Engineering/Architectural Graphics - Part 1
Orthographic Projection
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Lecture - 33
Orthographic Projections
Sections of Pyramids

Good morning, welcome to the 3rd lecture of this week where we are reading this course on architectural or engineering graphics. And our prime focus here is on orthographic projections. In this week, we are discussing or learning to draw sections of solids in orthographic projections. In the first lecture of this week, I had explained to you the introduction.

I had given an introduction to how the different sections of solids different solids in different conditions would be seen. And in the second lecture, we saw how to draw the orthographic projections for solids for prisms. And then these prisms were assumed to be cut by section planes either parallel to HP perpendicular to VP inclined to VP or inclined to HP. And in all those 4 various conditions and also the prisms were kept in different conditions.

We saw what would be seen as the section. And we also learnt to draw the true shape of the section. The fundamental for drawing the true shape was already given to you when I explained to you about the auxiliary planes. So, that basic knowledge of drawing auxiliary planes came handy here when we started drawing the true shape of the section. So, today we are going to take the section of solids for pyramids.

And again we will take these 4 different conditions where the section planes are going to be in 4 different conditions here. So, let us start by the simple examples and for the pyramids. **(Video Starts: 02:06)** So, the first pyramid that I am taking is a pentagonal pyramid. And if you remember the basics that I had told you, you would remember that in almost all cases when the plane which is cutting the pyramid it will be it is parallel to the axis of the pyramid. We will be seeing a very odd shaped section depending upon how many triangular surfaces are cut. And in case, the section plane is parallel to the base it is cutting the axis such that it is

parallel to the base. We will be seeing the shape of the base but in a different scale in the section. So, let us assume that we have a pentagonal pyramid which is kept on HP, it has its base resting in HP. And it is the axis is perpendicular to HP.

Now, it is assumed to be cut by a plane which is parallel to HP perpendicular to VP. And it is bisecting the axis. So, let us see what happens in that case. So, let us first draw this pentagonal pyramid. So, here we are assuming that the pyramid is kept in such a manner that one of its size sides is parallel one of the sides of the base is parallel to VP. So, let us start from there. So, we have a pentagonal pyramid of side 4 centimeters. Let us draw a pentagon.

I just hope you still remember how to draw the pentagons. So, every time I am drawing these. I am not telling you how to draw a pentagon. You have to remember all these construction methods by heart. So, this is for a square. This is for a hexagon. And this is the derived center for drawing the pentagon. It is one of the most foolproof methods of drawing a pentagon. So, I always use it. However, you may go ahead and you may use other methods as well.

So, this is our pentagon. And here one of the sides we have assumed to be kept parallel to the VP. This is the regular pentagonal base of the pyramid that is in question. Now, let us number them. So, a, b, c, d and e and this is the apex o. So, since it is a pyramid and it is kept in HP we will be seeing these edges connecting the apex to the points in the base. This is the original position. And let us also draw the front elevation of this pyramid.

This is the front elevation of this pentagonal pyramid. And here in this case, we are seeing all the edges except the edge at the back one edge at the back. Now, we assumed that there is a plane a horizontal plane which is cutting the axis at the center. So, this is an 8 centimeter long axis of this pyramid. So, let us mark the midpoint of this axis. And this is the point where the section plane cuts through the pyramid. So, this is where it is getting cut from.

Now, let us take the projections back onto the top view or the plan. So, what we have is let us go one by one. So, this is o. Now, oa is the line which is this line it is cut here. So, if we take this and bring it back, this is where it cuts oa. Now, let us go to ob. So, this is the point which

is cutting ob. And we will mark this point in ob. So, this method is slightly different from how we drew the sections for pyramids.

We are going to be taking these projections on the edges of the pyramid. So, this is where oe is getting cut. And this is where od is going to be cut. Now, if we start to join these points you will realize that these points are actually resulting in a regular pentagon which is having its sides exactly parallel to the exactly parallel to the original pentagon. So, now, since we do not have a point, so even if we get it back the point which is joining oc.

We do not exactly know where it is now. In this case, since it is a regular pentagon the distance of all these points from the center the apex is going to be the same. So, we can just take the circle. And we can extend it because that is how each of the point is going to be. It is lying since the plane is parallel all the points are going to be equidistant from the apex. So, what we have here is we arrive at this point like this.

And this is the final shape of the cut solid a solid which has been sectioned. So, if you look at this, if I darken it, this is also the true shape of the section which will be seen in its top view because the plane here is parallel to HP. And that is why you see the true shape of the section in plan. So, what do we see here? When the section plane is parallel to the base, the shape of the section is similar to that of the base.

