Metrology
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Module-2
Lecture-1
Angle plate, steel rule, spring calipers

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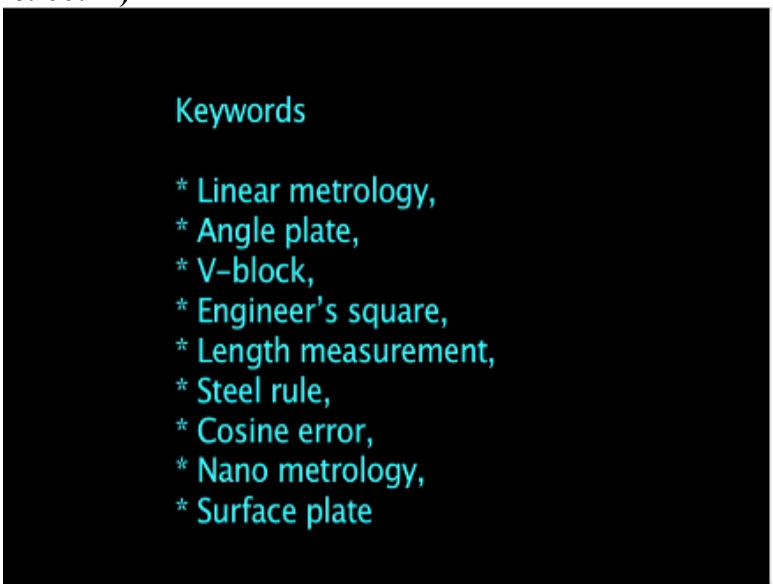

I welcome you for the module 2 lecture 1 of this series.

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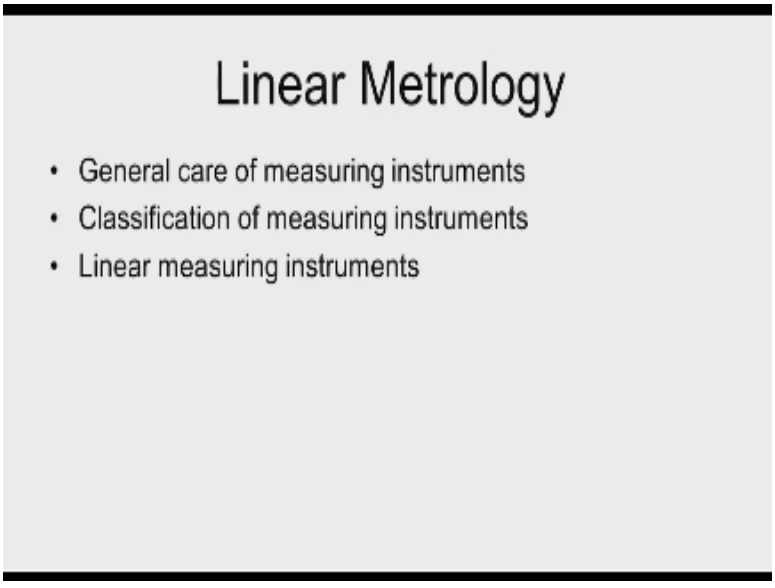

In module 2 we will be discussing about linear metrology, what is linear metrology, what are the various instruments used in the linear metrology, those things will be studying and then before we start linear metrology let us try to understand the general care of measuring

instruments and instruments are in use how to take care of the instruments and when they are in storage that means for a long time they are not in use.

And we are storing them then how to store what type of care we should take, so that they are protected from the environment. We will also study about classification of measuring instruments, how the instruments are classified based upon the type of physical quantity that is measured and then based upon whether they are they have graduated scale or no graduations are there.

And then depending upon the position and accuracy, how they are classified and then very recently is nano technology has evolved and what type of metrological instruments are used in the nano metrology that also will be studying and finally we will be dealing with various kinds of linear measuring instruments.

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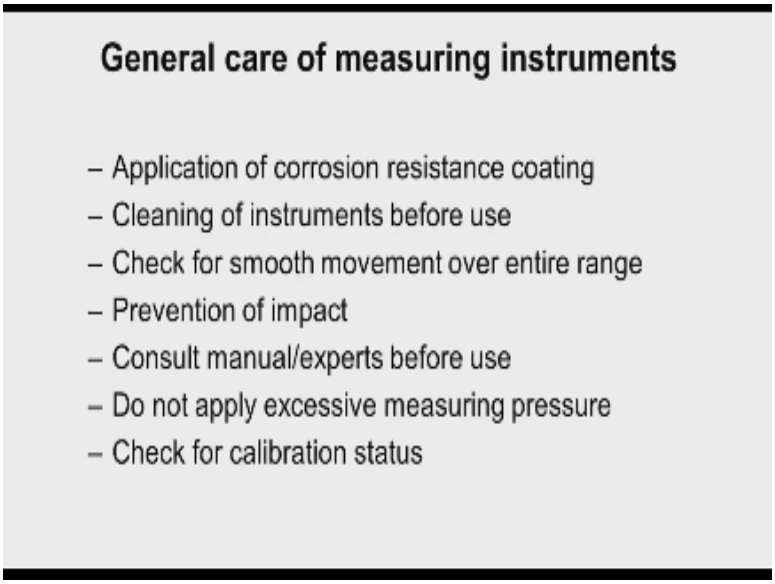

Now let us try to understand general care of measuring instruments now whenever the measuring instruments or not in use a long time it is essential that corrosion resistant coating is provided working surface of the instruments, for example if it takes a micrometre we should apply the corrosion resistance protective coating like petroleum jelly on the surface of and will and in the surface of spindle.

