Engineering/Architectural Graphics – Part 1
Orthographic Projection
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Lecture – 40
Intersection of Surfaces - II

Good morning, welcome to the last lecture of this ongoing online course on architectural graphics or engineering graphics. And in this course, so far, we have covered almost all the topics related to orthographic projections of points, lines, planes, solid, section of solids, development of surfaces. In yesterday's lecture, I had already talked about the intersection of surfaces, which is what we are going to continue today.

So, yesterday we had seen how to draw orthographic projections for 2 solids, which are intersecting. One was prism and the other one was a right angled cylinder. So, we saw 2 conditions there. One condition were the 2 axes what intersecting perpendicular to each other. And both the axes were assumed to be kept parallel to the VP. And the second case, which we had seen yesterday was the both the axis were parallel to VP, but they were inclined to each other.

So, one was kept perpendicular to the HP, and the other one was being inclined to HP while both of these were together be parallel to the VP. So, that was the condition which we saw yesterday. Today, I am going to take the case where 2 circular cylinders are going to intersect with each other. What I am going to assume as the first case is where one of the cylinders has its axis perpendicular to HP and other one has its axis parallel to both HP and VP, but the axes do not intersect.

So, we have 2 right angled circular cylinder, but their axes are not intersecting which means that the other intersecting cylinder passes slightly off the axis, the perpendicular axis. Let us see how to draw this intersection of these 2 solids. So, I am assuming here that we have one upright cylinder of radius 4 centimetre and it is kept in HP.

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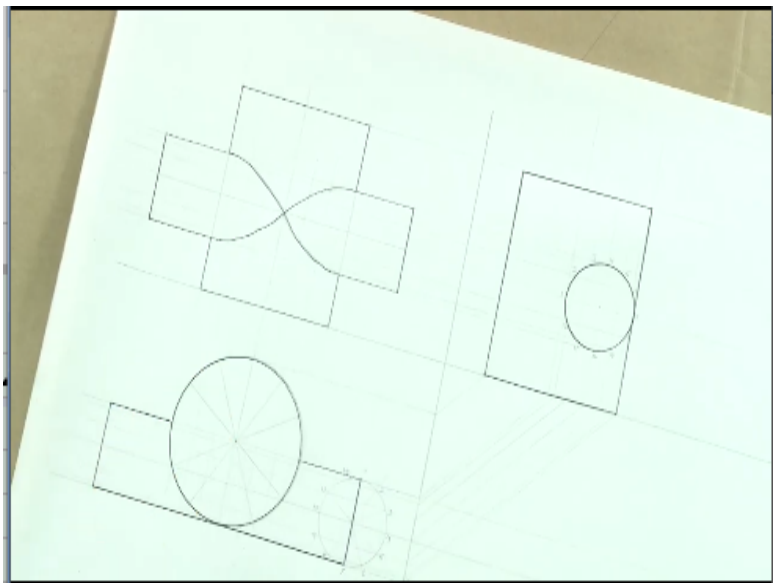

So, this is what I have drawn and we will then take its front view. So, we are assuming here a height of 10 centimetres for the cylinder and this is where the axis is going to pass through for this one. Now, for the cylinder which is intersecting it horizontally. We are assuming that it has a diameter of 4 centimetre which is equal to the radius of this upright cylinder and it is passing through this vertical cylinder.

So, we just take a part of this cylinder which is passing through this. Now, what we will do? So, we will have its axis passing through the centre which is somewhere here. And if I draw the reference circle, we will have to draw the reference circle. So, this is our reference circle which we are going to take for drawing the projections. So, to start with, so actually the cylinder is right up till here, I am just drawing the circle for the reference.

So, what we can start with is by looking at the side view, so, for this, let us first divide the circle into 12 equal parts. Now, we have 2 circles intersecting here. We have a bigger cylinder which is perpendicular to HP and we have a smaller cylinder which is parallel to HP and VP both. So, we will have to take 2 sets of these projectors. And we will first draw the side view.

