Engineering/Architectural Graphics – Part 1 Orthographic Projection

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Lecture – 08
Scales

Good morning. Welcome to the lecture 8 of this ongoing course on orthographic projections or architectural graphics. So, in this particular lecture we are going to learn about scales. Now, what is a scale and why is it so important for drawings? So, scale is basically required to literally scale up or down a particular drawing and draw it on a given size of sheet. So, for example, as I had said earlier also if you have to draw the drawing of this huge room.

So, how would you fit the drawing of a room on a small sheet? You could draw on a very small piece of paper and A 4 size sheet and A 3 size sheet or maybe an A 1 or an A 0 size sheet it could be any sheet. Now how would you draw that and all the drawings drawn on different sheets however big or small they maybe should be able to represent the same dimensions which we want them to read.

So, for example, this hall where I am standing currently is approximately say 5 meters / 15 meters. Now 5 meter / 15 meter in a true scale is not possible to be drawn on a sheet nor is it required. So, if I will draw it in such a manner that every centimeter 1 centimeter is equal to 1 meter. So, what does it mean? 1 centimeter = 100 centimeters 1 is to 100. So, that is a scale on which if I draw this room which was 5 meter / 15 meter would be drawn as 5 centimeter / 15 centimeter very simple.

This is a type of scale which we used to draw a bigger object, a bigger thing on a smaller sheet of paper. It could be the other way round. For example I am drawing an engineering machinery part which is a very small tiny part and I want to make it in such a manner that I am able to show the very fine details. So, maybe that it is a very small screw which goes into a machine and it is just 1 centimeter by say 0.5 centimeter of a screw.

And then there are all those wiring on that, there is a detail on the end and on the top and there are a lot of these things. So, what I will do? I will draw that 1 centimeter of that screw at an enlarged a bigger scale and I will see this 1 centimeter being represented as 10 centimeter. So that I can show all these details there the scale is 10 is to 1 so 10 centimeter of an object represented on the sheet is actually equivalent to 1 centimeter of the real object that is also a scale.

So, we could scale up, we could scale down or we could also draw on a true scale. For example the section of a door frame, so it could be exactly the same size and will be drawn at the same scale in the drawing that is a true scale.

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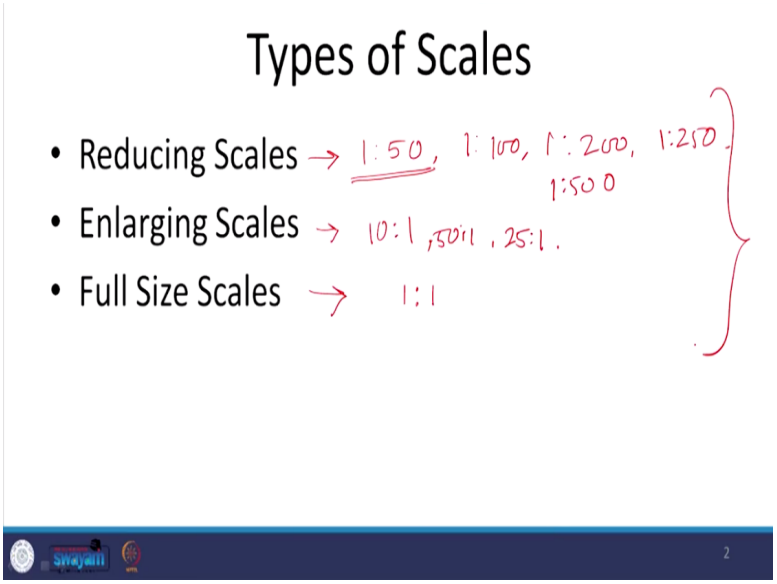

So, the first thing that we need to learn about this is what are the different types of scales? Reducing scales as I said are used when the object is much bigger. For example, somebody is designing a bridge now that is a huge bridge we cannot possibly draw it on the sheet of paper so we will have to reduce its scale. So, these are called reducing scales where the real object is much bigger than what is shown in the drawing.