It is just that the section will be what will be seen in section will be slightly diminished. This is the final top view which you will see. And we will also have these edges because these edges are still intact. So, there will be these 5 new points we can number them 1 to 5. So, if you remember we started with A. I am now finalizing them B, C, D, E. There is no O. And now, we have 5 points 1, 2, 3, 4 and 5. And we will hatch it up here.

Now, here if you look at this, so what you have is we still have this point A, B, C goes back and then we have D, E. And now, let us take back. This is 1, 2, 3 is at the back and then we have the 4 and 5. So, if I darken the front elevation, you can see that these edges in the bottom half of the pyramid, they still stay intact. You will see the base intact. And this is also the section line of this. So, this was the original O which we have not darkened.

And this is where the hatch is going to come. This is the section which will be seen. So, this is what we are seeing when the section plane is parallel to the base or perpendicular to the axis. And this is the true shape of the section. So, this is the first case when we draw the section of pyramids. Now, the other case could be when the section plane is perpendicular to HP but it is parallel to VP.

So, let us assume another case. And let us take a triangular prism in such a manner that triangular pyramid sorry we're discussing pyramids here. So, let us talk take a triangular pyramid here which is resting on one of its triangular faces in HP. So, let us first draw this triangular pyramid. So, assuming this triangular pyramid to be having a base side of 5 centimeters, let us draw this equilateral triangle here.

So, this is the I am just assuming the original position where this pyramid is going to be standing in HP. So, this pyramid currently is standing in HP. This is the apex. And this is the these are the edges joining the apex with the sides. So, this is the original position which we are assuming. Let us draw the front elevation of this. So, assuming that the height of this pyramid is again, say 8 centimeters. So, this is the point where the apex is going to be.

We will be joining these 3 points. So, this edge actually represents both the edges. And this is the apex joined to this. There is no line here. So, this is the edge represented by this. And this is the edge representing this. Now, what we are assuming is that this triangular pyramid is resting with its triangular face on the ground in HP. So, what happens in case we have a triangular pyramid like this?

All we are doing is we are totally tilting it such that this edge is now resting here. So, all we are doing is we are tilting this entire thing here about this edge. So, what happens that we take? We have done a similar exercise. So, this is where the new apex is. This is the new apex and this line the angle between these 2. So, if I take this angle of this edge here. So, it is the same angle which this edge is now making.

So, this is the angle between this and this which is how we will get the base here. So, this is the base now. This is where the axis is going to come. So, if you look at this. This is the axis. This is the apex which is coming here. And if I mark this edge from apex which will be cutting it and it shall be equal to this. So, this is what we are getting. This is the pyramid which is now resting on its triangular face in HP.

So, what do we see now? If we get back the projections. So, this point which was here has now come here. Both these points they remain the same. And the apex comes here. So, what we have? And, so what we basically have is this is the, so, this is O which is gone there. This is the point say A. This was B and C. B and C remain intact. A comes here, so, OA. Now, we see this edge OA here. This is the edge OB and the edge OC. Let us also mark the same there.

So, this is A C,B and O there. Now, this O is here. C and B are still there. And we have the A here. So, that is what the front elevation and the top view of this given solid is. Now, it says that it is being cut by a plane which is perpendicular to HP and parallel to VP. So, it is perpendicular to HP parallel to VP. So, we will be seeing a line and assuming that it is say 1.5 centimeters from the axis. So, this plane is passing 1.5 centimeters from the axis.

This is how it is getting cut. Now, we have to arrive at these points here in the front elevation. So, let us take back these points. So, this is the edge OC which is being cut here. And what is OC? OC is here. So, let us take it up. This is OC. Now, This is edge AC. AC is being cut here. Let us take it up there. So, we see AC being cut there. And the if we look at this section, what happens? It is cutting only AC and OA here which is here.

And the next line this A and say it is 1. This is 2. So, this line is going to be joined. So, we will be joining this line here. There is nothing else which is getting cut there. So, what we get as the true shape of this section here? We still have this line which is AC but it is cut somewhere here. OA here and a base. The true shape of the section is actually seen in the front view because the section plane was parallel to VP and perpendicular to HP.

So, this is the true shape of the section. Now, depending upon where your section plane is we would be seeing the final. What we actually have here is this. This is the remaining portion.

So, while we see it as an intact edge it is not the intact edge. This is where the section plane is coming. So, we do not need an auxiliary plane to see the true shape of the section simply because the plane is parallel to VP. And what we see here is the true shape.

Now, let us just number it. So, this is OA. This is the point 2. This is the point 1. One more edge which is to be darkened is this. And B remains intact. And this is the point 3. So, this is 3, 2 and 1, all in the same line which is 2, 3 and 1 respectively. We have an A there. And we have this O. So, this is the front view. And this is the top view of this triangular pyramid which is resting on one of its triangular faces in HP.