So, we will just take these projectors onto the side view. Now for this one, we will again have these 12 parts. So, we have the projections for this bigger circle also. Let us take it vertically up. So, we can assume wherever it is kept horizontally because the circle is coming

somewhere here. If we look at it in the front, we will see the entire thing coming but in the side view, we will have it shifted to one corner.

So, we have taken the projections for all the possible points. Now, assuming that the axis for this horizontal cylinder is passing somewhere here. So, what we will actually see is so, this is the centre where the centre is going to pass through. So, that is how we going to see the circle and if I take these points, these are where they are going to intersect on the surface of the circle or cylinder.

So, these are the points. Now, we can also number these points and we will have simultaneously, the same points passing here. So, we will just draw the horizontal projectors to these points just as we did earlier. It is just that we will have another curved surface where so, there are 2 curved surfaces intersecting. Now, if you look at this, when we see it from the front, what we actually have is we have these horizontal projectors.

So, what we see from here, so, this is actually the half of it. So, what we see here is the front half. So, when we see it, so, this is the half which is what we have here. So, this is the projector for the upper half and these are the projectors for the lower half as we see it. So, we seeing it from the top here like this and when we see it from the front, this is where it is going to come. So, let us number them, let us mark them.

So, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12. And now, so, this is the circle that we are seeing if it was kept like this the same here. And when we take them there, we have the same numbers coming. So, this is the circle. This is the same circle as we seen from here. 4 is actually the top. Now if you see it, when we see it from there, so, what we see is this 4 comes there. The next one is 5.

So, 4 is the central point which on this circle will be here. Then we have 5 and 9. So, if I look at this alright, so, this is the line 4 and 4 intersects here with the circle. And if you look at this 4 and this is 10, so, 4 and 10, we get these 2 points. If you look at 5 and 3 there, so, 5 is here. So, we get 5 there, 5 and 3 and in the bottom, we get 9. So, this is where we get 9. Now, if you look at 6 and 8, this is where 6 and 8 are intersecting. So, let us take 6 and 8 up.

So, this is where your 8 and then this is where your 6 is going to come. And then this is where your 7 is going to pass through. So, this is where your 7 is going to come and the same thing will happen this side. So, we will have to take the projectors back up. So, this is 4 okay. So, this is where your 7 now. If you look at this 6 and 8 here, this is where it intersects. So, what we have is the 6 and 8 here, then we have 5 and 9 which are coming here.

So, 5 and 9 are coming here. So, 3, 4, 5, 6, 7 and then we have the horizontal ones which are coming here and at this point, we will get a straight line. So, for these 2 points, we get a straight line. So, what we will actually see? When this smaller cylinder intersects a bigger cylinder like this, we see this kind of an arrangement here in elevation so, if I darken it. So, we darken it. This is what are we going to see when these 2 cylinders intersect.

We will be seeing, we see the smaller cylinder passing through the biggest cylinder here and in plan, we will only see the cylinder going like this. And when we see it, since it is a perpendicular surface, we will be seeing this complete circle here. The circle will not change since it is a perpendicular surface. So, we will only be seeing this perpendicular surface remaining intact.

This cylinder, one of the edges of the cylinder, the smaller cylinder which is the horizontal one will be seen continuous, which is what we are seeing here. So, this one line, this one generator if you see here, which is 1 and 7, which is this 7. So, here it is only the 7, 1 is going inside. It is passing through like this. This is what you will see from the top. This is what you are going to see from the front and from the side, we will be seeing the most clearer of the pictures for this particular combination.

So, from the side, we will be seeing it clearly like this. And what we see from the top is actually the surface getting cut along this curve, but it is perpendicular. So, what we see here is a very simple picture, but the front elevation will have it something like this, where it is actually going into the bigger cylinder. So, that is how we will actually be drawing the projections of 2 cylinders intersecting.

