purpose so depending upon the type of screw thread whether it is Whitworth thread or metric thread or acme method we should select appropriate chart gauges.

The chart gauge should be mounted on the viewing screen, so this is a chart gauge so which will have 2 contour lines and then we should obtain the image of the contour of the work piece if the image lays between the 2 lines on the chart gauge then the is this image obtained so if it lies within these 2 lines corresponding with maximum size and is corresponding to the minimum size so there is a tolerance band in the image contour is well within the tolerance band.

Then what piece is accepted so this is the comparison method in the moment method on the screen. We observe 2 cross lines say we want to measure the pitch of this screw thread. We should get the image and then we should move this cross line, so that it meets the crust here and the micrometer reading is taken then it is moved to the next position again it is the in at this particular place that is crest of for the next thread.

Then again the micrometer reading is taken so the difference between these 2 micro meter readings gives the pitch of the screw thread so this is all we can use the profile projector for pitch measurement. Now let us see a profile the projector to understand how the construction and working of profile projector.

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Now you can see the viewing screen of profile projector and we can also see the image of this screw thread the contour of a screw thread we can observe the vertical cross line and horizontal cross line. Now the horizontal cross line is contacting the crest of these screw thread, yeah now it is in contact with the crest of screw thread I can see the protractor ring with the vernier I can see the display X and Y display both are reading zero.

Now the cross line is moved so when we operate the micrometer the stage will move and image with also move now we can see the cross here is touching the crest on the other side and now we can see the reading so this page has moved towards the column and the initial reading was zero and now it is reading 11.657.

So 11.657 millimeters is the major diameter of the screw thread now again we are moving the work table you can see the cross line is moving here now both X and Y are 0 again we are moving this image I can see Y is showing -9.672. So this is the minor diameter of the screw thread that means a horizontal cross line has moved from root to root so which will give us the minor diameter of the screw thread.

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I can see the cross horizontal cross line is in contact with the root using the profile projector we can measure the minor diameter, major diameter, pitch, thread depth, triangle etc.

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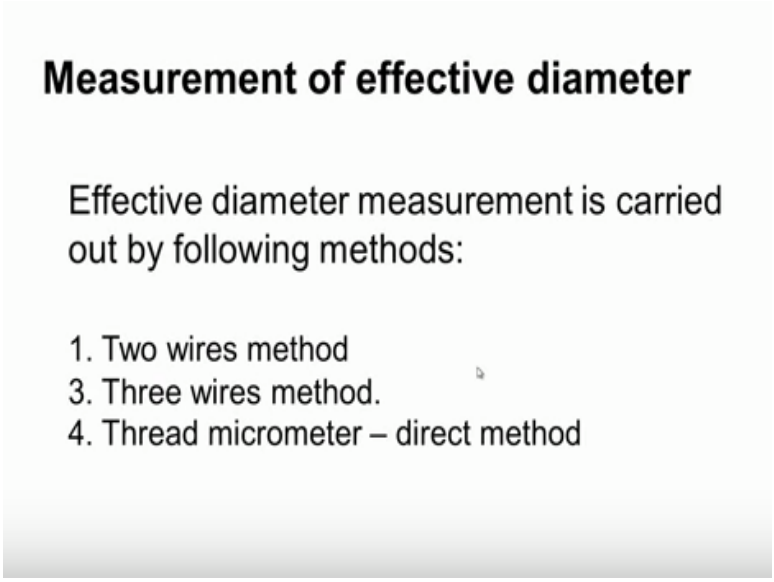


Now we will move to the measurement of effective diameter effective diameter the measurement is carried out by the following method that is by using by using 2 wires method, 3 wires method and by using thread micrometer so this thread the micrometer method is a direct method which involves no calculation it directly measures the effective diameter whereas the first 2 methods we will not give the direct effective diameter measure.

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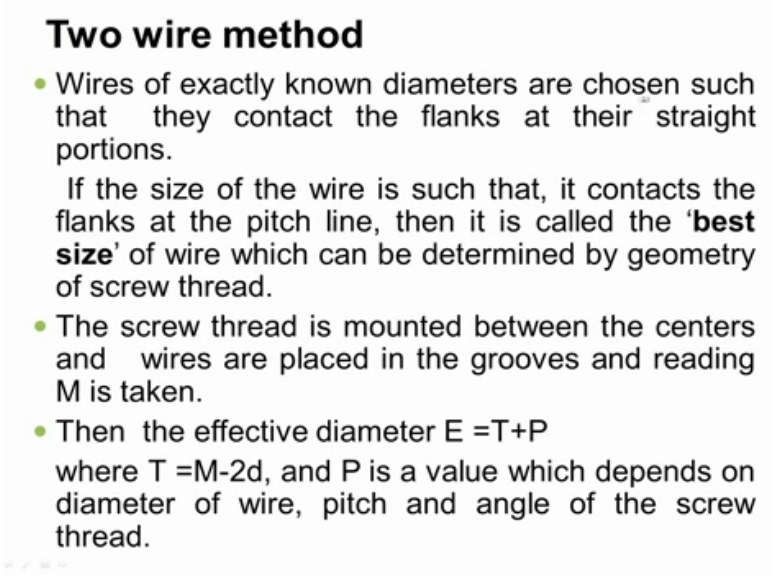

We have to calculate the effective diameter so 2 wire method the wires of exactly known the diameter are chosen such that they contact the flanks at their straight portion that is we have this screw thread. So we have to select a wire which will make contact the flank like this so this will be pitch line so the wire will make contact on the straight portion of the flanks it is size of the wire is such that it contacts the flanks at the pitch line, then it is called the best size of the wire.