Similarly if you take the example of vernier caliper we have to apply petroleum jelly on all the working surfaces, wherever there is a movement we have to apply whenever there is a how open surface automation services are there we have to apply petroleum jelly. So that the

surfaces are not corroded and now when they used when you try to use the measuring instruments it is very essential that the protective coating that is applied should be cleaned properly.

All dust particles should be cleaned protective coating should be cleaned by using maybe some chemical or by using soft cloth we have to clean all surfaces and then we have to check for smooth movement over entire range. For example if you have vernier micrometre you should be moving jaw should moving head should move throughout its range smoothly, that should not be any stick slip motion, so that we have to check.

It is we have to some corrections, so that the movement is smooth, and then we should not allow the instruments to fall down, so that when they are subjected to impact the working parts of the instrument may get they may bend and it becomes unusable. So it is very essential that when using lot of care should be taken, so that they would not fall. And then whenever we are in doubt how to use.

We do not know how to use the instruments, we should always better to consult the manual or consult the experts who know about operation for those instruments. So that we should not they are not mishandled, then it is very essential that whenever we use this instrument we should not over pressurize or we should not apply excessive pressure. So that they moving jaws or angles they will not impinge the surfaces.

For example if you over pressurize the spindle of the micrometer and then the spindle will enter into the work piece and intent mark will occur. So it may damage the work piece as well as it may damage a spindle. So such things should be avoided and it is very essential that we should have the proper sense of a feeling. We should have we should feel before we apply pressure.

And it is always better if you have instruments where in application of excessive pressure is avoided such systems or such a mechanism is there we should try to have such instruments and then we should always check for calibration status whether the calibration is required for that instrument or when it is required such things we should see whenever calibration is required by have to arrange for sending it for the calibration purpose.

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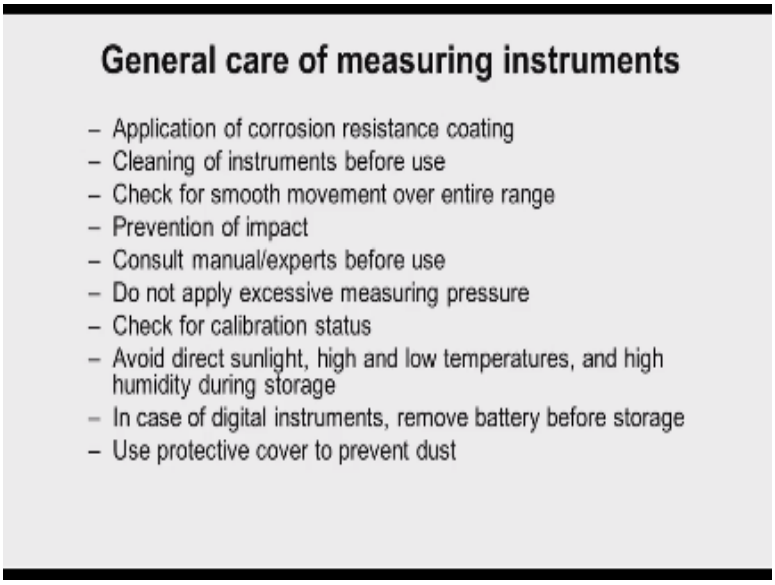

It is also important to avoid direct sunlight and high and low temperature and high humidity during the storage of measuring instruments and in case of digital instruments it is necessary that we have to remove the battery before storage, if you are not using the instruments battery operated instruments for longer duration and then where about possible we should use protective cover on the instruments to prevent dust settling on the instruments.

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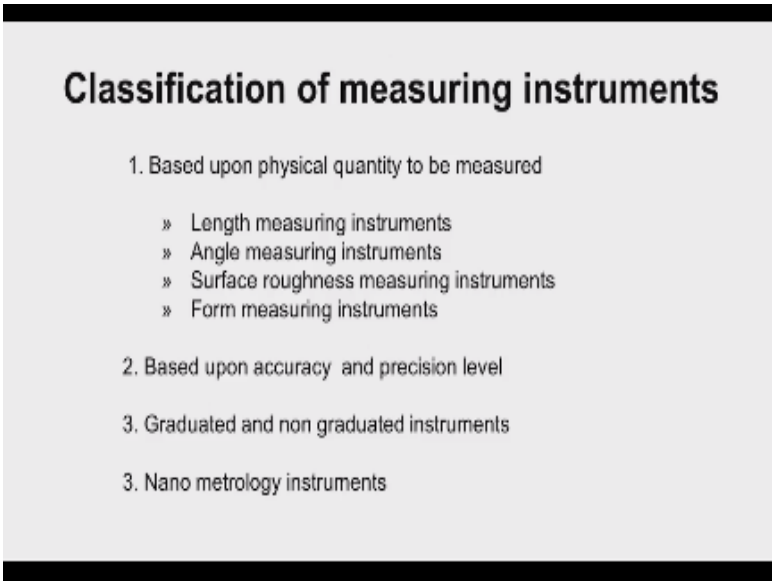

Now after this let us try to understand how the measuring instruments are classified the classified based upon the physical quantity that is to be measured. For example length measurement we need to measure length of the work piece or breadth of the work piece, depth of the work piece or say diameter of hole. So this represents the single dimension quantity.