Now, assume that we have a cone and a cylinder is passing through that cone. Now, that is required often when we have to create, when we have to design a frustum of a funnel basically. So, a part of the frustum will be connected with that of a cylinder. So, how will that be connected can be derived; can be found out if we draw the projections for a cone and a circular cylinder. So, that is what we will see here.

We will again assume these to be in simple conditions, but the only thing that remains here, unlike this where this surface was a perpendicular surface. For a cone, this surface is going to be inclined. So, even these points will vary what we were seeing as a perpendicular cup surface, these points will vary if the horizontal cylinder has to pass through a cone. So, let us see this example here and try to derive the solution.

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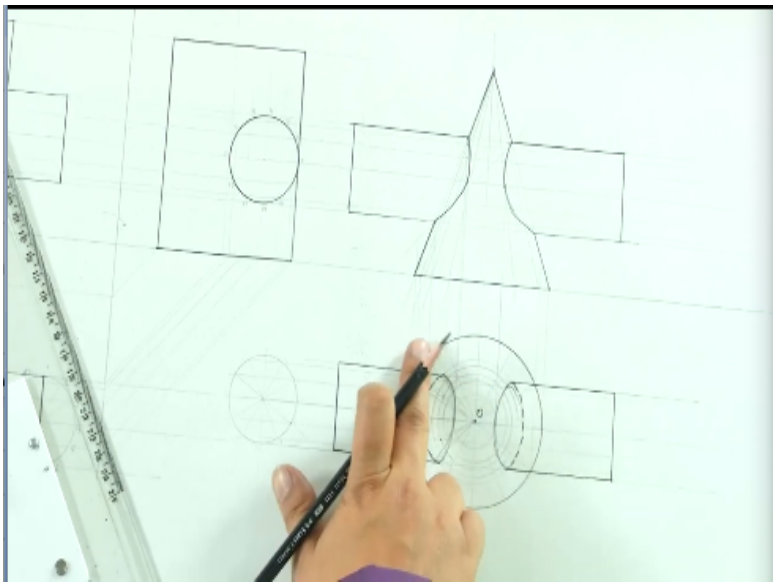

So, I am assuming the same size of a cone. So, this is the cone in question. To drive elevation first, let us draw the apex along the axis. So, this is the original cone without being intersected by a cylinder. So, we will draw its generators again. So, we divide this base circle into 12 equal parts. And these all are going to be the generators of this cone. So, this is what the cone is and we will just project these generators.

Just like we do, whenever we draw for cones. So, there are 2 methods. If you remember, we had the concentric circle method and we had the generator method for drawing the cones. So, we may be needing a combination of these 2 here. So, this is the cone. Now, we are assuming

that there is a cylinder which is passing through this cone and for simplicity here, because we are starting with cone for the first time, let us draw the axis of this, assuming it here and assuming the circle, the cylinder to be of the same size as we took previously.

It is just draw an imaginary circle here. So, this cylinder is going to pass through the cone here. We do not know how the cylinder will puncture the cone and where will it exactly do it. So, what I am assuming that this cylinder is passing through the centre of the axis here. And it is the same size. So, I am just taking it forward like this and the projectors will also remain the same which we had taken earlier for simplicity.

So, this is how the cylinder is going to pass through it, but where will it exactly cut that we have to determine. So, we are again dividing the circle into 12 equal parts. And we will take these horizontal projections as well. Now, if you look at this here, so, this point 10. So, if I am dividing the circle like this, so, this is the horizontal thing. So, which is exactly here 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12.

So, if it is passing through this, this circle is perpendicular, so, 7 is the top here, okay, so here if we looking at it, 4 is the top here, so, then we will have a slightly different numbering here. So, anyways, we have numbered it in the elevation, let us not number it in the plan, it might confuse us alright. So, now, what happens is that as the circle punctures the top most point of this circle is intersecting this point here, right.

And if we see, we have these 2 points coming here. If we seen from the top, so, this is the circle. So, we are seeing from the top, these 2 other points here and they will intersect the cone, if you look at this. So, this is the generator that we talking about where it intersects and if you bring it back, this is where we will see the top most point intersecting. So, this is the top most point intersecting the cone here on this generator.

