Engineering/Architectural Graphics – Part 1
Orthographic Projection
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Lecture – 23
Orthographic Projections
Projection of a Plane Inclined to One and Perpendicular to the Other Plane

Good morning, welcome to the third lecture of week 5, where we are discussing about the projection of planes. So, in this course which is on architectural graphics, we are covering the orthographic projections for various different geometric forms and we are now at planes. So, earlier in the previous 2 lectures of this week, we have already discussed how the projections of the planes which are perpendicular to both the reference planes would come.

And then we saw how the projections of planes which are parallel to one of the reference planes, but perpendicular to the other reference plane that would be drawn. Today, what we are going to see is: when the plane is perpendicular to one of the reference planes, but it is making an angle; it is inclined to the other reference plane, how would the projections come?

So, let us quickly understand this by taking **(Video Starts: 01:23)** the example or visualising it with the help of this quadrant system. So, this is our quadrant system. This is our quadrant here. So, we have say, a plane, a triangular plane here, which is a flat plane. Now, if we kept it like this, it is perpendicular to VP and it is parallel to HP. It could be at any different height; it could be touching the VP; it could be in HP, whichever way but it remains parallel to HP.

So, what do we see? We see the true shape of this plane in HP, which is the reference plane to which it is parallel. Now, here we are assuming that this plane is perpendicular to VP and it is making an angle with HP. So, this is something like this. So, it is still perpendicular to VP and it makes an angle with HP. So, what do we see? We see that the line which we got as a projection on VP, which is the vertical trace is now inclined, but it remains the same length.

And this change in HT, (02:36) the horizontal trace is not the true shape anymore, because it is not parallel to HP anymore. So, we have, we will have a diminished slightly reduced size which will be seen in the HP. What if the plane which is in question is perpendicular to HP and parallel to VP and then it makes an angle with VP. So, this is how the change happens. So, right now, it is parallel to VP but perpendicular to HP.

And when we incline it like this, it becomes inclined to VP and we see a diminished or changed shape in VP which is its vertical trace. So, let us see the steps how to draw the orthographic projections of a plane which is making an angle with one of the reference planes and is perpendicular to the other in a stepwise manner. **(Video Ends: 03:31)** So let us assume a problem. Here, I am going to show how do you work with circle because rectangle and square will become very easy if you have already understood the circle.

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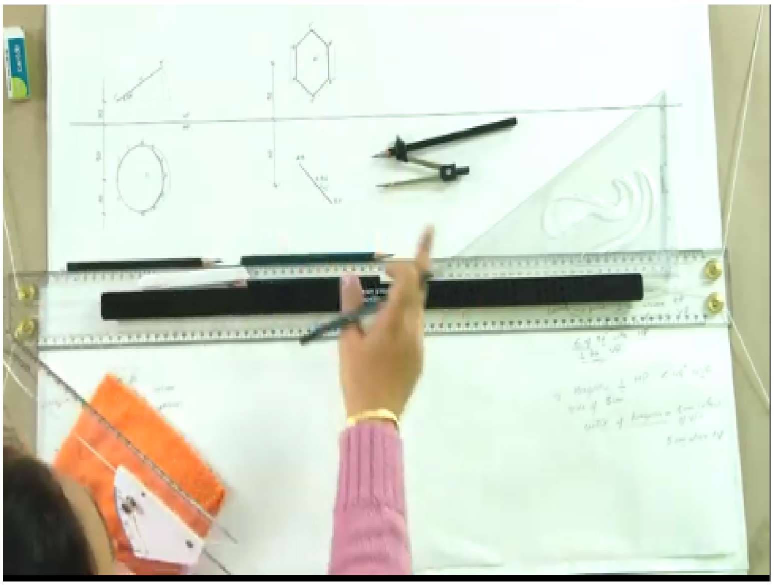

So, let us assume that we have a circle which is of radius 3 centimetres and its lowest point is 2 centimetre above HP. The centre is 5 centimetre in front of VP and this plane the circle makes an angle of 30 degree with HP and it is perpendicular to VP. Now to start with, we will have to determine where the circle is. So what it says is that this circle has its centre 5 centimetre in front of the VP. So, what do we take?

We just draw a line 5 centimetre in front of VP. So, it will be seen in HP. This is the line where the centre of the circle is going to lie. Now, this circle is of radius 3 centimetres. So, we take 3 centimetres and keeping centre of the circle on this line, we will draw the original in case assuming that the circle was parallel to HP and perpendicular to VP. So, we will draw its projections.

Not this that we are drawing, which is the original initial position, not the original position the initial position which we have assumed, we will draw it lighter. It will not be drawn very dark, then we take its projections. Now, it says that its lowest point is 2 centimetres above HP. So, assuming that this point is the lowest point. We will mark a point 2 centimetres above HP and it makes an angle of 30 degree with the HP. So, we will make an angle of 30 degree with HP.