So when we use the instruments for single dimension measurement then we say their length measuring instruments. Then again if the instruments are used for the purpose of measuring angles then we say that angle measuring instruments. For example bevel protractor is an example for angle measuring instrument. Then there are some instruments which are meant for measuring the surface roughness of working machine surfaces.

For example the surface tester used to measure the surface roughness and then in some cases we use instrument for measurement of form of the work piece whether there is any out of roundness is there or some but drum shaped is there or barrel shape is there. So if we use the instrument to measure such thing then they say they are from measuring instruments. Now based on accuracy and precision also we can classify instruments as very accurate instruments and not so accurate instrument.

Similarly very precise instruments or not so precise instruments, then if the instrument is having a graduated scale then we say they graduated instruments and if there is no scale on the instrument we say non graduated instrument. For example a spring caliper is a non graduated instrument, whereas a Vernier caliper is a graduated instrument and if the instruments are used to check the characterization of nano particles. Then we say such thing such instruments are nano metrology instruments.

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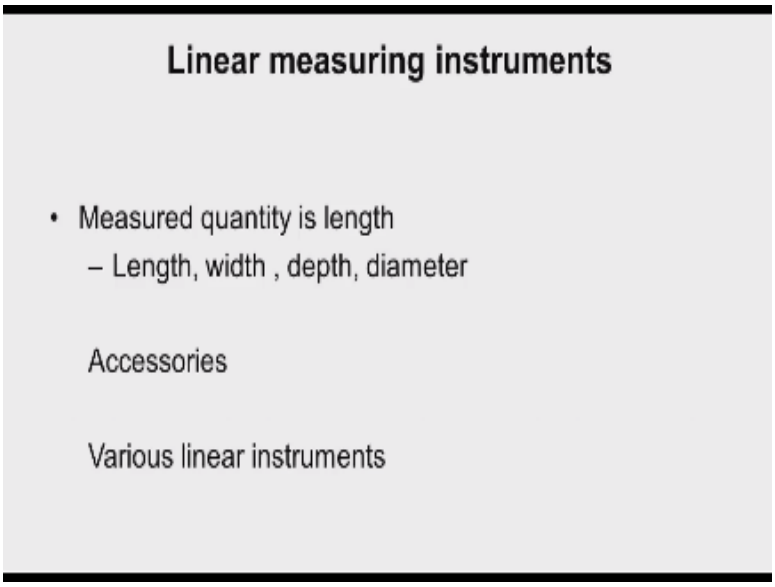

Now we will study about linear measuring instruments, so in this type of instrument in this classification the measure quantity is learnt, that means linear measuring instruments that used for measurement of length, breadth, depth, diameter and such thing one dimensional

quantities. Now under the first will study about various accessories used for the measurement and then we will go for studying different kinds of linear instruments.

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Now the cast iron surface plate is a very very important accessories whenever they want to conduct the measurement classes. Now this figure shows a cast iron surface plate, we can see the top surface of the cast iron surface and we can also see different kinds of ribs are there in the sides, and then there is prevision for inserting the handles on both the sides we can insert the handles.

So that we can easily lift the lift and move the cast iron surface plate, so normally they are placed on steel frames as shown in the figure.

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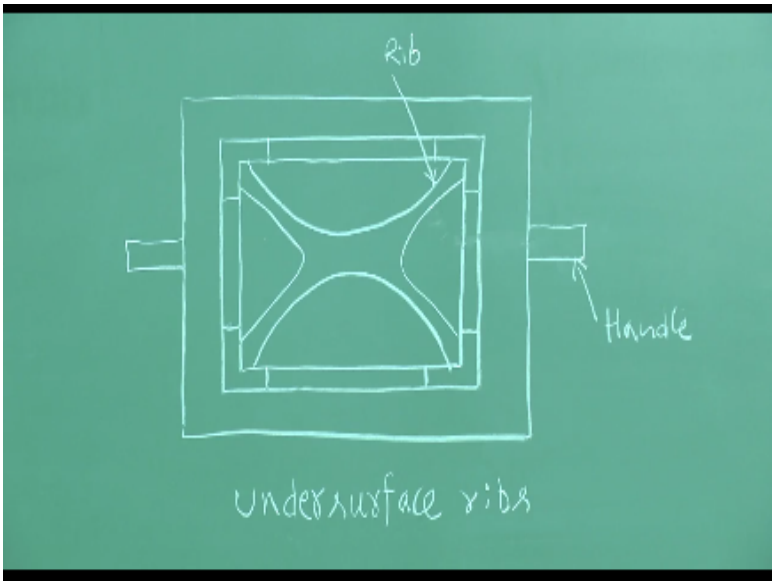

Now over to black board we can see the undersurface of the surface cast iron surface plate, there will be lot of ribbing provided. So that the surface plate will not bend due to the weight of the instruments kept on the surface plate.

