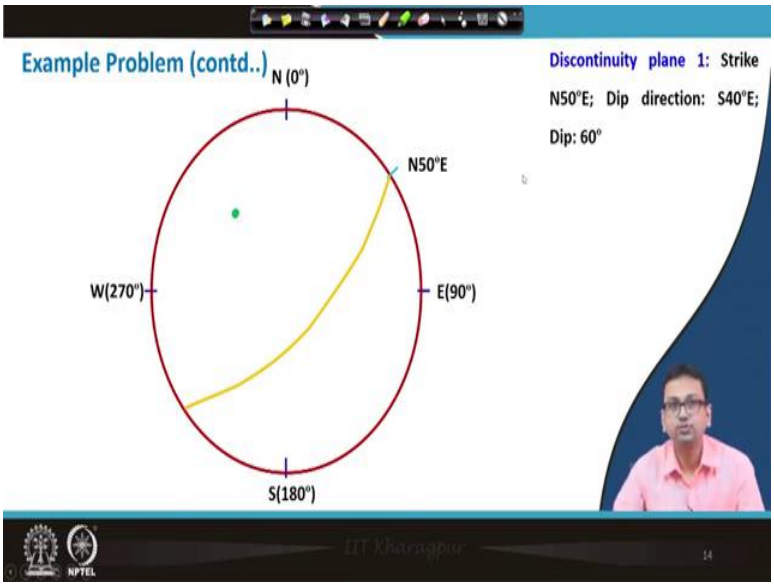
Rock Mechanics and Tunneling
Professor Debarghya Chakraborty
Department of Civil Engineering
Indian Institute of Technology Kharagpur
Lecture 06
Stereographic Projection

Hello everyone! Let us start our lecture 6; basically this is the continuation of our last day's lecture. We have started the stereographic projection. If you remember, in our last class, we were doing a problem where we had to identify two planes on the stereonet and also we need to find out the orientation of the intersection line.

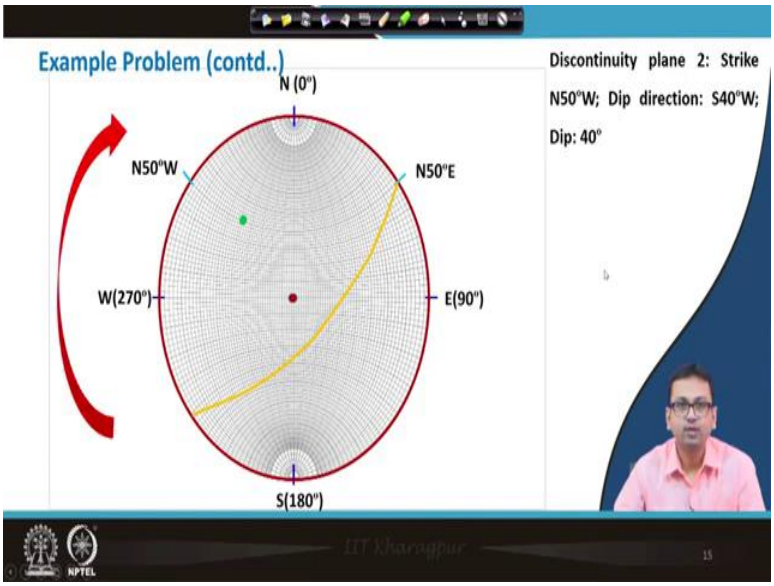
So, in our previous class, we did up to the plotting. We have plotted the plane 1 on the stereonet, but from today, we will start from the plotting of the second plane on the stereonet.