So, right now, so, we were only assuming that this was this was parallel to HP. So, initially, it will not be the 30 degree. We will only have a straight line which is which is the projection of this circle onto VP. Now, what we are assuming is that this line becomes inclined at 30 degrees here. So, what will we have? We will have the same circle inclined at 30 degree. And this is what we will have. So, what we do?

We make the circle its true shape parallel to HP first and perpendicular to VP and then we incline it by 30 degrees, which is the final trace of this circle. Now, we have to bring it back. How do we do that? So, what we do to achieve this is, we will divide the circle into 12 equal parts, which is our standard procedure when we are working with circles be divided into equal number of parts.

So, here we have divided the circle into 12 equal parts. And we will take the projections of all these 12 parts onto the vertical projection. So, what we have here is both these points if you have drawn if you have divided the circle in 12 equal parts, you will have these projections merging for the 2 points. This is what you get. If you see, we have divided the circle into 12 equal parts and we have projected all these points onto the vertical trace.

And now, what we will do? We will take the projection of all these points onto this line which is inclined at 30 degrees. So, what we have is all these 12 points projected onto this line which is inclined at 30 degrees. Now, we will bring back the projection. So, this is the vertical projection and what we have to do? We have to bring it back to match the horizontal projections.

So, the horizontal since we are inclining it with HP and if you remember how we inclined the lines that are being incline lines or the single incline lines, we only take the locus of the point in one plane, it just remains the same. So, what we are doing here, when we are inclining this plane for example, this was the plane. This was parallel to HP and now when we incline, so, what happens?

The points move but their horizontal projections remain the same. So, their vertical projections change. So, a point which was here has gone up there, but horizontally, it still is falling in the same line which is the principle which we have employed here. Now in very light, I am going to mark these 12 points for clarity. So, let us start with this point 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12.

And why I say that we are going to market in very light is, because this is not the final projection. The final projection is going to come now. Now, we will bring back the projection of these points. So, we took 7 here, now 7 went up there and it is coming down. So, when it comes down 7 meets 7 again. So, the horizontal projection remains the same. The vertical projection has shifted from this point to this point which is what we get.

So, this is the point 7 now. Now, we get this as the point 6 and 8, we bring it back. So, this is the point 6 and this is the point 8, then we get the points 5 and 9. So, this is the point 5 and 9, you just have to remember that the vertical projection and the horizontal projection should match up. Then we have the points 4 and 10, next we have the points 3 and 11. And then we have the points 2 and 12 and the point number 1 remains at the same place.

Now we will have to join these points to get the final shape of the circle, which is what we are going to do by using the French curves. So, we have these French curves here. Now, we will start to fit the curves as you go on to use these curves, you will become more familiar with how these curves would fit and it will become much faster. But yes, initially using

French curves is a little tricky process and you may have slight difficulty in finding the correct fit.

So, if you see this, we have been able to match up the points onto this curve fairly well. So, now, if I darken it, ideally you should be darkening using the French curves only. This is the final shape of the ellipse that you get. So, the final shape of the circle which is now projected which is tilted is this ellipse and the final projection onto VP is this line which is inclined at 30 degrees. So, what do we get? We get all the conditions satisfied.

The plane which is circle is inclined at 30 degrees to the HP. Now, it is located at 2 centimetres. So, it is located at 2 centimetres above HP which is fulfilled here and then the centre is 50 mm in front of VP which is what we get here. And then we have this circle with a radius of 3 centimetres. So, what we need to write is the radius of the circle which is shown here. So, we write 30.

So, what we have done? We have fulfilled all these conditions here and we have also shown it in the solution as well. So, this is our solution and if you also have to number it, number the circle. This is the point O dash and then this is one dash, this is the final 7, 6, 5, 4 and the same numbers you can take up. Ideally, you should be erasing these numbers because they will confuse.

So, either you draw them very light or you do not write them at all if you can manage without writing them and then in the top, we can just mention this 7 dash and so, it will be clear that this is how the circle is being projected. This is a circle which is inclined to HP at 30 degree and it is perpendicular to VP. These are the steps you will start by assuming that the plane is parallel to one of the reference planes and then gradually inclining it. To start with you should keep the plane to which it is perpendicular as the same. In this case, it was perpendicular to VP. We took it as that and then we inclined it with HP.

Now, let us have another case. So, let us make a hexagon which is perpendicular to HP and add an angle of 45 degree to VP. Side of this hexagon, let us take as 3 centimetres and let us define the position of centre. Centre of this hexagon which is 6 centimetre in front of VP and 5 centimetre above HP.

So, now, let us start drawing it. So, the first thing that we have to do is to locate where the centre of this hexagon is going to be and the centre is fixed. So, we have the centre 6 centimetre in front of VP. So, what we get? Again, we will draw it in HP. So, we have this 6 centimetre in front of VP, which is where we will draw the line. So, the Centre for the hexagon continues to stay on this line.