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Sl.No	Normal Size (in mm)	Maximum deviation from flatness over the entire area expressed in Microns as per IS 2285 - 2003			Approx. Weight
		Grade-0	Grade-I	Grade-II	in kgs.
1	300 x 300	4	7	15	21
2	400 x 400	4.5	9	17	50
3	450 x 300	4	8	16	39
4	450 x 450	4.5	9	18	62
5	600 x 450	5	10	20	79
6	630 x 400	5	10	20	96
7	600 x 600	5	10	20	128
8	630 x 630	5	10	21	156
9	900 x 600	6	12	23	204
10	1000 x 630	6	12	24	271
11	1000 x 1000	7	14	28	514
12	1200 x 900	7	14	28	437
13	1500 x 1200	8	16	33	986
14	1600 x 1000	8	16	33	870
15	1800 x 1200	9	18	36	1188
16	2000 x 1000	9	18	37	1345
17	2400 x 1200	10.5	21	42	1683
18	3000 x 1000	12	24	48	1845
19	3000 x 1200	12	24	49	2085

Now this table shows what are the various sizes available, for example 300 millimetre/300 millimetre is a square shaped cast iron surface place similarly 400/400 is again a square shaped cast iron surface plate and then we can have a rectangular shaped surface plates also . We can get surface plate of size 3,000 millimeter/1200 millimeter size.

There available in different grades grade 0, grade 1, and grade 2. Grade 2 is normally used for used in the workshop for regular inspection of the work pieces. There are grade 0 is used the calibration and standards room for caliper purpose. Now ID the cast and surface plates are made as per IS2285 2003 standard. Now this table shows that these figures they indicate the maximum deviation from flatness over the entire area.

For example for grade 0 and they cast iron surface plate of 300/500 the maximum deviation from flatness is 4 micrometre, so meaning of this is if you have 2 parallel planes separated by a distance of 4 micrometre, then all the points on the cast iron surface plate of all the points should lay within this gap of 4 micrometre. So that is the meaning of that flatness over the entire area of the cast iron surface plate.

For grade 2 for the number 1 that is 300/300 millimeter sized cast iron plate for grade 2 the flat deviation from flatness is 15 micrometre. Now these surface plates are made out of cast

iron and there also available in glass as well as granite. The advantages of glass and granite is they are not subjected to corrosion whereas cast iron plate is subjected to corrosion if not properly protected.

So whenever the surface plates are not in use it is necessary that they should be covered with a wooden cover, now advantage of glass and granite surface plate is when a solid object when work piece falls on the surface plate. In case of glass and granite plates no bur is formed. So a dent will be form which will not affect the measurement process whereas in the case of cast iron burs will be formed which may affect the measurement process. They may get some measurement error due to the bur formed.

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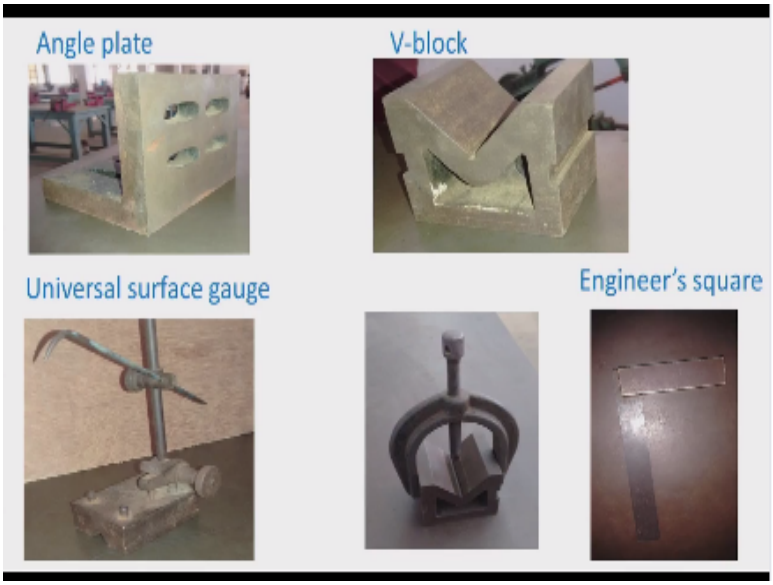

Now we have some other accessories like angle plate.