So, any scale where we have 1 is to 50, 1 is to 100 there could be any scale for that matter, 1 is to 200, 1 is to 250, 1 is to 500 all these scales where 1 unit represents a larger bigger number unit that is a reducing scale. So, here the real object will be much bigger than what

will be represented on the sheet. Now, the other one the second one where the real object is much smaller.

And what is shown on the sheet is much bigger version of it that is called an enlarging scale. In this you will write say 10 is to 1 so 10 units represented on the sheet are actually representing just 1 unit of the real object 10 is to 1, 50 is to 1, 25 is to 1 it could be any depending upon how do you decide that what is the scale to be followed. Usually there are some standard scales.

So, the ones that I have written are usually the common ones used they are the standard ones., but you choose a scale depending upon the size of the drawing to be represented, size of the object to be represented. For example, you have a huge side for example there is a city plan being drawn. Now you also need to put it on a scale it has to be proportionate, but then it has be reduced.

Now how would that be reduced? So, depending upon the size of the sheet on which it has to be printed. So, for example the city plan sometimes if you go cities you find transportation plans where the road network would be shown or maybe the broad districts are shown or something like that. So, depending upon the sheet of paper it could be an A 4 sheet which is a handout, it could be a bigger sheet or sometimes it is even bigger than A 0.

So, maybe 4 A 0 together put up one city plan. So, depending upon that the scale could be very odd 1 is to 5750 just to fit that entire drawing on to this sheet that entire city plan on to this sheet. So, depending upon the size of the sheet these scales could also vary you could choose some scales which are not standard ones, which are not commonly used, but still they will serve the purpose and that is desired at that moment.

So, the scales are chosen depending upon the real size of the object and the sheet on which they have to be represented. The last one which is full sized scale is 1 is to 1. So, when the real size of the object is drawn on the sheet it is called a full size scale 1 is to 1. So, if it is like 10 centimeters big object it will be drawn exactly as a 10 centimeters on the sheet that is what the full size scale is.

Now these different types of scales could be represented on sheet in multiple various ways that is what we are going to learn in this lecture. So, whenever you are drawing, writing, mentioning the scale or drawing a scale is mandatory, we have to draw the scale and it could be done in multiple ways.

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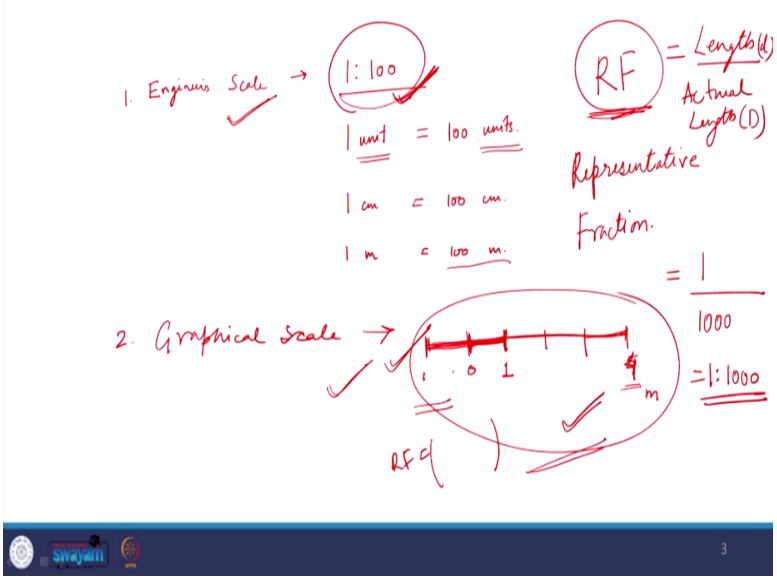

The first one which is very simple and which is often used it is called the engineers scale and how do we do that just as I had done in the previous slide. So, what do we do? We just write 1 is to 100 that is the scale. So, it implies that 1 unit is equal to 100 units. I do not write what unit is it depending upon what unit are you going to use it will be. So, 1 centimeter = 100 centimeter, 1 meter = 100 meter anything.