Which can be determined by geometry of the screw thread so if the screw thread profile and this is the pitch line if the screw thread if the wire size is such that it contacts if flank exactly the pitch line, then it is called the best size wire. The screw thread is mounted between the center and wires are placed in the grooves and reading M is taken, reading M mean measurement over ruler.

So then after finding the M the effective diameter can be calculated using this relationship E=T+P. Where T=M-2d M is a measurement over roller which is obtained by micro meter and the small d in the wire size. So when we deduct twice wire diameter from the M we get T and then we can calculate effective diameter using this relationship T is E=T+P and P is a value which depends on the diameter of wire pitch of screw thread and angle of screw thread.

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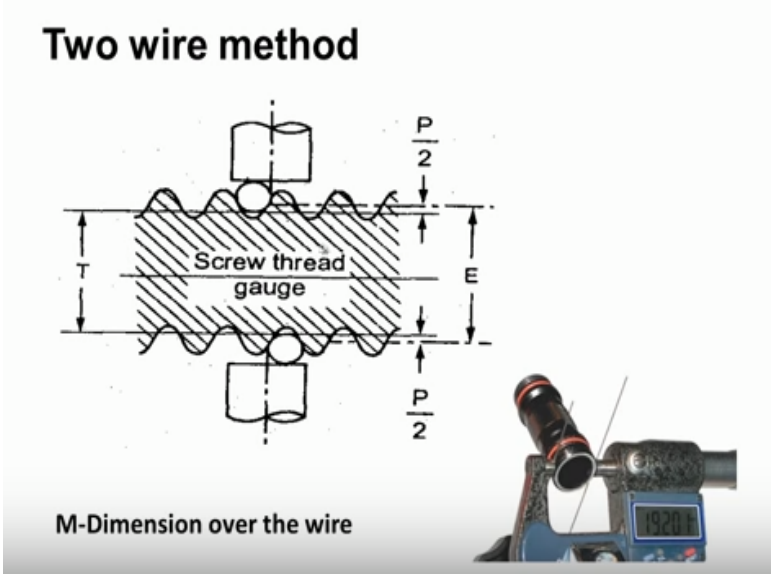


Now you can see here in this schematic diagram we have a screw thread this is a screw thread gauge is the work piece who is the effective diameter is to be measured and we have 2 wires 1

wires or rod is placed in the groove and in the opposite groove we have placed another wire of known the diameter small d small d is the diameter of this wire.

Now we can see the rod has entered into the thread and some portion or of the rod is the below the effect below the pitch line. So this is the pitch line and is the ball lowest point so this gap=P/2. Similarly on the other side we have P/2, so we can measure the M it is measurement over wires so this is the M this is M dimension over the wire this can be measured using a micro meter then effective diameter can be calculated by using this T is measurement under rollers measurement under roller +P.

So P/2 here and P/2 here we have to add so we get E=T+P where T is measurement under the rollers which can be obtained. So T=M-d-d, M-2d, so T can be obtained M is obtained by measurement diameter is the known so T can be calculated and P it depends on the thread angle pitch which can be calculated.

I can see 2 wires or 2 rods are placed this is the work piece having routed 2 rods are placed in the opposite direction and these are the angles of the micrometer. So this is this shows the measurement of M measurements over roller and this will indicate micrometer will indicate what is the value of M.

These 2 rods we can hold them by hand or we can use a machine known as the floating carriage micrometer which we will discuss after some time so some arrangement is provided hooks are provided in the floating carriage micrometer, so the rods can be hung from this hook.

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The effective diameter E is calculated by $E = T + P$

Where, $T$ = Dimension under the wires = $M - 2d$

$M$ = Dimension over the wires

$d$ = diameter of each wire

If $P'$ = Pitch of thread then

$P = 0.9605\,P' - 1.1657d \Rightarrow$ Whitworth thread.

$P = 0.866\,P' - d \Rightarrow$ For metric thread.

Here, $P$ =The difference between the effective diamet and the diameter under the wires.

The diameter under the wires '$T$' also can be determined by

$T = S - (R_1 - R_2)$

Where, $S$ = The diameter of the standard.

Now the T is the dimension under wire which =M-2d and M is dimension over wires d is the diameter of each wire P dash is pitch of the thread then we can calculate P in a previous picture we discussed about this P which depends upon trade angle and pitch it can be calculated using this relationship for metric thread capital P=0.866Pdash-d where d is the diameter of rod and P dash is the pitch thread.