And it is being cut by a section plane which is perpendicular to HP and parallel to VP which is giving us the true shape of the section here. So, these are the 2 simple conditions in which we can see. And it will not be much difficult to actually arrive at the true shape of the section. However, if one of these is cut by a plane which is inclined to either of the planes we might have little difficulty not difficulty.

But we will have to use certain tricks to arrive at the true shape of the section or even the plan or elevation of the section as it will be seen. So, let us take a hexagonal pyramid here. So, we will take a hexagonal pyramid of side 4 centimeters. And let us assume that 2 of its faces 2 of its edges in the base are perpendicular to the VP. So, this is how we will make the hexagonal prism. And we are assuming that this one is actually standing in the HP.

This is the apex which is the center of this circle. And we should also be joining these lines. This is the apex O. And these are the lines. Now, let us also draw the front view assuming this to be a 10 centimeter tall pyramid. This is where we are connecting these. So, this is how your hexagonal pyramid is going to look like. Now, let us assume that this pyramid is being cut by a plane which is inclined to HP and perpendicular to VP.

So, assuming that this plane is say at an angle of 45 degrees and it is cutting the axis and at the midpoint. This is the section plane. Now, let us get back the projections back into the top view. Now, we are clear that we are not going to see be seeing the true shape of this section in

the top view. So, let us again number. I number these surfaces these points simply because it helps us to arrive at the projections.

So, that is an easy way. And you should also try to number it. So, this is A, B, C, D, E, F and an apex O which is here. So, now, what is this edge? This edge is actually both OE and OD. So, where is this OE and OD being cut? It is being cut by a plane in this point. So, when I project it back onto the top view these are the 2 points where OD and OE are being cut respectively. So, I get these 2 points here.

Similarly, this is the edge which is representing OA and OB both. So, if I bring back this projection point back to cut in OA and OB respectively these are the 2 points that I get now. We do not know exactly where this OC and OF are going to get cut. Now, how do we get it? If you remember the first example, suppose we have a plane which is parallel to this passing through the same point.

So, it will cut this line in this hypothetical point which if I get back here will be the same distance which we will have on this line on this OC and OF. So, what we will do? We will project it back here. These are 2 hypothetical points. Assuming that the plane is parallel take the distance of these 2 points from the center and this is where we are going to get our points on OC and OF. Now, if I join these and you join this what we see is a distorted hexagon.

But it will still be a hexagon. So, this is the final top view that we are going to be seeing in case of a hexagonal pyramid. Arriving up to this point is still not difficult. Now, the trick is to arrive at the true shape of the section. So, this is the final top view. And we are going to quickly hatch it. This is the final front elevation which you will see. Only the remaining portion is what we are going to draw here.

Also these edges the remaining edges will be seen in the top view which is what I am drawing here. This is the line of the section plane. So, this is the final front view of this hexagonal pyramid. Now, we have to arrive at the true shape of the section. So, as I said we are going to get the true shape of the section on an auxiliary plane which is parallel to this. So, we will be getting the projections onto this auxiliary plane.

So, what we are going to do? The process remains the same. Since this is the true length as we will be seeing. So, we are going to take the distance that each of these points has from the reference lines. So, let us take the farthest distance here. So, this is for the point I will also number it. So, 1, 2, 3, 4, 5 and 6. So, this is for the point 6. I am just extending it or maybe I will draw this reference line slightly closer to the section plane.

So, this is for F this 6. And then this is the distance for the point 3. So, let us simultaneously mark it. This is 6. And this is 3. This is 4. And this is 5, 2 and 1. So, it is slightly extending. So, what we had is 2 and 1 and 4 and 5. So, if you see it 1, 2, 3, 4, 5, 6 is the correct order, so, which means that we are in the right direction. And now if I join these we will be getting the true shape of the section here.

So, as I say orthographic projection is a very methodical procedure. If you follow the procedure you do not have to you will not go wrong. And you do not even have to think just follow the process. And you will be arriving at the final shape. This is the true shape of the section as we will be seeing. In the top view, this section is seen like this. So, we will just hatch it. This is the section 1, 2, 3, 4, 5, 6. And we will also number them here.

So, if I write this is A,B B,A C is not seen, this is D here and E. So, this is E and D. And this is F F. And on the top, let us mark these points. This is 1,2. This is 5,4. And this is the point 6,3 at the back. So, these are the same points that will be projected here. And we get the true shape of this section. This is when the section plane is perpendicular to VP and inclined to HP. There is one more condition which is the last condition.

When the section plane is inclined to HP inclined to VP but it has certain angle it is making certain angle with the VP. So, taking any one of the examples say the same pyramid the hexagonal pyramid, let us draw the projections. Let us draw the section when the section plane is going to be inclined to VP. So, I will quickly draw the same pyramid. And let us see how do we arrive at the section for the given pyramid?