So, any unit you pick up here will be equal to 100 units of the same object in reality. So, it means that a 100 meter long road will be represented as a 1 meter long road here 1 is to 100 is not that reduced a scale. If you look at the map of India sometime you could actually be seeing it at 1 is to 50,000, 1 is to 5 lakh depending upon at what. So, whenever you see the map of India whether it is you might have definitely used the map of India for your geography classes in school.

So, the small sized map is also very proportionate you look at it and you say this is the map of my country why because it is proportionate it is just that it is scaled down, it has been

reduced by using a reducing scale. So, the scale there the number will be much bigger. So, 1 is to say 1 lakh, 1 is to 5 lakh they do not mention it is just proportionate, but if you really look at that there must be a scale.

Now, the purpose there is not to actually measure the dimension it is just to know relatively that okay where that river is or where that city is. So, you tentatively draw that, but if we are to measure the distances. So, in all the geographical maps whatever you find wherever you will always find a scale in the bottom somewhere. Now, it could be written represented as an engineer scale which is just simply written as a number or the second one is graphical scale.

Now this is something that we usually use. Now graphical scale is where you draw that this particular unit, this unit it could be 1 centimeter, 1 inch, this unit is equal to how many units? So, that is what we would write. So, if it is 0 maybe there are say 4 so if we write it like that we would write this is 4 meters. So, instead of reading it as how many units actually drawn here are equivalent to 4 meters we just draw it that this is equal to 4 meters.

Now what is this and how will we read it? So, to read it we will just measure, we will take a divider we will just measure how much is this and measure the same thing on the drawing that is represented on the sheet. So, you measure that drawing and you put it on the scale and you will know that how many units are being represented here that is what this graphical scale does.

Now why at all do we need a graphical scale? Why could not we just do with engineer scale we could just write and most often by the way we write especially because we are now drawing making the drawings on computers. So, what happens that digitally you anyways have that drawing which you draw in full size scale and then while printing you just reduce or enlarge it and it could be reproduced very easily, but it was not the same in the old times.

So, how were the drawings being made? They were being made by hand we were drawing it by hand. So, when you were drawing it by hand and then the paper would shrink sometime they were on the piece of cloth. So it would shrink during the winters and then sometimes it

would expand. So, instead of just writing now if suppose we had written that okay this country's map is drawn at the scale of 1 is to 50,000.

And then somebody just went on to measure that okay how much is the overall area of this country? He or she would get a different result every time because the actual thing, the actual dimension which we were measuring on the sheet would vary in different seasons over the years and all that. So, to avoid that they would draw a graphical scale like this on the same sheet of paper.

So, if the paper would shrink this entire scale would shrink simultaneously along. So, whatever this distance is of course initially there would be a proper scale which would have been used, but whatever this unit is would remain the same and it would still mean 1 meter. So, the paper has shrunk this particular distance has also shrunk simultaneously and that is how the graphical scales are actually used to look at it to measure it by using a tool.

And then read the dimension that is what the intent of using a graphical scale is. Now whether we are using an engineer scale or a graphical scale, but more for graphical scale one thing which we need to know is RF or representative fraction so it is called representative fraction and we very commonly use this term as RF. Now what is RF? RF is equal to the length of the drawing upon the actual length of the object.

So, if I say that the length of the drawing is 1 centimeter and the actual length of the drawing is say 10 meters. So, that is 1,000 centimeters same units we have to keep. So, the representative fraction is 1 is to 1,000 which is how we represent this scale. So, this is the way of representing this RF, this representative fraction. So, this engineer scale is a way of representing this RF representative fraction which is say 1 is to 100 here and the RF here would be defined.

It would be determined and it would just be represented as a graphical scale here. So, that is what the purpose is?