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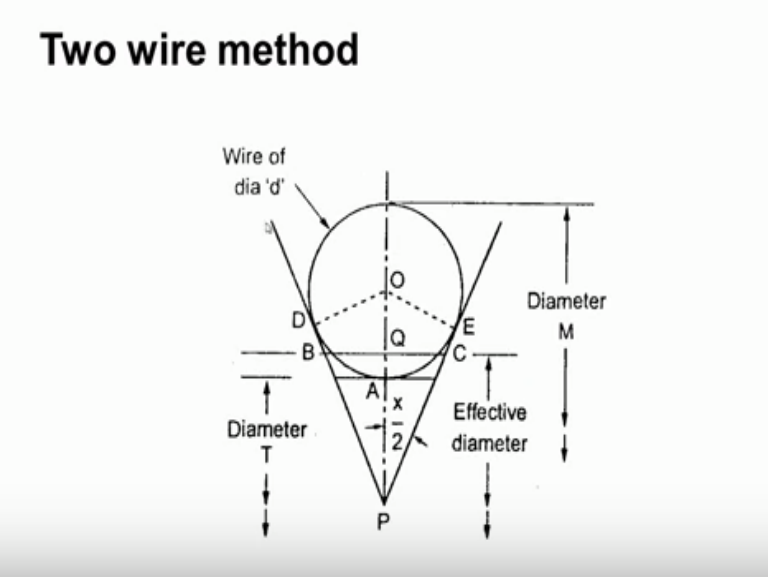


So this p value we can insert here and T can be calculated then E can be calculated. So this shows the geometry of 2 wire method so we have this groove and this is the wire wire of diameter d and we have to measure the diameter M by using the outside micrometer and this is

diameter T below the under the wire and this is the pitch line and this is the effective diameter and X is the flank X is the thread angle X/2 is the flank angle.

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$$\therefore AQ = \frac{P}{4} Cot(x/2) - AP$$

Here, $\boxed{AP = \frac{d(Cosec\, x/2 - 1)}{2}}$ → AP=OP-OA

$$\therefore AQ = \frac{P\,Cot(x/2)}{4} - \frac{d(Cosec\, x/2 - 1)}{2}$$

and

AQ is half the value of $P$

$\therefore P$ value = 2AQ

$$\boxed{P = \frac{P}{2} Cot\frac{x}{2} - d\left[Cosec\frac{x}{2} - 1\right]}$$

**Then the effective diameter E =T+P**

So by following this derivation we can get the value of E. Which depends upon the wire diameter and the flank angle, so once we get to the P we can also get T. T=M-2d so by knowing the T and P we can get the value of E effective diameter.

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## Three wire method

- The three-wire method is more accurate method.
- In this method three wires of equal and precise diameter are placed in the groves at opposite sides of the screw.
- One wire on one side and two on the other side of thread are placed. The wires may be held in hand or hung from a hook.
- This method ensures the alignment of micrometer anvil faces parallel to the thread axis.

Now we will move to the another method the 3 wired method this is the more accurate method, so the reason is in the case of 2 wired methods, so we have this thread like this we have 1 rod here another rod here and then these are the anvils of the micrometer. So these were 2 rods are

not in the plain perpendicular to the axis. There is some inclination so because of this the anvil faces while measuring anvil faces may slightly deflect will not be parallel.

So, because of that some error will be introduced in the case of 2 wire method in case of 3 wire method. There is a face with anvil faces are parallel to the thread axis. Since we are using the 3 wires and on the other side we have 2 wires 1 wire here and another wire here in the case of 3 wire, so this is the thread profile in replacing one wire here and we be placing 2 wires on the other side and then we have the anvil.

So because of this arrangement their chances of deflecting the anvil surface anvil face is very less and these 2 faces anvil faces will be parallel and the measurement errors will be less and this 3 wire method is more accurate. So in this method the 3 wires of equal and precise diameter are placed in the grooves as shown here the wires may be held in the hand or hung from a hook.

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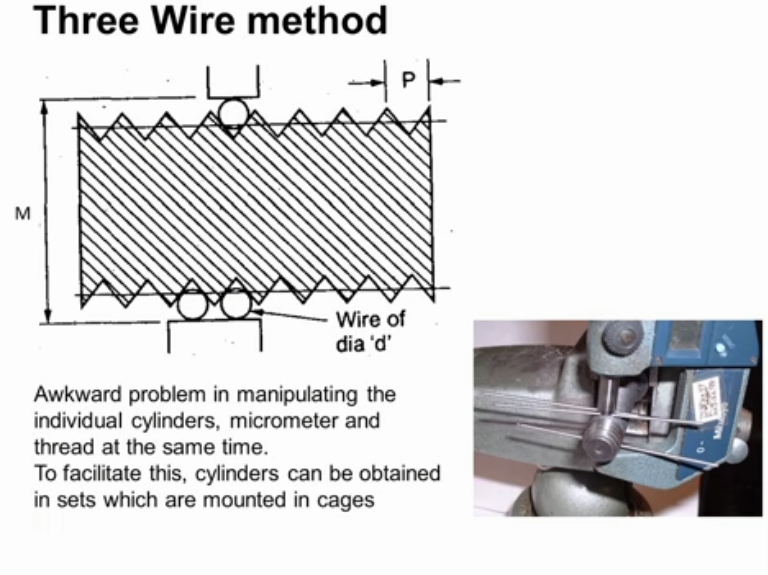


Which are the disarrangement is available in the floating carriage a micrometer so you can see the schematic diagram we have placed 1 wire here and 2 wires here and see the pitch of screw thread d is the wire diameter and this is the measurement over wire you can see the arrangement here.

Where 2,3 rods are there the work piece that is screw thread is held between handle and the 2 rods are placed here and 1 rod an opposite side so it will be very difficult to handle the work piece micrometer and 3 rods together it becomes time consuming so for easy handling cylinders can be obtained in sets which are mounted in the cages so using these cages or it will be easy to measure the effective diameter by 3 wire method.