Now, it is 5 centimetres above HP. So, we will draw a line 5 centimetres above HP. This is what it is. So, we just have a line. We do not know where the centre is. So, we can assume it anywhere. Now, since it is perpendicular to HP, so, we will be seeing the single line in HP and to start with let us assume that it is parallel to VP. So, we will be seeing the hexagon in VP first. So, let us draw.

So, the side of the hexagon is 3 centimetre. So, it will be inscribed in a circle with radius as 3 centimetres. So, assuming this circle, the centre of the hexagon anywhere on this line, let us draw the hexagon. Now, it does not say anything about the hexagon, we could start from anywhere. And in this case, if it were given that one of the sides is parallel or perpendicular or to either of the reference planes, we could have taken that.

Now, here what I am taking is, I am assuming that 2 of the sides, they remain perpendicular to VP as a line, not as a plane. So, now here, we will draw this. This is the initial hexagon that we will get assuming that it is parallel to VP. So, this is the hexagon in question. Now, currently, this hexagon is perpendicular to HP and parallel to VP. So, we will draw the projections for these points and we will have their horizontal trace.

So, what we have now? We have it like this. So, we have 2 of the points represented here. 2 of the points plus centre represented here and 3 points represented here. Now, what it says? It is inclined at 45 degrees to VP, but the centre remains fixed at this position we do not have a point which is fixed here. So, in this case, what will happen? When we incline it to, it is making an angle of 45 degree to VP. So, what do we see?

We see it in the HP making an angle of 45 degree but it rotates about its centre. So, what happens? The centre remains fixed which is here and we will rotate the hexagon about the centre. So, what happens? We get the new points here in HP. And now, we take their projections back to the VP. In this case, the vertical projections they remain the same. And here we will have the same horizontal projections coming which is how we have done earlier.

And the new points that we get are these and the 3 points which were represented by this point on this original trace, they remain the same because their horizontal and vertical projections, they still match in these points. So, now, what do we get as the new shape of this hexagon? So, what we have here is this is new hexagon that we will get which is the final projection of this given hexagon which is perpendicular to HP and making an angle of 45 degree with VP and what we get here is this line which is its horizontal trace.

And now, it is making an angle of 45 degrees with VP which is what the given condition was. You can now label it. So, to start with, we will start with VP. So, A dash, B dash, C dash, D dash, E dash and F dash and we also have an O dash here which was important. Now, when we see it here, we're seeing it from the front we get A B and here we get E D and this is the point which is F , O and C.

Now, all you have to do is you have to dimension to represent the location of the centre. This is what we are doing here. So, we had it 6 centimetre in front of VP so, which is represented here and 5 centimetre above HP. So, we say that the point O which is the centre of this hexagon is 5 centimetre above HP and 6 centimetres in front of VP. Suppose, we were given a condition where we were defining the side, the condition of the side saying that this side makes, it is at an at a distance of x and y from HP and VP respectively.

In that case, we would not have inclined tilted this plane about its centre. In that case, we would have inclined this plane about its corner about one of its corners. So, that is how the change in the projections would come, but here this was to show how it would look like. So, depending upon how the plane is being inclined, it will become skewed. Now, if you also see in this case, since it is being inclined only in one direction, it is inclined only in one direction, the lines which are remaining parallel to the plane the reference plane.

For example, in this case, the circle suppose we have this as a circle and it was originally parallel to the HP. Now, what is happening in this case is as we inclined these assume that each of these lines is in the circle is still there. In that case, the line will still be seen as the same length, which is what is happening, the horizontal trace remains the same. The same thing happens in case of this plane hexagonally plane, which is assumed as parallel to VP and now when it changes like this, each of this line individually, not the plane, each of this line individually still remains parallel to the VP.

So, we still see these vertical lines having the same dimension that is why this side AB and DE, which was originally parallel to the VP still remain parallel to the VP and that is why we see the original dimensions there. They would still be 3 centimetres in size **(Video Ends: 27:23)**. So, if you look at it from a fundamental point of view, whatever we have learned or understood through the projections of lines straight lines is applied here and that is good enough to tell you whether this solution that you have derived is correct or not.

And gradually as we move on, as we move on to solids, it will become more complicated. We will not be able to decipher the projections of solids with the help of lines only. We will have to understand surfaces which is made which is these planes. So, that is what we are doing currently. We are understanding how these planes behave when they are inclined to one or the other reference planes or as we will see in the next few lectures, what if the plane is inclined to both the reference planes or in that case, the plane is called an oblique plane.

So, I hope you have clearly understood how to draw the orthographic projections for planes which are inclined to one of the reference planes and perpendicular to the other reference plane. So, thank you very much for being with me in this lecture today. We will see you again in the next lecture of this week. Till then, bye, bye.