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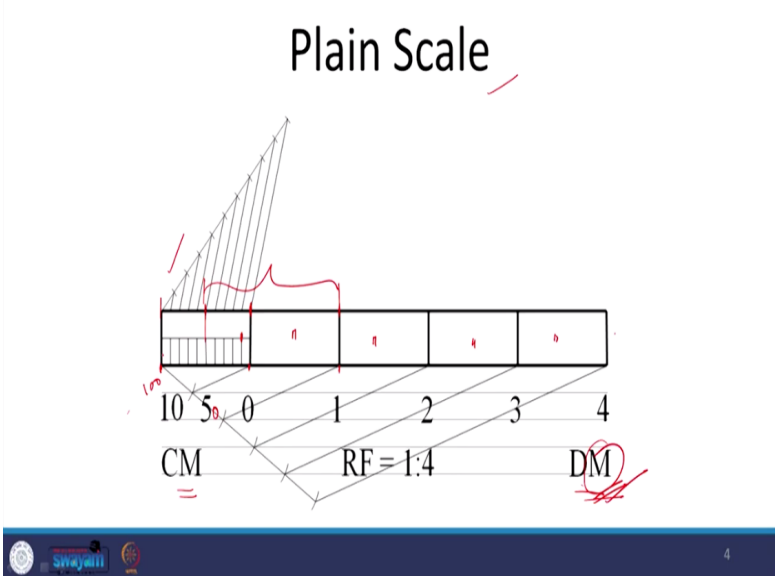

Now what we are going to learn about is how to draw the graphical scales? There are various different types of graphical scales which are used. We are going to learn about two scales here. I am showing it to you here on screen and after that we would quickly look at how to draw them. So, this is a plain scale the first one is a plain scale and what we do here is that we would simply draw a simple scale a straight scale.

We would divide it into some equal number of units sufficient enough to measure the maximum dimension on this drawing whatever drawing is given. So that is what we would use. So, this is say RF 1 is to 4 this is in decimeters and here we measure centimeters. So, the last unit so the 0 as you might have realized, observed in the previous slide also, we always start 0 at one unit from the left hand corner.

And then have equal number so these are all equal. So, these are equally spaced line so say 4 units this side and 1 unit this side. Instead of writing one here we have written 10 which is the 10th division of this bigger unit, it could also be 100. Suppose, if it was meter and we were representing centimeters here so then we would have this would have been 100 here. So, while it is 1 meter here this is actually 100 centimeters here and instead of 5 we would have had 50.

And what we would do? We would divide this last one into equal number of divisions depending upon what is the scale. Suppose, we are using inches and feet so in that case we

would have divided into 8 equal parts, but since mostly we are using the metrics system and I am also demonstrating this entire process for metrix system we would most often divide it into 10 equal parts and each part is equal to one-tenth of the unit being represented here.

So, if it is meters here this 1 is equal to 10 centimeters. If it was decimeters we would have measured 1 centimeter here at whatever scale we would have drawn. So, that is what this simple plain scale is. It is easy to draw the only thing that we have to do is divide this 1 unit representation into 10 equal parts. We have already seen how to divide any given line into equal number of parts so that is simple, that is very easy we can simply do it.

So, that is what the plain scale is and we always mentioned the representative fraction. The second one is a diagonal scale. Now in this one if you have to measure I would say suppose we are considering meters and centimeters here if I say that we have to measure 1.5 meters it was easy. We would measure 1 here and 0.5 here and so this distance would be equal to 1.5 meters here 1.5, 1.1, 1.2, 1.3, 1.4 like that. Now, what if I say that I have to measure 1.37 meters how do we do that? It is not possible.