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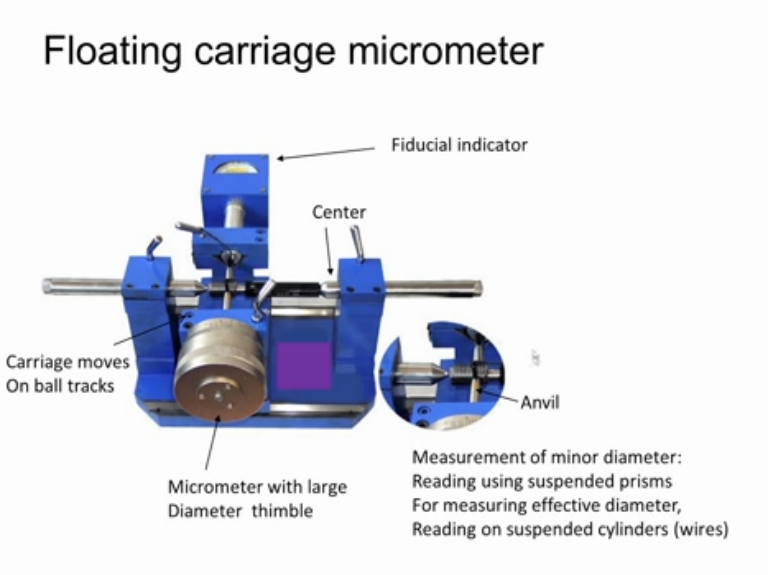


Now this shows a floating the carriage micrometer they can see the cast iron base and then they have 2 centers 2 centers are provided for mounting the work piece the centers can remove the in and out to accommodate the work piece of different sizes and the centers can be clamped by operating these levers.

Now perpendicular to the center axis we have another axis wherein the micrometer which the large diameter thimble is provided and on the other side we have fiducial indicator to indicate the measurement pressure the work piece is mounted between the center and measurement can be taken using this micrometer and for all measurements. We can always apply the proper pressure or the same pressure.

You can see here the arrangement is provided hooks will be provided here. So that the prisms or the rods can be hung from the hooks, so this will help in the measurement of minor diameter and in the effective diameter so this carriage which is carrying the micrometer moves on the ball

tracks freely hence it is called the floating carriage micrometer for measurement of minor diameter reading is taken using the suspended prisms.

Prisms can be suspended here and readings can be taken for measurement of effective diameter reading is taken on suspended cylinders or suspended wires.

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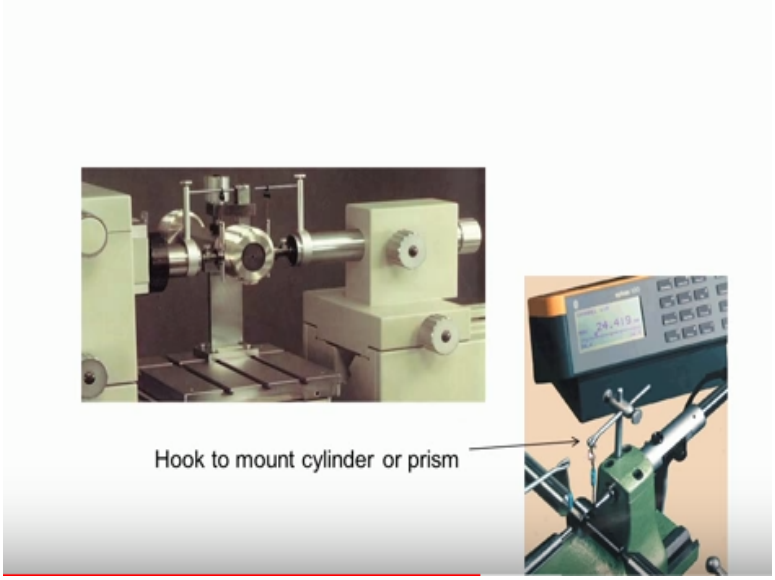


I can see the the hook here this is a hook to mount the cylinder or prism you can see the rod cylinder is hung from this hook we have one rod here we have another rod here which is a work piece screw thread and these 2 are the center the work piece that a screw thread is mounted between the center and then we have the measuring anvils.

You can see there is a digital indicator so directly it shows maybe they measure a major diameter minor measure diameter and minor diameter and effective that is measurement over roller so such things that will directly indicate and here you can see rods are there by which you can place the prisms or rods conveniently so these centers can be moved in and out to accommodate the work pieces of different size this body can be moved and it can be clamped at any desired location.

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Now the in the commercially the floating carriage the micro meters are available with the specifications like this base is made of cast iron material maximum longitudinal measurement is 90 mm different longitudinal moment is possible 100 120 like that they are available maximum Traverse measurement is 30 millimeter and each side these count of 0 indicator is the 0.01 millimeter.

The least count 4 micrometer is the 0.001 millimeter, micrometer range is 0-25 millimeter and a masterpiece is provided with the machine whose diameter 16mm if we require masterpiece of different diameters which are available in the market the specimen size M16x2 one specimen is provided by dimension for yeah wire size is 1.35mm for 3 wire method if you want to set up for wires that is also possible overall size of the machine is 300/300x200 mm and weight will be normally 10 kg.