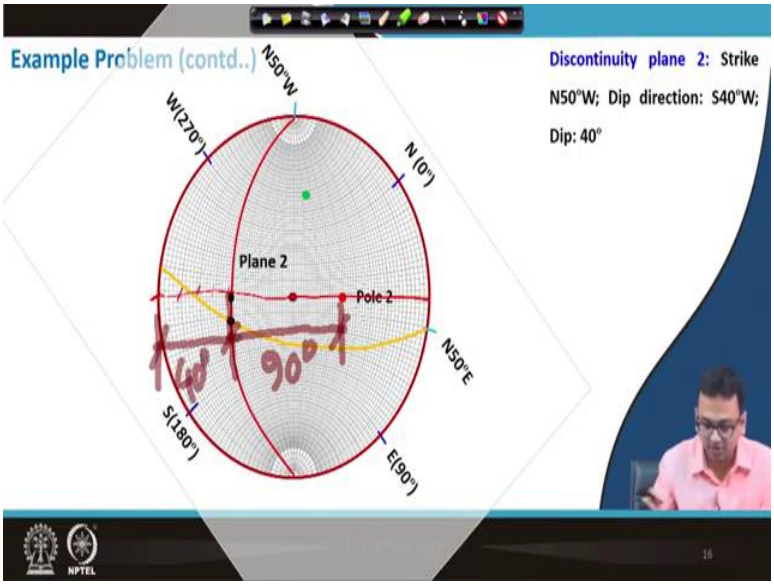
(Refer Slide Time: 01:12)

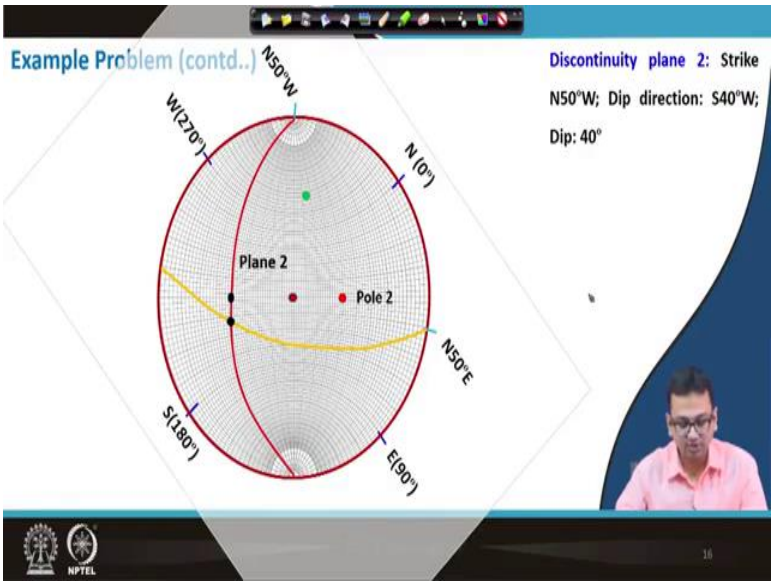


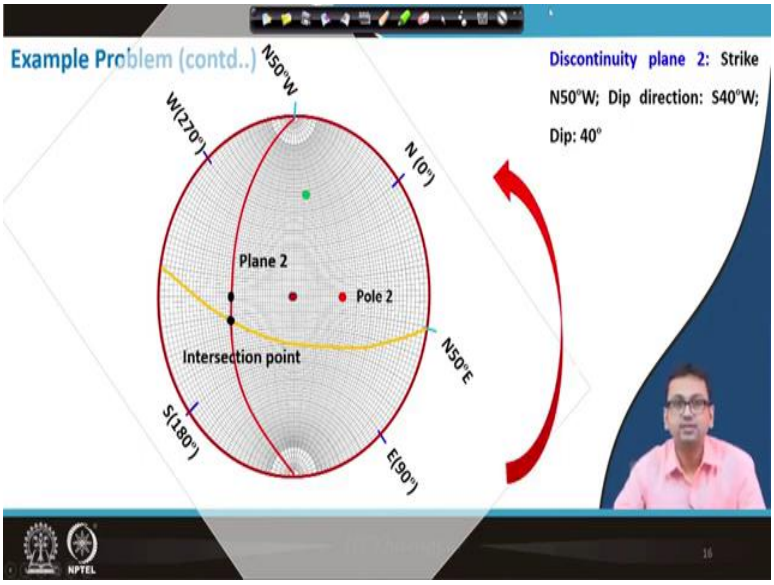
So, this is what we wanted to get. So, we wanted to represent the discontinuity plane, which we can represent by this strike, dip direction and dip, that we could able to present on a 2D plane with the help of stereonet over here, and this pole is very much important. This actually contains all the information. So, this is very much useful.