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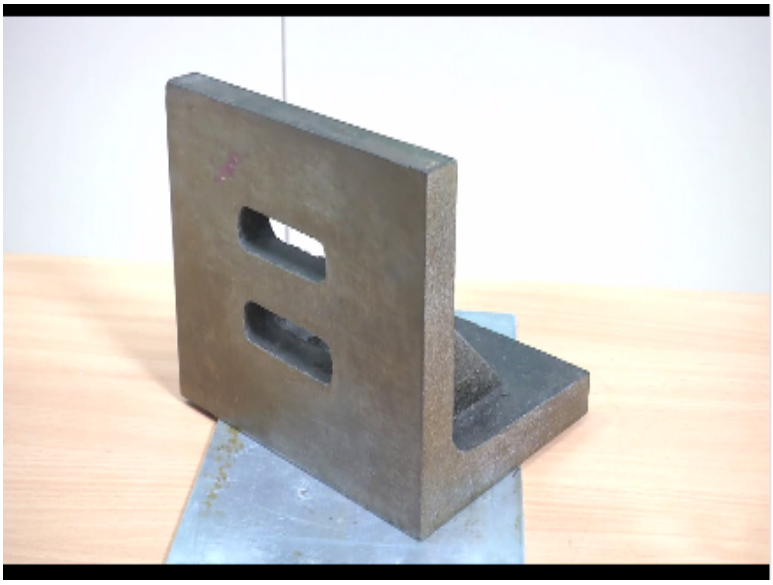

Now I am showing an angle plate which is a very important accessories used along with the surface plate. Now you can see the shape of the angle plate this is the L shaped and is the bottom working surface and surface is again a working the surface which is perpendicular to the bottom surface. So this is the length of the angle plate and then this is the height of the angle plate and then this is the breadth of the angle plate.

Now it is very essential that this bottom surface and this surface should be square. Now IS2554 1963 specifies the various sizes and what are the accessories needed for angle plate. For example the size is 125/75/100 and if they for this particular size the flatness of this working surface should not exceed 5 micrometre. Similarly this working surface also for the same size of 125 millimetre/75 millimetre/100 millimetre.

The flatness of this bottom surface should not exceed 5 micrometre. Then the squareness of this working surface with the bottom surface for a height of 100 millimetre the squareness of the surface with the bottom surface should not exceed 10 micrometre and then for the same size the parallelism of opposite faces, that means if this also working surface the deviation from parallelism in this surface and this surface should not exceed 13 micrometres.

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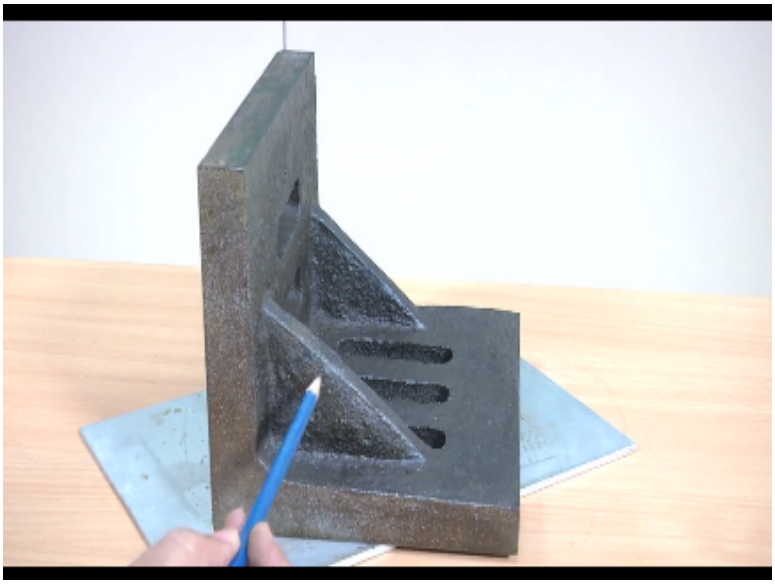

Now we can just see the other side of the angle plate now you can see there is a rib between the vertical plate and the horizontal plate. So that the angle plate will be rigid. You can also see 3 slots here and we have to horizontal slots used for clamping of work pieces. And then we have V-block which is another accessory used for the measurement process.

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Now we can see a cast iron V-block, we can see the V channel and then we have V channel on both the sides. So this is the top surface and this is the side working surface and this is a the end surface. It is necessary that all the surfaces are square to each other and now these V-blocks are used for clamping cylindrical objects and for making centre of cylindrical objects. We can always clamp the work pieces using this type of clamp.

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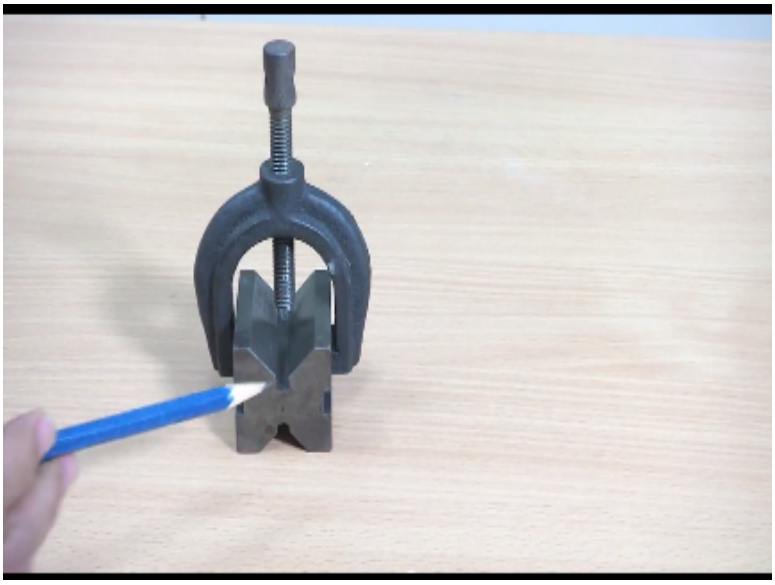

So in between the V-channel and the screw we can place the cylindrical object and we can clamp it. Now there is another accessory known as universal surface gauge. This is used for scribing the lines on the work surfaces. This intimation can be change by operating this mechanism. So that any height can be adjusted and lines parallel lines can be scribed on the work piece surface.