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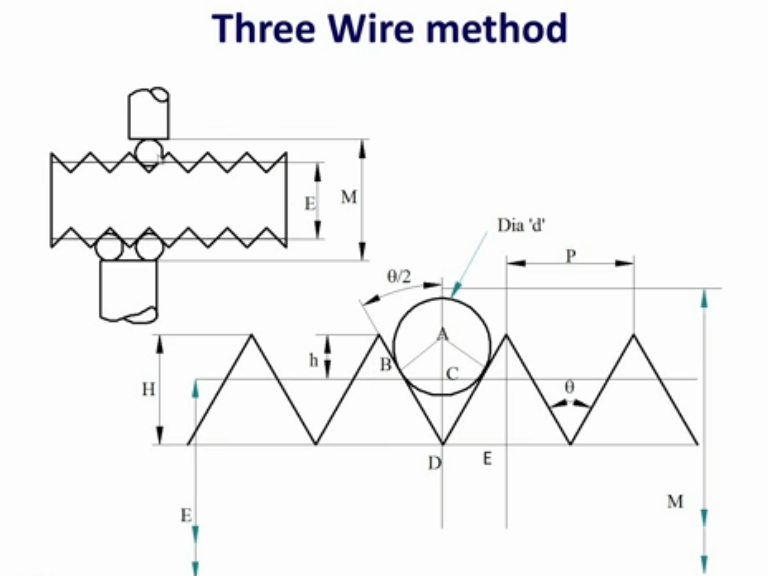


Now the geometry of 3 wire method on 1 side we have placed 1 cylinder or wire and on the other side we have 2, 3 cylinders. So this is the pitch line and this is the effective diameter and M is the measurement over rollers and roller is placed in a groove. Now you can see the roller is not contacting the flank at the pitch line that means this is not a best size wire if it is best sized wire then the wire will contact the flank at the pitch line like this at the pitch line.

The wire will contact you can see here is a pitch line and the wire is contacting the flank at the pitch line then this wire is called a best size wire and we have a thread angle so M is measurement over further and P is pitch small d is the diameter of wire this is the flank angle. So H is the center rod or cylinder center height from the pitch line that is the H and capital H is thread depth.

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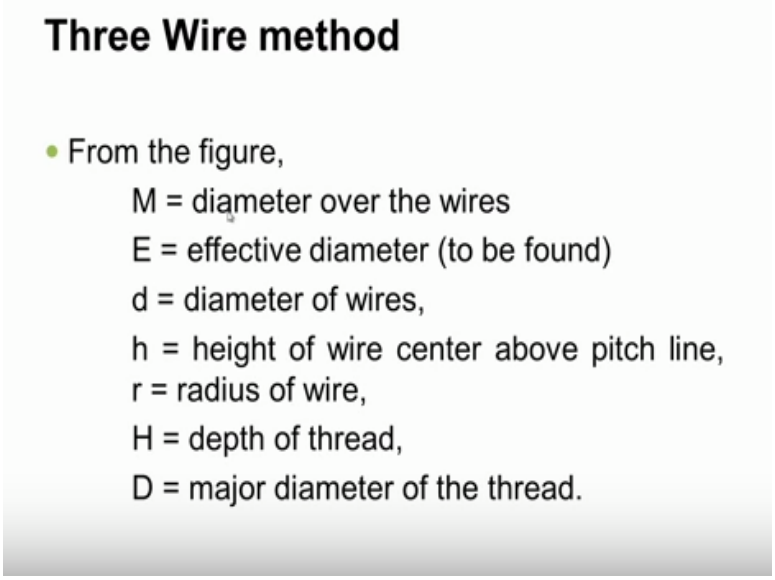


So from the previous figure M is capital diameter over wires, E is effective diameter pitch is to be determined, small d is a diameter of wire, H is height of wire Center above the pitch line, r is the radius of wire, capital H is depth of thread and D capital D is major diameter of the thread.

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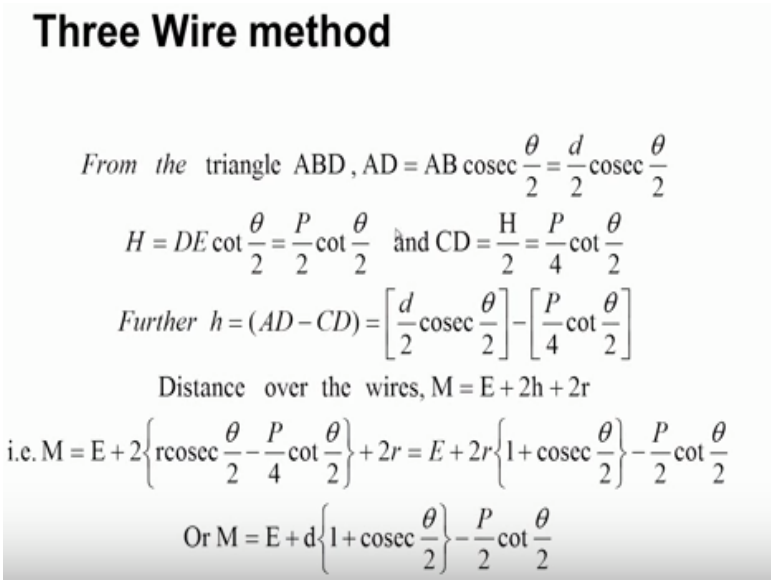


Now using the geometry we can derive the relationship between the effective diameter and the measurement over roller the derivation is represented here M is measurement over roller, and E is affected diameter, D is the diameter of wire, theta is the thread angle, and P is pitch. So by measuring the M and by knowing D and theta and the by measuring P we can get this effective diameter.