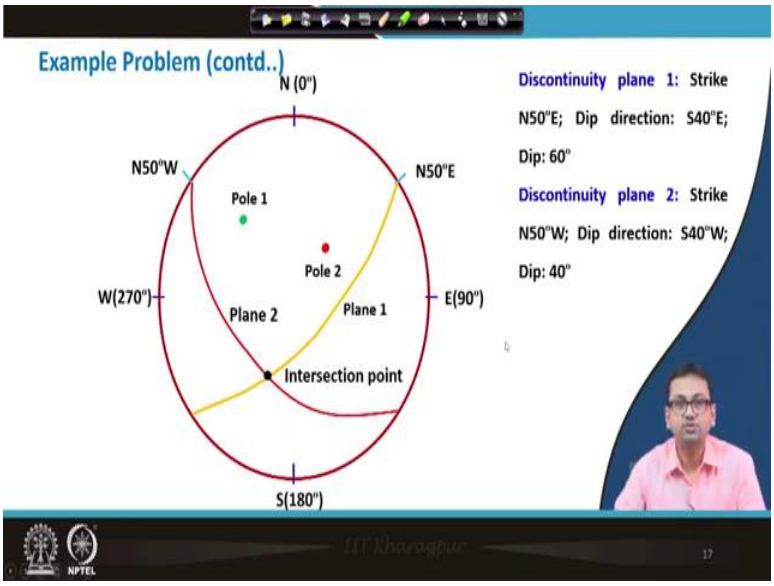
(Refer Slide Time: 01:39)

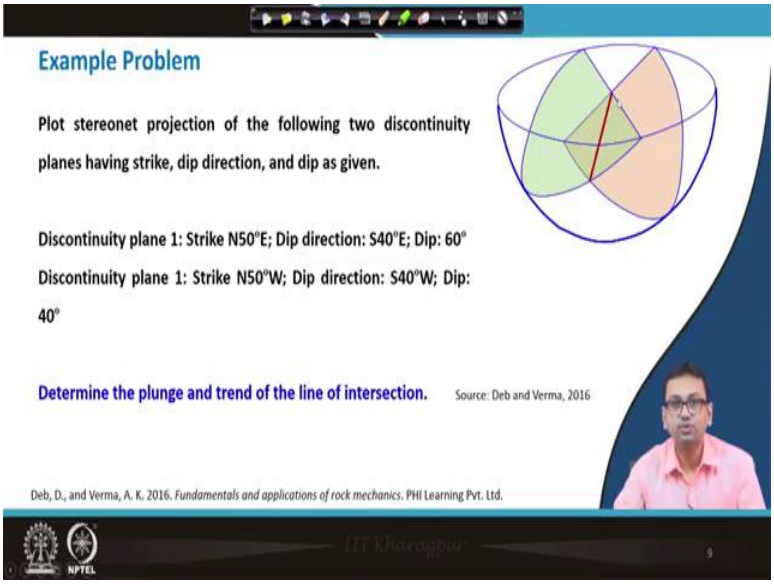





Example Problem (contd..)
Discontinuity plane 2: Strike N50°W; Dip direction: S40°W; Dip: 40°
N50°W
W(270°)
N (0°)
Plane 2
Pole 2
N50°E
S(180°)
E(90°)
NPTEL
16


Example Problem (contd..)
Discontinuity plane 2: Strike N50°W; Dip direction: S40°W; Dip: 40°
N50°W
W(270°)
N (0°)
Plane 2
Pole 2
Intersection point
N50°E
S(180°)
E(90°)
NPTEL
16





Now, next is another discontinuity plane. You see, this is the discontinuity plane 2. Strike is N50^{o}W. Dip direction is S40^{o}W and dip is 40^{o}. So what we will do, it is already there with us. Now what is done, this strike is identified over here. So, similarly 90^{o} apart we have the dip direction also, that is S40^{o}W.