Now, look at the next 2 points. So, 3 and 5, not 3 and 5 will go and if it was a perpendicular plane, if this plane was perpendicular, they would have cut somewhere here, but since it is not a perpendicular plane, so what is happening? But these 2 points are what we are seeing as 3

and 5 here. So, these 2 points when they cut, when they penetrate it, they will actually be intersecting the height of the cone somewhere here.

So, if we take the circle, so if I draw a parallel plane, which is cutting this here and using the same method of concentric circles, if we divide if we get it here, so, what we get? We get a concentric circle at this height, but if we have to take it back, we will have to draw a generator passing through this point and joining the apex. So, this is the generator. Now, I get it back. This is where the generator is going to come.

So, when we project these points 5 and 6 and what we get here is, okay, this is the point where we had to join the generator. So, what we get here is the generator intersecting the horizontal points like this. So, these are the next 2 generators. Further, we repeat the same process, we get the horizontal and then we join it with the generator wherever it intersects, bring it back, connect the generator and horizontally when you join these, so, we get another 2 points.

And then in the bottom generator what we actually have is, this is the point where the bottom most one. This point number 10 is going to come and this is what it is, this 7 which is right in the centre. So, when the 7 comes, so, this is where we get the other 2 points in the top and bottom. So, these are the 4 points where the circle is going to intersect this cone and form a very skewed shape of conic section or curvilinear section here.

So, we get these 12 points projected, get back the generator and get the generator back here. So, this is where the bottom part of the circle is going to come. The second is where this bottom part of this circle is going to come. So, we will just be drawing the concentric circles through these generators and wherever they intersect, through these generators in the top is where we are going to get each of these points in.

So, that is how we will get this very odd shaped curve here and a similar curve, we are going to arrive here. So, a similar shaped curve will be arrived here. This is how the cylinder is going to pass through the cone and what we will see is not this full thing. We will only be seeing the top part of the, so, okay, it is actually going to come here. So, what we will be

seeing is something like this. The bottom part of this curve is going to come like a hidden line.

So, we just get it like a hidden line here and this is the cylinder because it was parallel to VP and HP both. So, in the top view, what we will see? We will see the apex being intact. The cone being cut in a very odd shaped curve here, because from the top, it is smaller and as it goes to the bottom, the bottom part is bigger and towards the top, it tapers. So, this is how it will taper and the bottom part remains relatively flatter because it has a broader radius here and the base of the cone remains intact.

In the elevation, what we will see? In the elevation, we will just be seeing the cylinder straight like this. So, if you look at this now, this has to again go back at varying heights in the cone as well. So, what we see? We see that this is being cut here and the point where it is getting cut. So, if you join all the 12 points, we will be seeing the curve like this and this is how the cone will be intersecting with the cylinder in the elevation.

And this is how you will actually be seeing it from the top. If you see it from this side, you will only be seeing a flat circle alongside a cone or right in the middle of the cone here. So, that is how we will derive the projections of a cone being intersected by a cylinder. The only thing that we have to remember is that we have to follow the concentric circle and the generator method together such that each of this point is derived together because what is happening currently is, we do not have for continuous.

We do not have a straight plane here it is, this surface is also curving and incline and this surface is also a curved surface. So, we will never get a straight point. If this cone was being intersected by a straight plane like this, we would have arrived at an ellipse but it is not happening that way. It is getting cut at different heights and at different widths, which is what will yield in a very skewed shape here.

So, I hope with this, you have at least understood the fundamental of how to draw 2 intersecting cones and cylinders and 2 cylinders together with the help of this generator method and this concentric circle method. You can try practising these problems and I am

hopeful that you will be able to get at how to draw the orthographic projections of these intersecting solids.

With this, we wind up our course here. This is the last lecture. Kindly write to us with any queries that you have and I will try to answer them, solve them and all the best for practising the orthographic projections at home. Thank you and bye, bye.