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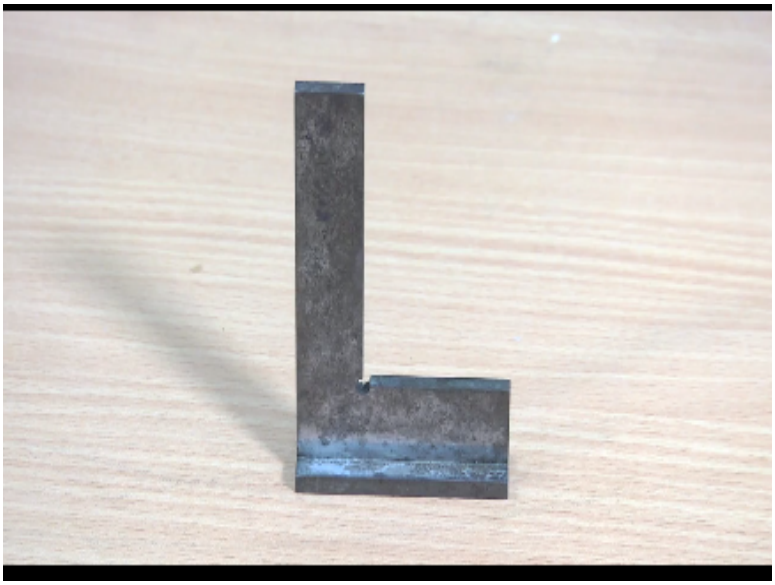

So we have another accessories known as a engineers square. We have the bottom surface and we have a vertical surface here. This is used to check squareness of the work pieces. These are made as per Indian Standard 2001 03 1972 and different grades are available A grade, B grade and C grade depends upon the type of work whether it is used for used in the machine shop or whether it is used in the standards room.

We need to select appropriate grade, it is very essential that this surface and the bottom surface should be square to each other. Now these squares engineer squares are used to check squareness of the work pieces.

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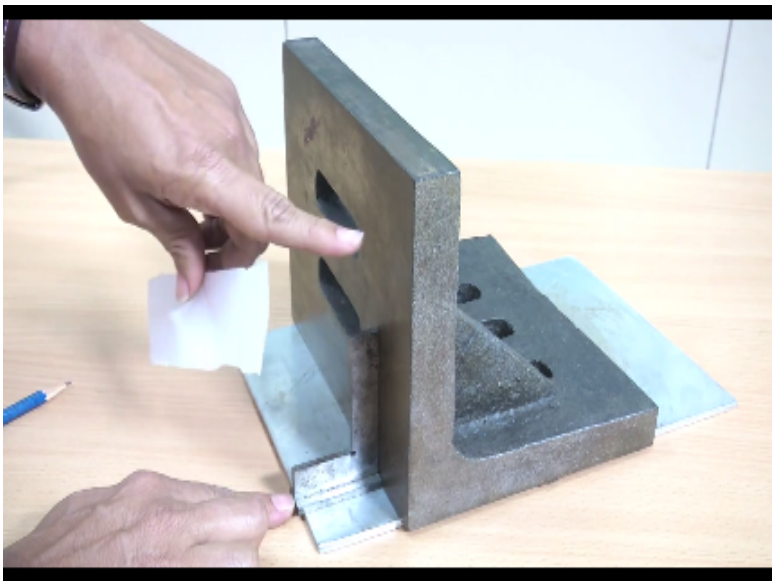

So let us assume that this is the work piece and I want to check whether this surface is square with the datum surface. So far that we have to keep the engineer square like this and then we have to take thin paper and we have to insert the paper between engineer square and the work piece. If it enters it indicates that there is some error, if it does not enter then it indicates that squareness is ok. Now it is not entering so squareness of the work piece is ok.