That also we can identify or without that also we can proceed because anyway what we will do, we will rotate it and place the N50^{o}W on this location. So, as we did previously. We rotated in the counter-clockwise direction. Here, we will rotate it in clockwise direction because that is nearer. So, that is up to you.

So, now we will rotate it clockwise and we will shift this point over here. So, it has now gone over here and you can see the horizontal line. So, this one is the East-West line which is passing through this red point. So, this is the horizontal line. Now what is stated? Dip is 40^o. So, what will we do? 10, 20, 30, 40, so we will identify like these. So we can see this point that is what? That is corresponding to the dip = 40^o.

And now, the great circle is passing through this point, which we can mark on the stereonet, means not on the stereonet, on the tracing paper, keeping the tracing paper over the stereonet. So, we can draw this line. So, this is nothing but the discontinuity plane 2. Now, we want to represent this information with the help of only one point, which is pole.

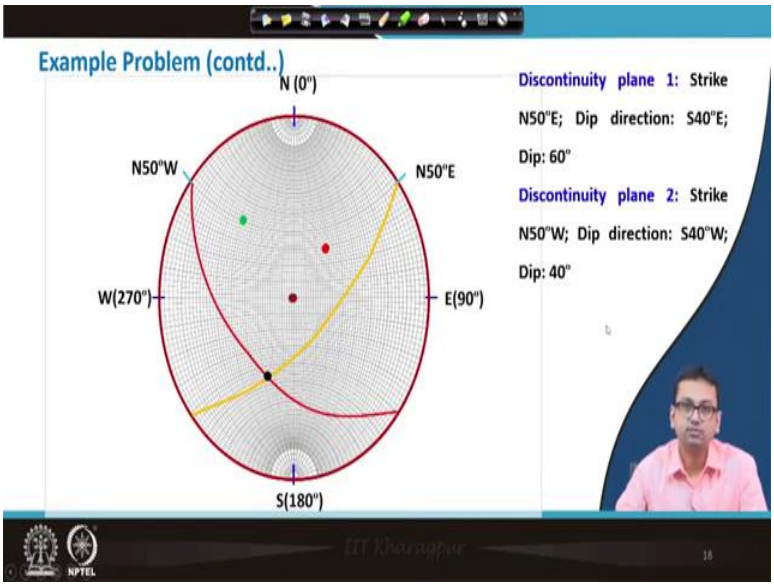
So what will we do again? We will go in the right hand side direction i.e. towards the East and we go up to this. So, this is nothing but the pole 2, if you see the divisions that are again 90^o. This is 40^o, corresponding to this. So, let me clear everything. Now, we have identified the pole 2.

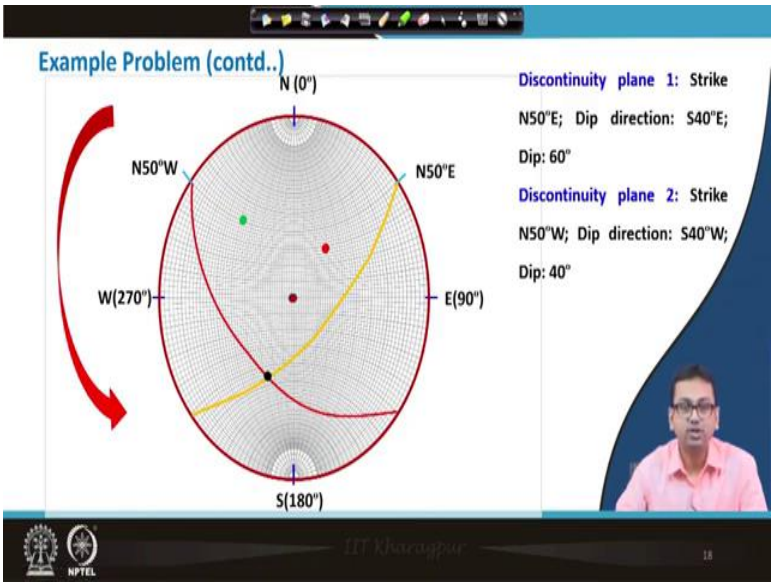
Now, you can also see here one extra thing. You can see the intersection point between plane 1 and plane 2, and the question was not only to plot the two planes on this stereonet, but also tell the plunge and the trend of this intersection point. So what will we do? We will rotate it once again and we will bring this North to its original home position.