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## Three Wire method

For Whitworth thread, $\theta = 55^\circ$, depth of thread $= 0.64P$

$\therefore E = D - 0.64P$, $\operatorname{cosec}\frac{\theta}{2} = 2.1657$, and $\cot\frac{\theta}{2} = 1.921$

$M = D + 3.1657d - 1.605P$ where D is the major diameter of the thread.

For Metric threads, Depth of thread $= 0.6495P$

$\therefore E = D - 0.6495P$, $\theta = 60^\circ$, $\operatorname{cosec}\frac{\theta}{2} = 2$, $\cot\frac{\theta}{2} = 1.732$

$\therefore M = D + 3d - 1.5155P$

We can measure the value of M practically & then compare with the theoretical values using formulae derived above. After finding the correct value of M, as d is known, E can be found out.

For metric threads, for metric depth of thread that is capital H=0.6495P and then the effective diameter =D this is the major diameter of the screw thread D-0.6495P so we can measure the value of M practically using the micrometer or floating Carriage micrometer and then we can calculate E.

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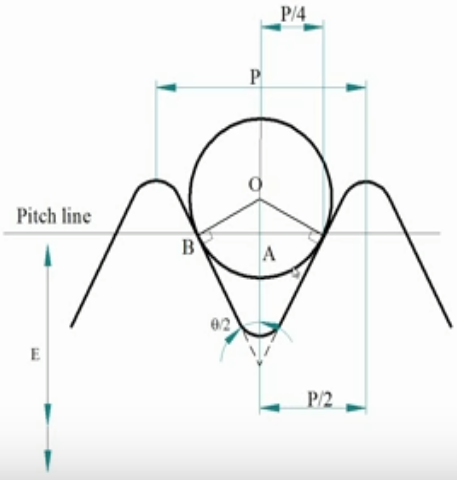
## BEST WIRE SIZE




Now you can see this is where the geometry which shows the best size wire placed in the thread groove we can see the contact the wire is contacting the flank at the pitch line. So if this is the case then such a wire is called the best size wire. So wherever possible we should calculate the best size wire and then the nearest wire nearest size wire should be selected and then is be used for measuring the effective diameter.

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## BEST WIRE SIZE

The best size wire is the one which makes contact at the pitch line or effective diameter of the screw thread. In other words, as shown in fig OB is perpendicular to flank portion of the thread at the pitch line.

$$\text{In the triangle OAB, } \text{Sin}\left(\hat{BOA}\right) = \frac{AB}{OB}, \text{ or } \sin\left(90 - \frac{\theta}{2}\right) = \frac{AB}{OB}$$

$$\therefore OB = \frac{AB}{\sin\left(90 - \frac{\theta}{2}\right)} = \frac{AB}{\cos\frac{\theta}{2}} = AB\sec\frac{\theta}{2}.$$

$$\text{But OB} = \text{radius of wire} = \frac{1}{2} \times \text{dia of best size wire } (D_b)$$

$$\text{i.e. } D_b = 2 \times OB = 2 \times AB\sec\frac{\theta}{2}. \text{ Also since AB lies on the pitch line, } AB = \frac{P}{4}$$

where P is the pitch of the thread.

$$\therefore D_b = 2\frac{P}{4}\sec\frac{\theta}{2} = \frac{P}{2}\sec\frac{\theta}{2}$$

Now you can see here so Db is the diameter of best size wire this =P/2sec theta/2 P is pitch and theta is thread angle. So theta will be 60degree for metric screw threads and pitch can be measured using pitch gauge and then Db that is best size wire can be calculated and then they we have to see what is available they set of wires to C and we should select a wire which is the almost equal to the best size wire that is calculated.

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- For metric thread, the range of wires:
  - Max. wire diameter = 1.010 P
  - Best size wire = 0.577 P
  - Minimum wire diameter = 0.505 P

For a metric thread the acceptable range of wires is shown here the maximum wire diameter can be up to 1.01xP where P pitch and the best size wire =0.577P and then minimum wire diameter is

the 0.505P. So we can select the wire within this range and then we can use them to find the effective diameter of the screw thread.

**(Video Starts: 53:47)**

Now we will conduct an experiment to show how the 3 wire method that can be used for measurement of effective diameter you can see is standard the wire of different diameter the diameter is measured and it is mention you can see this is the cage which carries the 3 wire of same diameter this is the single the cage with the single wire of 1.65 millimeter and in this case we have 2 rods or 2 wires with the same diameter 1.65 millimeter.

So like this complete set is available with the different diameters so we should calculate what is the best size wire depending upon the type of thread that is pitch and a thread angle and then nearest wire that is available in this set should be taken out you can see 1.35 millimeter diameter so this will be screw thread whose the effective diameter is to be measured.

This is the micrometer we have checked the pitch of the screw thread and we found that it is a 2.5 millimeter and then the best size the wire is calculated using the relationship P/2 sec theta/2. So theta since we have selected the metric thread theta that is the thread angle is the 60 degrees and pitch of the given screw thread is 2.5 millimeter so best size wire is 1 4434 millimeter.