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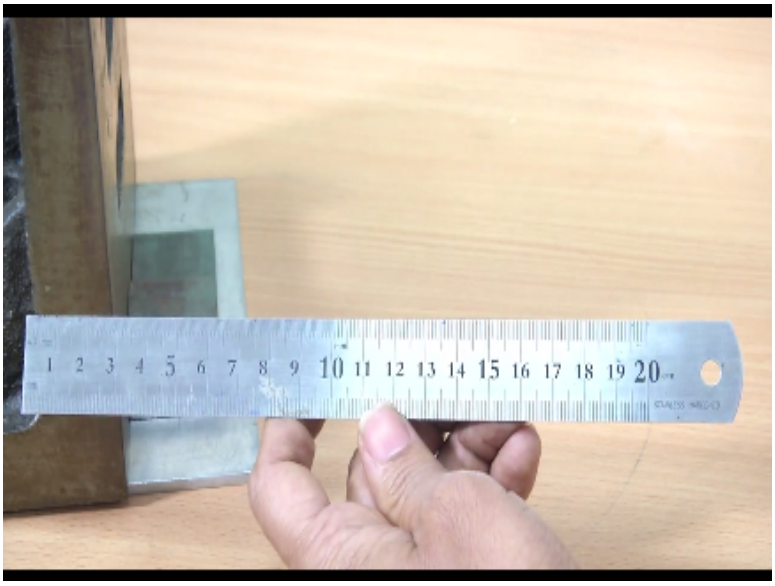

Now we have a steel rule which is the most common instrument for measurement of linear dimensions. Now you can see here this steel rule is made out of stainless steel and then it is

harden. Now the range of this scale is it start from 0 and then we have 20 cm. So 0 to 20 cm is the range of this and then coming to the resolution we can see here up to 10 cm we have a very fine resolution of 0.5 millimetre and then from 10 cm to 20 cm we have a resolution of 1 mm.

Now depending on the accuracy required we can use this portion variant regulation is 1 millimetre or if final accuracy is required we can use 0-10 varying resolution is 0.5 millimetre and then graduations are marked in both the edges and then the graduations are available on both sides also. So anything we can use. Now before using this steel rule it is very essential to check whether this end is proper or not, sometimes this may be or not.

In that case we should not use this edge, we should start from 1 marking and then we should use it and then we should not forget to detect this 1 cm from the reading of time. Now I will show how to use this to measure the length of a work piece. Now you can see here have work piece ok, it is but against the angle plate now I am keeping the steel rule on the work piece ok.

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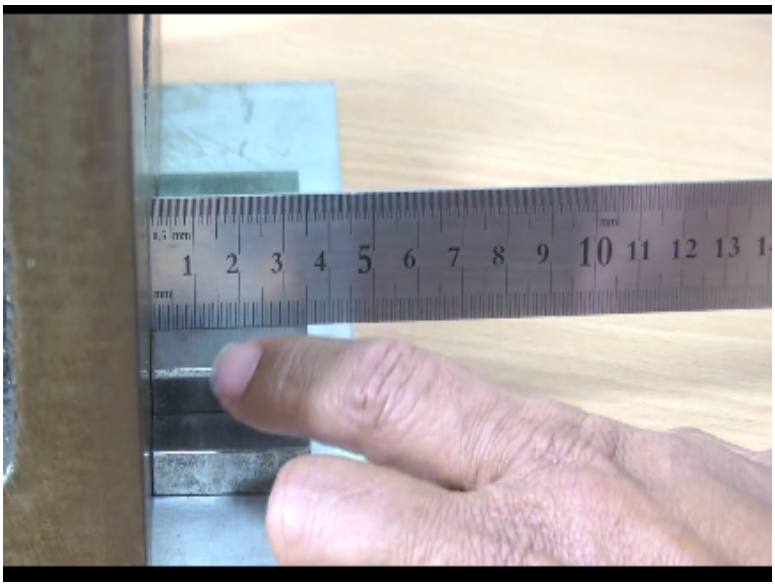

And now you can read, so this edge is the reference where in the reading is 0 and then on the other side we have the measurement point, so now the reading is 35 millimetre that means length of this work piece is 35m. Now it is very essential to read the steel rule normal to the steel rule. Otherwise parallax error main creep in. Now in case this edge is torn out then how to use this steel rule.

I will just show how to use this steel rule when the edge is corn out. Now you can see the number 1 is coinciding with one edge of the work piece. This is the reference point and then on the other side we have 45. Now you can see the observation is not normal to the scale. So there is some parallax error. Now the reading is difference between the measurement point and reference point is 35 millimetre.

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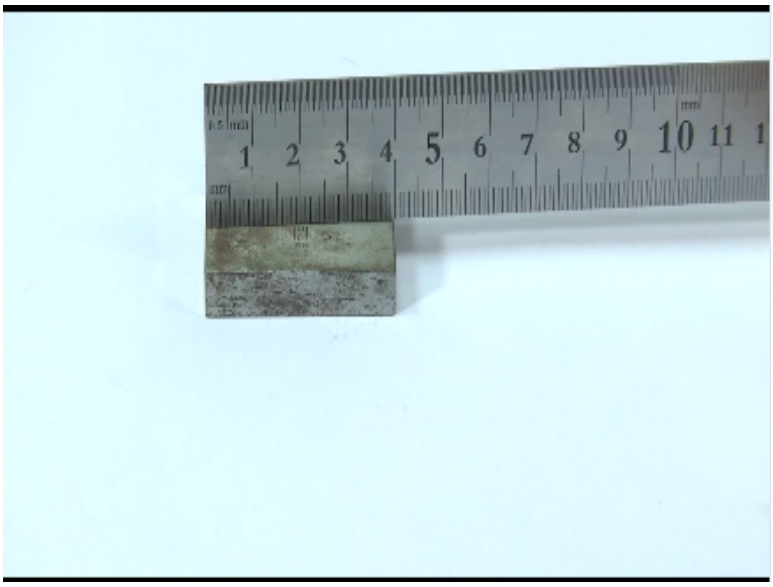

Now I will just show how the profile error creeps in like we see the work piece and then we need to measure the length of the work piece for that I am using this steel rule, the one end of the steel rule is coinciding with this edge, so this is a reference point and then this is measurement point, now it is reading 40 millimetre, now the steel rule is parallel to the physical quantity to be measured that is learnt.