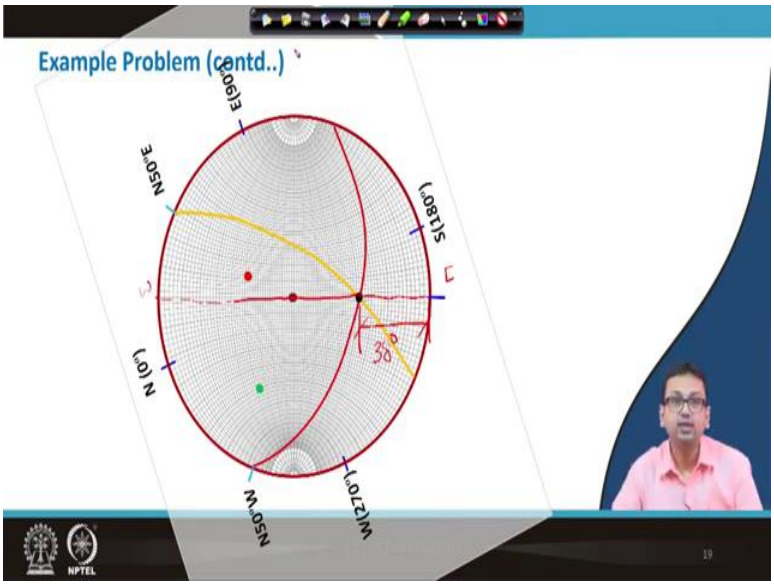
So if you do that and if we just see the tracing paper, it will look like this. So, here, we have identified plane 1, plane 2, pole 1, pole 2 and intersection point. Now, we have to find out the intersection point, basically what we can see that in 3D, is nothing but a line. As we have seen in this diagram. Again I will just show you so that things become clear.

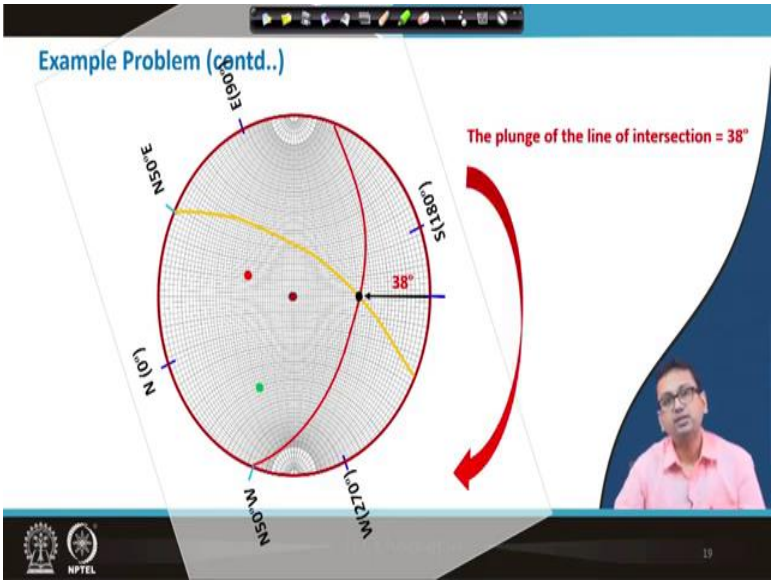
The problem when we have discussed, you see, this is the intersection line and out of that, you are seeing not the line in 2D. You are seeing only the point where it has intersected. So, that intersection point is nothing but this point. Now, we have to find out the orientation of this, means we have to find out the plunge and the trend.