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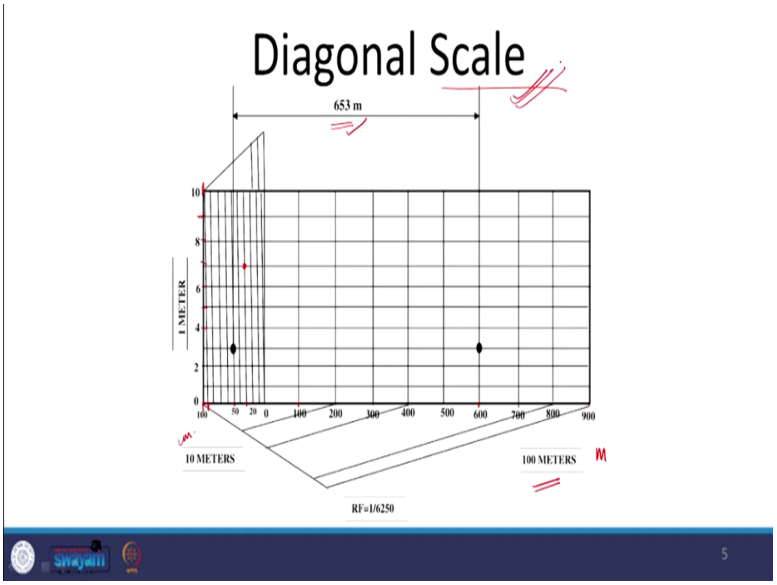

So, to take it to the second decimal we would use this diagonal scale it is much easier. So, what we do here is for the first line 0 to say so this is a 10 centimeter line or 10 units line and it represents 100 meters. So, each one represents 100 meters, 100 units in the last one what

we do we further divide it into 10 parts as we have done for the plain scale, but in addition to that we also raise a scale vertically.

So, we raise the scale vertically we divide it into 10 equal parts and then we join the first fraction here to the first fraction here. Now, as this triangle goes on increasing we can see that the horizontal distance here is one-tenth of this unit. So, suppose just like in the previous example if we were counting meters here and we are taking say centimeters here we can then go to the second decimal place.

We can now measure 1.37 so how do we do that? Say 1 here, 3 units here so this is 1 to 3 units and I move it up to say 7. So, this point is 37 this is what this distance is. Now here as it has shown 653 meters so this is 600, 50 and then we take it to the third one. So, this has already increased from here as 650 to 653 at this point that is what this diagonal scale enables us to do.

So, we can actually measure it up to the second decimal place or we can actually measure it like this. This is what diagonal scales enables us to do. So, in any drawing in reality we always do not get the simple fractions that okay it will be 650 it does jump like this. It could be 653, 657, 651 whatever it could be anything and that is what is measured using this diagonal scale.

So, let us now move on to the sheet and we will see how to draw both the scales, both the plain scale and the diagonal scale and every time you draw your sheets you have to mention both in engineer scale as well as using graphic scale depending upon what kind of scale do you require if it is a simple drawing you can do with plain scale, you can go ahead with that if not you have to draw the diagonal scale. So, let us shift to this sheet and see how to draw the scales.

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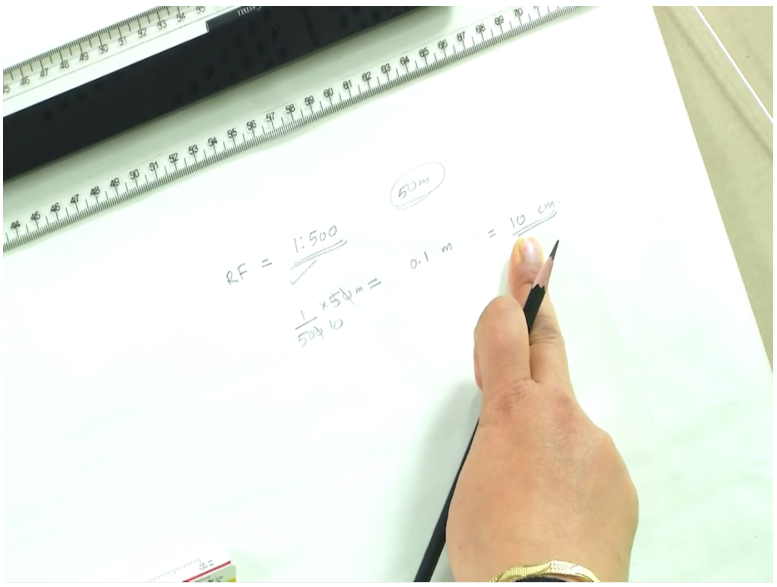

So, now we are drawing the scales both types of graphic scales not the engineer scale of course. So, we are drawing the scale on to the sheet let us see how do we do that? So, suppose I am drawing say a 1 is to 500 a scale to represent this RF of 1 is to 500. Now, if I have to draw a scale big enough to measure say 50 centimeter. So, 1 is to 1 upon 500 into 50 that will give me 0.1 meter this is meters here.