Now when there is some angle like this now you can see the steel rule is not parallel to the physical quantity to be measured. So this is the length of the work piece but we have place the steel rule at some angle theta. So because of this there will be cosin error, so actually when we measure we get it now this is around 41 millimetre, it is showing 41 millimetre where as the actual length will be Lcos theta.

So this cosin error can be avoided by keeping the steel rule parallel to the quantity to be measured like this.

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Now I am explaining how to use a steel rule for outside diameter measurement. Now I am keeping one edge of the steel rule at this place, so this is a reference point and then I am slowly adjusting the steel rule, so that a measuring the diameter not be called is now the measurement is at this place and it is showing 4 cm. So the diameter the work piece is 40 millimetre. So this is example for direct measurement where in we can directly get the size of the physical quantity and there is no need to have any calculations.

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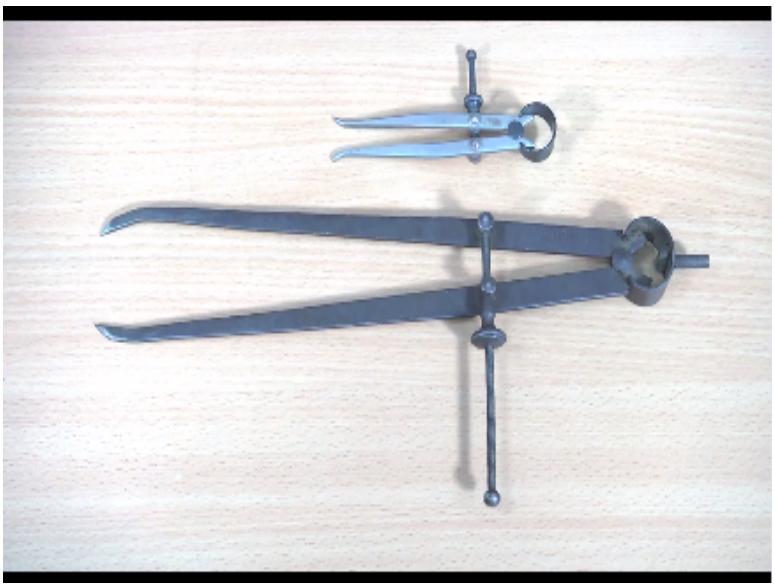

Now I am showing a few non graduated instruments, this one is spring caliper outside spring caliper for measurement of outside dimension this is inside caliper for measuring inside dimensions. These are the legs of the caliper and we have a screw and we have a net and the this is a spring which provides necessary tension to the legs. So similarly we have two legs here for the inside caliper.

And screw and a net by rotating this time we can adjust the distance between these two measuring points. Now these edges are hardened to nearly 600 because hardness. So that they do not wear much.

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Now let me demonstrate how we can use an inside caliper for measurement of inside diameter, now we have to insert the caliper both legs of the caliper inside the hole and then we have to adjust the screw till we get the diameter, so slowly we have to rock inside caliper till we get the minimum dimension. If it takes a dimension in this position in current position there are chances of getting cosin error.

So we get the minimum dimension always the instrument should be perpendicular to the work piece like this, so I am getting minimum dimension. Now better remove the instrument from the work piece and then where to transfer this distance on to the steel rule. Now we can see 1 point is coinciding with it graduation mark 10 and then graduation mark 12 is coinciding at this point. So the distance between these 2 is 20 mm, so the diameter of the hole is 20 mm.

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Now let me explain how this outside spring caliper is used to get the diameter of the work piece, now we have to keep the work piece on the surface plate and we have to hold the caliper like this, we have to rotate the net. So that to tips in contact with the work piece, now we should take care that the 2 tips are in contact at the diameter and now we have to remove this spring caliper from the work piece.

And then we have to use the steel rule, now you can see this trip is in contact with the edge of the steel rule and we have this is a reference point and this is the measurement point. Now we can take the reading, so it is giving 40 millimetre that means the diameter of the work piece is 40 mm. Since the spring calipers do not have their own graduated scale, there use only for transferring the distances.

Now let me conclude this session. In this session we learnt about general care of the measuring instruments and then how we can classify the measuring instruments. Also we learnt about linear measuring instrument where in we discussed about the different kinds of accessories like surface plate and then angle plate and then engineers square and then we study about the linear measuring instruments that is a steel rule.

How to use steel rule for length measurement, how to use steel rule for inside diameter measurement and outside diameter measurement and then how to use spring caliper for transferring the distance from the object to the steel rule, tomorrow we will continue with the other kinds of instrument used for linear measurement, thank you.