(Refer Slide Time: 6:22)

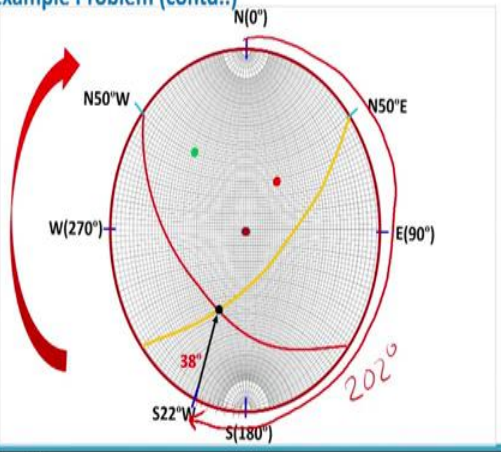





Example Problem (contd..)
E(90°)
N50°E
S(180°)
N (0°)
N50°W
W(270°)
38°


Example Problem (contd..)
E(90°)
N50°E
S(180°)
N (0°)
N50°W
W(270°)
38°
The plunge of the line of intersection = 38°

Example Problem (contd..)

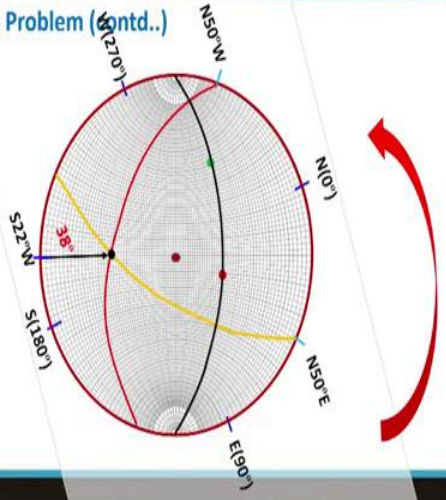


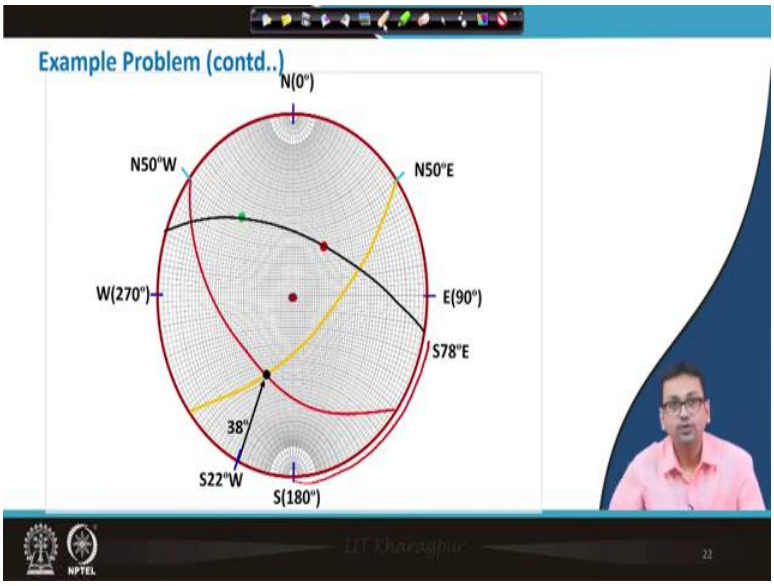
The trend of the line of intersection = S22°W