Now we are collecting a best wire 1 wire, we are selecting a wire of 1.35 millimeter we will screw thread you can see how to hold the wires we have a hole in the cage the cage can be inserted into the anvils and will now the 2 cages they are placed in a oppose side 1 wire is on 1 side and 2 wire on the other side of the screw thread and then slowly we have to rotate the thimble of the micrometer.

So that the angle advances the spindle advances. Now we can take the measurement over roller that is M now we can take the reading measurement over roller is 15,16,17,18,19,20 millimeter and then 0.05, 0.09, 20.093 millimeter is the M and also we can see third decimal place the main scale reading is 20 thimble reading is 0.09 and then third line is coinciding with this line. So M is 20.093 millimeters.

Now we know the M and we know the diameter of rod used we know the thread angle 60 degree pitch is 2.5 millimeter. So using these values we can calculate the effective diameter E we can see the close view of the arrangement close view of the arrangement we have single rod here and 2 rots this side and this is a work piece having the screw threads and the micrometer. So now we can see the reading it is the main scale reading is 20, 20.093 millimeter.

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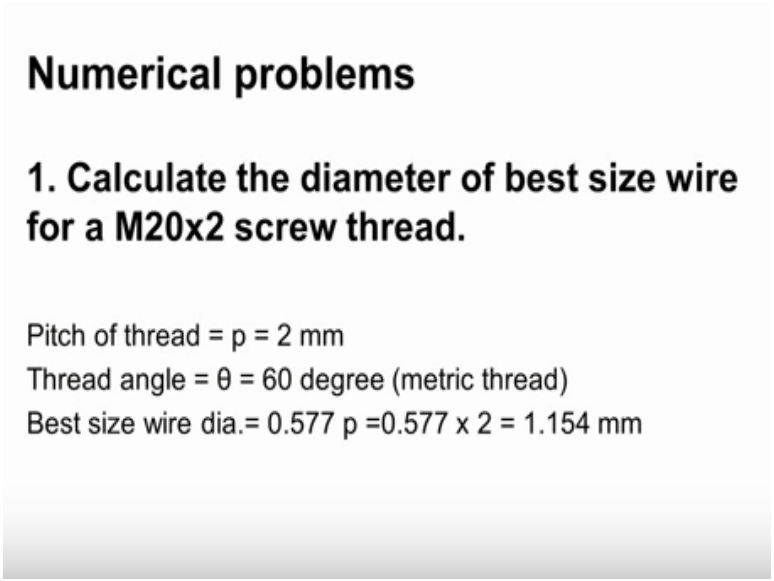


Now we will solve some numerical problem in the first problem we have to calculate the diameter of best sized wire for an M20x2 screw thread the data that is given is pitch of the thread =p=2 millimeter and since it is a metric thread the thread angle theta is the 60 degree now the using where this relationship0.577p.

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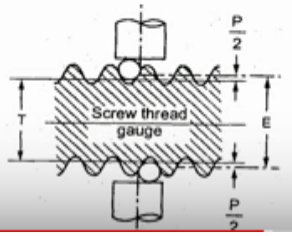
**2. Calculate the best size wire diameter and the difference between size under wire and effective diameter for a M16x2.5 external screw thread.**

Pitch = p = 2.5 mm

Best size wire = d = 0.577 p =0.577 x 2.5 = 1.442 mm

P = 0.866 x p – d = 0.866 x 2.5 – 1.442

E-T = P = 0.723 mm




We can calculate the best size wire diameter that is0.577 x 2 = 1.154 millimeter is the diameter of the best size wire. Now we will move to the second problem we are required to calculate the best size wire diameter and the difference between size underwire and effective diameter for a M16x2.5 external screw thread data that is given is pitch=2.5 millimeter so we can calculate the best size wire =d=0.577 x p that =1.442 millimeter then from this picture.

I can understand that we are required to calculate the difference between size underwire, so this T is the size under the wire and effect this is the effective diameter so E-T=p/2 here and P/2 here. So when we add these 2 it becomes P, so E-T we have to find so capital P=0.866 x P-D, so this =0.723 millimeter, so difference between size and a wire diameter is 0.723 millimeter.

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**3. When measuring the effective diameter of an external screw thread of 3.5 mm pitch, a 30 mm diameter cylindrical standard and 2 mm wires were used. The micrometer readings over the standard and wires, and over the screw thread and wires, were 13.376 and 12.242 mm respectively. Calculate the effective diameter of the screw thread.**

R1 = Reading over standard and wires =13.376 mm
R2 = Reading over screw thread and wires 12.242 mm
S = Diameter of standard cylinder = 30 mm
d = diameter of wire = 2 mm
p = Pitch of screw thread = 3.5 mm
T = Size under wire = S – (R1-R2) (Dia. Of standard is larger)
T = 30 – (13.376 – 12.242) = 30 – 1.134 = 28.866 mm
P = 0.866 x p – d = 0.866 x 3.5 – 2 = 1.031 mm
E = Effective diameter = T + P = 28.866 + 1.031 = 29.897 mm

In a third problem when measuring the effective diameter of an external screw thread of 3.5 mm pitch, a 30 millimeter diameter cylindrical standard and 2 millimeter wires were used. The micrometer readings over the standards and wire and over the screw thread and wire were 13.376 and 12.242 millimeter respectively we are required to calculate the effective diameter of the screw thread.