And in this case, what I am doing is I am assuming that one of the points is going to be in the reference line. So, we are going to draw it in such a manner that the same pyramid is placed with one of its points of the base touching the reference line to draw this hexagon with one of its points of the base being in the reference line. So, this is the hexagonal base as we will be seeing in the original position in the top view.

This is the apex to which all these points of the base are joined. So, this is your point O. And let us lightly number them. We will take the front elevation taking the same height as the previous one. This is the front elevation in the original condition. Now, what we are assuming is that we have a plane which is perpendicular to HP and it is inclined to VP. So, let us assume that this is a plane say inclined at 45 degrees to VP.

And it is cutting the pyramid like this. Now, what would we see? So, we have OA intact that is not going to change. We have OD intact that is also there. Now, this line OE is getting cut in this point which is here. So, we will take it back. And this is where OE is going to get cut. At the back of it, OD remains the same. So, that is what we get. Now, again we have to get this point OF. Now, where will this OF be?

So, if we look at this, this will be the process reverse of this. So, here what we had taken? We had assumed that the plane is parallel. Now, here if I assume that this is where the parallel plane is going to be, so, it will cut the other lines also at the same distance from the apex. Assuming that the plane is parallel, it if I take this back this is where the parallel plane is going to cut it from.

And if I bring it here, this is where this plane is going to intersect this OF. So, I get this point. And then in the base which is AF. I get this point which is here. So, I get this 1, 2, 3 and the 4th point is in DE which is again here. So, what I get? I get 4 points here which is 1 which is here, 2 which is on OF which is here, 3 which is on OE which is here and this point on DE which is the point 4 which is here. So, now let me join these points for this section 2 and 3.

The side the edge OA it remains intact. So, it will be seen as it is and this is what. So, if you see clearly which all surfaces are getting cut AOF is cut, OFE is cut, number 2, OED is cut

that is third and in the base we have this cut. So, what if I if you remember my introductory lecture what we said? The shape that we are going to get is going to be having as many sides as the number of surfaces which are being cut here. 4 surfaces are cut.

So, we are seeing a quadrilateral. That is going to be seen in the front elevation and in the top view we will just see this line. Now, what we have to draw? We have to draw the true shape of the section as well. So, let me draw an auxiliary plane parallel to this section plane. So, we will take the same distances because they will remain the same. So, this is 1, 2, 3 and 4. And now, what we have to do is the same distance as these points.

1, 2, 3 and 4 have from the reference line here we will mark. So, 1 and 4 are in the reference line. And we will mark this distance of points 2 and 3 from the reference line. So, this is 3 and this is 2. So, what we have now is 1, 2, 3 and 4. If I darken this if I join this, this is the true shape of the section which is achieved if a section plane inclined to VP and perpendicular to HP cuts this hexagonal pyramid.

If you wish you can also draw the overall pyramid the remaining pyramid along with it. Sometimes, you may also be needing. So, for this case, let us draw. So, this is the line where A is going to come. This is the line where O comes. The point D and all the heights of each of these points we are going to be taking. So, what we actually have is that all these points A, B, C, D, E and F are in the reference line. So, we have this B. We have the A. So, A is here.

And, what we going to take is this O which is equal to the height of the pyramid. So, let us measure 8 centimeters here which is what the height of the pyramid was if I remember correctly. No, it was 10 centimeters. So, let us take 10 centimeters on this projection line for O. This is where your O is going to come which is the apex. So, what we have now is we have OA. Let us lightly join and then you will be able to understand. This is OA.

If I project this F is anyways not there but if at all it was there then this edge is where 2 will come on the joining of this. So, I have this O2. O3 is the one which was connecting O and E. And D is still intact. So, we will have this point connecting to OD. So, if we are seeing it

from this, right now this image is what we are seeing from here. So, we will see OA, part of OF, part of OD, OE and OD completely.

This is how we can also see what the remaining cone looks like if it is seen perpendicular to the reference plane. So, it shows the true shape of the section. And it also shows the rest of the pyramid along with it. So, I will also draw this hatch. This is the true shape of the section 1, 2, 3, 4. The front view, this is going to be hashed again. So, you will hatch it, darken it and this will just be a straight line which will be representing the section plane.

So, in this manner you can draw the sections of pyramids given different conditions of these section planes parallel to HP perpendicular to HP parallel to VP inclined to HP and perpendicular to VP. And this one is inclined to VP and perpendicular to HP. So, I hope with this you have fairly understood **(Video Ends: 50:59)** how to draw sections of pyramids? And we have already covered the sections of prisms earlier.

So, this was all in the lecture today. In the next lecture tomorrow, we will be seeing how to draw sections of one more type of solid? So, thank you very much for joining me in this lecture today. See you again tomorrow, bye, bye.