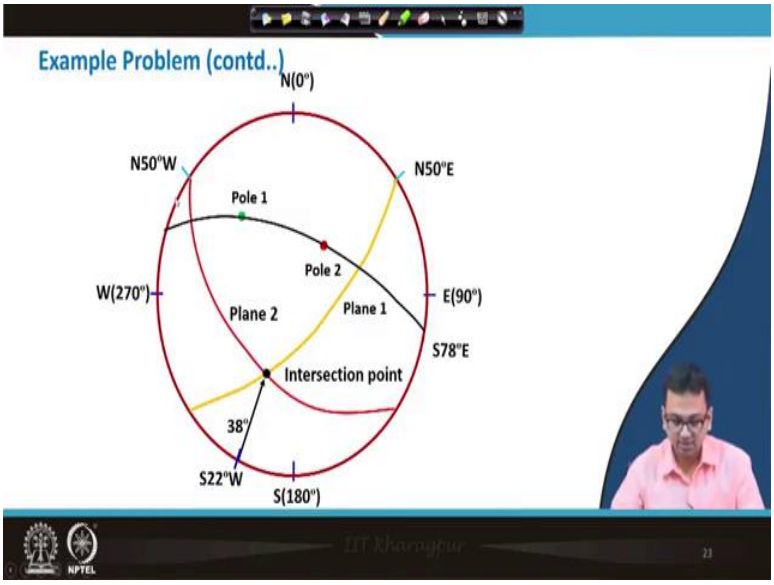
or

202°

Example Problem (contd..)







So, how to do that? Again we will place it over the stereonet. I mean it is already there, we are not lifting. Just for your understanding, I am just showing this that if the stereonet is not there how it will look like. I wanted to show you the clean picture. Now, we will focus or concentrate on this point. We will find out the orientation of this point.

So what will we do? We will rotate it again in counter-clockwise direction or you can take it clockwise also, no problem. It means ultimately you have to take it, you have to orient it like this or on the other end, means this point near the East side or this point near the West side, so even here, I have just rotated like this. Again I am rotating it towards counter-clockwise direction and placed it point over this East-West line, right? East-West line is present.

This East-West line is present over there and what I did, I have measured the distance between these two. So basically, I have placed this point over this East-West line and now I have found out the distance. It means how many degrees are there? So, each small division is 2^o and if you see over here, there are 19 that kind of divisions.

So, this will get it as simply 38^o. So, that is only you can see. So, the next step will be to identify how many divisions are there. These are again the great circles. So how many divisions are there? We can see total 19 divisions and each of these divisions is 2^o; so, the total is 38^o. So this is nothing but the plunge of the line of intersection.

Again what we did, we have identified two planes, two poles and intersection point. Then we are rotating in counter-clockwise direction, bringing it here, measuring this, how many degrees are there? It means how many great circles are there? So, we can see that total 19 divisions are there, each division is 2^o so total is 38^o.

So, this is nothing but the plunge. Now, again we will rotate and bring the North to its home position. Yeah, it has gone to its home position and it is the 38^o. Now what will we do? We can count again, what is this angle? So, again each division is 2^o. So if I check that, this is becoming 22^o from South.

So, this is S22^{o}W, and if we see from North, it is nothing but 202^o, right? So, what I mean to say is, this angle is now 202 degree and simply if we count from here, 11 divisions are there. So, it is basically 22^o. So, this is nothing but the next question, what was asked actually. What do you need to do? You have to find out the plunge and trend.

So, you have already found out the plunge and this is nothing but the trend i.e. S22^{o}W or simply 202^o from North. So, that is it, but along with that we will see another thing. Though, the question was up to this only, we will quickly see the next thing. If we now rotate is once again and bring this point.

So, the location of this point is on this West East axis. If you place it, you will see, if you little bit adjust it properly, just look at over here. I am deleting other marks; so, if you see, if you place it. So let me do it once again. So, what we did after, anyway just I am rotating in the clockwise direction and taking this one in this location.

I will put this intersection point over this West-East line or axis. Now, you see, these were nothing but the pole 1, pole 2 and you see, they are falling on a great circle. So, if you connect it, you see it is looking like this, and then you can again rotate it counter-clockwise from there and bring the North to its home position.

And you can see that this angle is from here if you count, South, if you count this one, this angle. So this angle is basically 78^{o}. So, finally if we see the plot, though our question was only to plot the planes and to find out the plunge and trend of the intersection line, but additionally we also have seen something extra that is this one.