So it means that I have to draw a scale of 10 centimeter if I have to measure a maximum dimension of 50 meters on an RF of 1 is to 500 I will have to draw a line of a scale of 10 centimeters that is what we are going to do right now.

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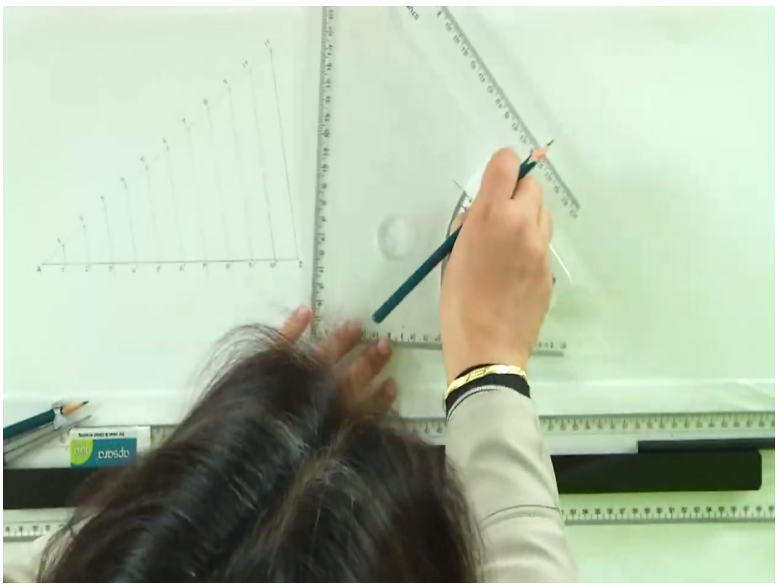

So 10 centimeters, so here we measure 10 centimeters. Now this one we will divide in 10 equal parts. So, I have already divided this line into 10 equal parts, but the very first division we will have to divide into 10 equal parts.

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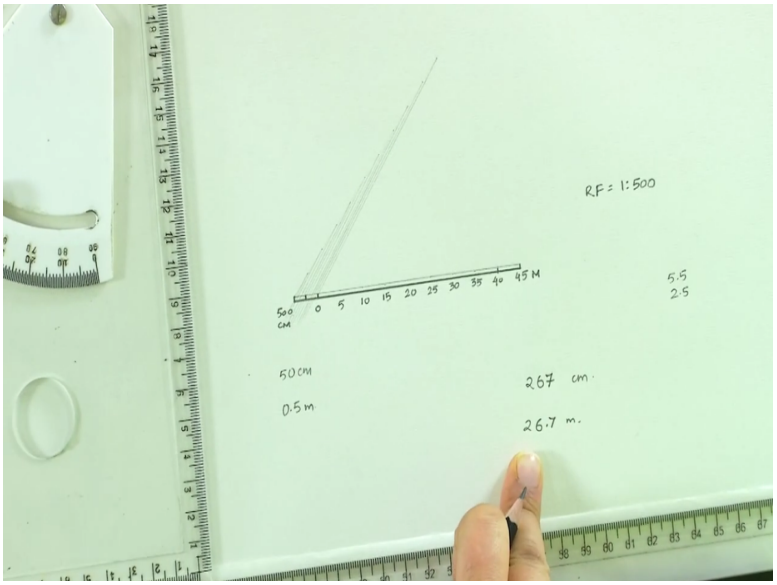

So, to make those 10 divisions I again draw a line at an acute angle and I am again taking here a 10 centimeter line it could be anything, but just for the convenience so that I could mark it here. I have drawn another line acute line here with 10 divisions on it and now I will connect it now the first unit has to be divided the first division has to be divided into 10 equal parts using the same division of line rule.