So the data that is given in R1= reading over standard reading over standard and wire is 13.376 millimeter and R2 is reading over screw thread and wires is 12.242 millimeter and standard cylinder diameter is the 30 millimeter and diameter of wire is the 2 millimeter pitch of the screw threads is a 3.5 millimeter.

So we can calculate the T size underwire =S-R1-R2. So the diameter of the standard is larger so like that they are taken so T=SC is 30 millimeter and R1-R2 the values should be inserted so finally we get T=28.866 millimeter then P=0.866xP-d. So P will be=1.031 millimeter then effective diameter =T+P. So that is the 28.866+1.031 millimeter this =29.897 millimeter is the effective diameter.

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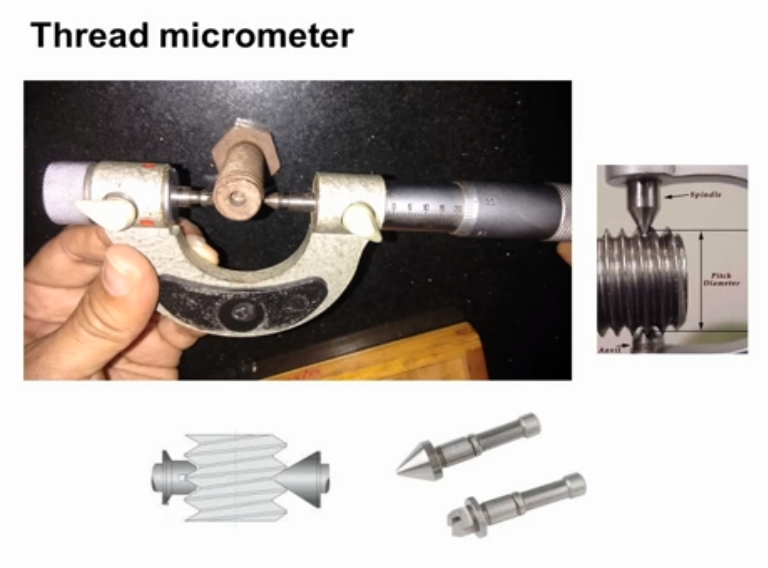


Now we will move to thread the micrometer using the thread micrometer we can measure the effective diameter directly this picture shows a thread micro meter. I can see the here we have a hollow iron mill and again this size we have hollow spindle. So in the hole on the spindle as well as anvil we can insert these replaceable anvils, so depending upon the pitch of the screw thread.

We can select appropriate anvil and we can insert them and you can get the effective diameter directly by using the thread micrometer. We can see the close view or is the spindle with a pointed end and this is the this anvil is placed in the other side so now the thread micrometer will directly give the pitch diameter you can see the tips are not shot they are made flat.

If they are very sharp chances are just that at a point may touch the root so to avoid that the tips are made flat and similarly here again the tips are made flat so that they will not contact the root they will contact only the flank.

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A set of anvils will be available so depending upon the pitch of the screw thread and the type of screw that whether it is metric or Whitworth we have to select appropriate anvil so if the pitch is 1.25 millimeter then we have to use this set it is if it is Whitworth thread with 12 TPI then we have to select the set.

So like this depending upon the type of screw thread we have to select the appropriate angle and we have to place them into a screw thread micrometer and then we can directly measure the effective diameter.

Now let us conduct an experiment to measure the effective diameter of escrow thread using thread micrometer I can see this is a screw thread the micrometer range is 0 to 25 millimeter and least count is 101 millimeter you can see the anvil can be moved in and out to accommodate the work piece of different length range of this instrument is 0-25 millimeter and the least count is 0.01 millimeter.

Now this is a set of anvils depending upon the type of screw that where to collect appropriate set appropriate pairs should be selected and should be used. Now I am selecting the M1.75 I am using a metric screw thread with 1.75 pitch so I selected this particular pair you can see the tips are made flat

So I selected 1.75 pair we have to insert the anvil into the micrometer and then we should advance the spindle till it comes in contact with the anvil this is essential to check with whether there is any 0 error if 0 error is where we should move the anvil and we should make it 0 otherwise we should account for the 0 error.

Now the spindle is in contact with anvil I can see there is a smaller error of 0.8 millimeter so 0 error is 0.8 millimeter this should be subtracted from the reading given by the micrometer. The screw threads should be held between the anvils and slowly, we should advance the spindle the 2 anvil should contact at the maximum size I can see the spindle and anvil the anvils are contacting the flanks.

Now we can take the reading, reading 9, 10.54, 10.5 + 0.4 that is 10.9 millimeter. So the reading given by the micrometer is 10.9 millimeter 0 error is 0.8 millimeter, so we should subtract this from the reading given that is t10.9-0.8 millimeter that =10.1 millimeter is the effective diameter of the given screw thread.

**(Video Ends: 1:15:54)**

Now, with this let us conclude this session in this session we discussed about the pitch measurement and effective the effective diameter measurement. We studied about different methods of measuring the pitch that is optical methods and use of screw pitch gauge.

Then we studied about the measurement of effective diameter wherein the discussed about 2 wire method 3 wire method and use of screw thread micrometer to get the direct measurement of the effective diameter with this we will conclude this session. Thank you.