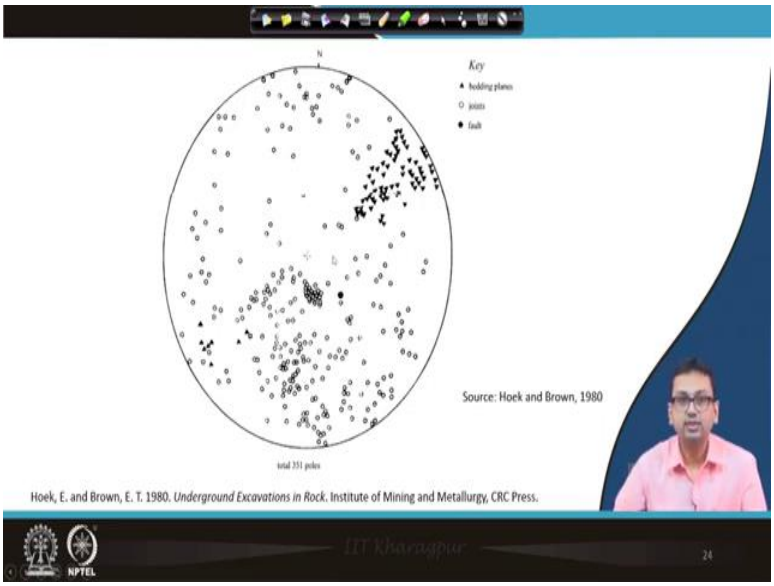
If you connect this one, so where it is intersecting that is nothing but giving us this information. So that is it, in this way, we could able to project the plane 1, plane 2, on the stereonet. With the help of simply these two lines and as well as you can able to identify the orientation of this intersection line which is nothing but point on the stereonet.

And what is the orientation? That is nothing but plunge = 38^{o} and trend = 202^{o}. Now this way, basically what we have seen that we do not even require these plane 1 and plane 2. If you can identify the poles, that is good enough. From there, we can obtain all the data like what is dip, strike and dip direction by back calculation. We can very easily find out as we could able to see from here.

Because the intersection point that we actually did, the initial plane 1, plane 2, we have plotted, what we did, first we have plotted these planes and then we have identified the poles. On the other hand, we first identified this one, which is 38^{o} and after identifying this point, we have identified or drawn this great circle from there.

So, anyway, if we have these points, the orientations of these points are known. The plunge and trends are known. You can obtain other required information also.

(Refer Slide Time: 15:11)



Just to show you its application, we will apply this knowledge when we will probably discuss this slope stability analysis or the foundation, there how we can utilize this stereonet we will discuss, but this is just a one nice picture, it is from Hock and Brown (1980). You see, there are total 351 poles are plotted on the stereonet and finally if you see the tracing paper, on this it will look like this.

You can see here. What are the things, faults are present, only I think we can identify one fault over here. Suppose this is a construction site and there with the help of the compass, you have probably identified the strike, dip direction, and dip or maybe you have identified the plunge and trend for an intersection line.

And then if you plot it on the stereonet it may look like this and what we can see, these triangular solid markers are indicating the bedding planes. Whereas, this circular solid block is fault and these again hollow circles are joints. So you see there are so many bedding planes (())(16:36) in this region.

One fault is present in this region or construction site, or there are several joints as expected. As I have told you, you remember joints are the most common discontinuities. So, when we are designing any structure or if you are checking the stability to slope, with the help of this we will

get an idea that where the fault is present, where the bedding plane is there, where the joints are there.

And based on that we will learn how to go for the slope (()) (17:14) stability analysis, that we will learn later but this will become extremely useful, using this information we have plotted 351 poles over here, within just a small 2D diagram. Here, we could able to provide the information of 351 discontinuities. So, I think we should appreciate that idea.

So, with these basically, today we have discussed the stereographic projection in detail. It is little complicated. So, please see this lecture once again probably and I have tried to explain it in detail. So if you once again see yourself this video, my lecture, if you see it once again. I hope other doubts will be cleared. I hope it is clear to you. So thank you, in our next class we will start our next module. Thank you.