So, what I have done I have drawn a line an acute angle from this given line and then I have drawn 10 marks 10 equal divisions on that and now I am connecting the last of the mark with this point and we will just draw parallel lines from these points coming on to this division the first division. Now you see here we have already achieved the 10 divisions of this first division.

Each one measuring equal to 1 mm or one-tenth of the centimeter, but what we were taking here is that this is a scale the representative fraction is 1 is to 500 here and we are representing a line of 50 meters here. So, when we are writing when we draw so 1 centimeter here is equal to 5 meters that is what we are representing and if we start to draw like this one becomes 0 this is the division.

So, what we have here is 0 and then we can start writing 5, 10, 15 because each unit is 5 meters. So this line is this is equal to 45 meters here and on this side this is 5 meters or we could also write 500 centimeters. So, we could also write 500 centimeter here and this side it is meters. This is a scale and then for each division we could also mark these lines or we could just mark the middle one which is 250 centimeters or we could also write the divisions in between depending upon what is the common unit, the dimension to be measured?

This is a plain scale representing an RF of 1 is to 500 that is what this particular plain scale represents. Now, the next one is a diagonal scale so with the help of this one you can actually measure distance dimension which is the minimum unit of that, the minimum fraction that we can measure from that is one-tenth of 500 centimeters that is 50 centimeter. So, we can measure say 5.5, we can measure 2.5 because each fraction of this first division measures equal to 50 centimeter or 0.5 meters.

We cannot measure anything lesser than this 0.5 meters or 50 centimeters. Now, if we want to measure a dimension of say 267 centimeters. So, which means we want to measure 2.67 meters or we could also make it bigger because here we can measure all the way up to 45 meters. So, we could measure 25 meters here 25.53 meters. So, suppose we want to measure 26.7 meters then how do we measure?

So, we will draw a diagonal scale to measure this 26.7. So, while drawing and say the representative fraction now is different.

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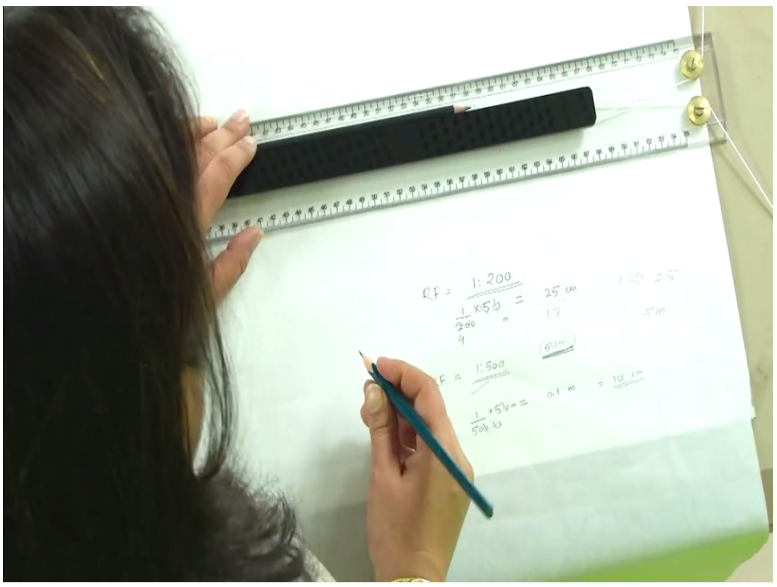

Suppose, let us take this RF to be of 1 is to 200 and we are going to be measuring 26.7 meters the maximum that we want to measure is 50 meters. So, for a given RF of 1 is to 200 how much do we need to draw is 1 is to 200 into 50. So, this is 1 / 4 meters that means 25 centimeters 0.25 meters 25 centimeter. So, for a given RF of 1 is to 200 where we want to measure 50 meters we will be drawing a line of 25 centimeters.

So, let us draw this diagonal scale here. So, we have taken 25 centimeters and we want to divide. So what we want to take again is we want to measure up to 50 and we can divide into 10 equal parts where we divide into 10 equal parts each part will be measuring 2.5 centimeters and that will be equivalent to 5 meters.

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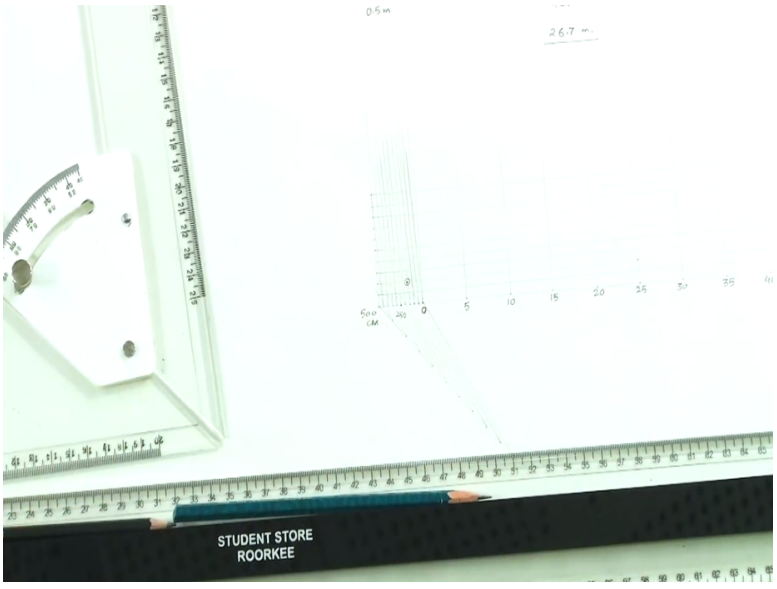

So let us do that. So, we make these equal divisions of 2.5 centimeter each and now what we have to do is we could have drawn it using the division of line method, but since it is a simple unit and we could have divided using the scale that is what I have done and now what we have to do is we have to divide this first division into 10 equal parts and we will do it using the same method as we use.

So, I am again dividing this line into 10 equal parts and we will have these 10 divisions equal divisions by drawing the parallel lines. So, we now have these 10 divisions in the first fraction on to this diagonal scale. Now, what we are required to do after this is we have to draw further 10 divisions. Now it could be any size of the line there. It does not need to be 1 centimeter each or whatever, but just for ease we may take it to be a simple division.

So I am taking 0.5 centimeter here and we will again draw parallel lines. Again you draw vertical parallel lines at each of these fraction. So, what we have here this is 0 and each 2.5 centimeter division is equivalent to 5 meters. So, we write it here 5, 10, 15, 20, 25, 30, 35, 40 and 45 this is meters and RF here is 1 is to 200 that is what we are drawing. Now this side we have again 5 meters, but we will represent it as 500 centimeters here.

And now let us again take these 10 divisions in very light lines vertically up. So, we have again taken these 10 equal parts up and what we are going to do here is we are going to join the first part here with the top first line that is how we draw and we fix up this angle and then we draw these 10 equal parts that is what the diagonal scale is. So, what we now have to measure is say 26.7 meters.

So, we have 25 meters here so just look at it carefully 25 meters here. Now what we have to do or we could take 20 this is 500 centimeters what we have to do. So, each division this is 10 divisions here, this is 50, 250 now if I divide this is 50 each. So, if I take this is 50 centimeters so it is 0.5 meters I am here at 20, 25, 25.5 meters, 26, 26.5. Now I have to measure a 0.2 so I take it at here this is 26.7.

So, that is how we will measure so simply we will just measure the distance here from here and that is what we are going to get. This is how we are going to measure any given distance,

but then it depends upon how we draw this scale this is for an RF of 1 is to 200 and this scale is capable of measuring up to 50 meters. So, this is how we are going to draw a diagonal scale for any given RF and to measure a given distance.

I hope you are able to understand the concept of scales and how we draw these scales on sheet and why we draw it. From the next lecture onwards, we will start to understand the different basic shapes that are going to be used solids as well as two dimensional shapes that are going to be used in our graphics course. So, thank you for being with me here today. Let us see you in the lecture 9 tomorrow. Thank you.