Pressure Prism Concept

SPEAKER: In this section, we'll be discussing what pressure prisms are. Basically, they are a geometric representation of hydrostatic forces on a plain surface. It's an easy way to determine what our forces are on that object and where the force is located on that object. The distribution of pressure and its resultant forces on a similar surface can be described by these pressure prisms and are usually done by trapezoidal areas. And then all of the forces are summed on the object. These prisms are an easy way to graphically depict the variation of the pressures and the pressure forces on the object. For example, as we see here, the big black line, let's say we put a plate down, a glass plate, in the middle of a body of water that is at rest, no water is flowing at all, okay? We see that the force is--the pressure force is described by the triangular area. And as you can see, the pressure increases linearly with depth, and that's why we get that triangular area. So at the bottom, or at the stream bottom, let's say, our pressure is equal to the specific weight of water times the depth of that water. So if you see that equation, "P" is equal to gamma times "Y." Well, at the surface though, our pressure is zero. The centroid of that pressure prism, you can see with the black round dot, and it's called the centroid of the pressure prism there. And that's where our resultant force of all those pressures on that object, that plate, is at.

Now, let's take a different case. Let's say we are only interested in part of that object, let's say there's a gate down there on the bottom half of this plate and the gate has a hinge on it, so it can move up and down. We want to be able to determine the pressure on that gate only, not on the upper part, but only on the gate part. Well, we have to break it up, our triangular area a little bit here. We have to know what the pressure is at the top of the gate, which is Y1, the depth Y1, and we have to know what the pressure is at the bottom of the gate, which is at the bottom of the stream bed, let's say for example, which would be Y2. So the pressure at the top of the gate would be--and we're going to call that Section 1, is P1 is equal to the specific weight of water times the depth at that portion, which is Y1. Now, the pressure at the bottom of the gate is the same as it was before in the previous diagram, but we're going to call it Section 2, that's why we designate it as P2 is equal to gamma times Y2. And we can determine what all those pressures

are and then determine what our resultant force is on that gate.

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Now, let's say we have our plate at--resting at the bottom of the stream bed. Well, our force is directly in the middle of that because the force is equal, as we mentioned before. So our pressure there, again, is equal to gamma times the depth of the water at that point. And then our force would just be the specific weight of water times the depth of water times the area of that plate that's resting at the bottom.

Now, we might have an incline plate--or let's say our gate is inclined. We can also do this the same way. We have to know what our pressure is at the top of the gate, at Section 1 there. It has a depth of Y1, and then we have to know what the pressure at the bottom of the gate, which is at our stream bed, which is at Section 2 at the bottom of the stream bed. We can determine what the centroid of the pressure is, and you can see that with the yellow line for our force. That is what our force will be for this.

In summary, our total force on an object is represented by the volume of the pressure prism. This is an easy and graphical depiction and it--thus we don't have to use calculators or other methods to do it. The volume is described by the pressure prism. The pressure--the volume is described--is equal to the mean pressure of the object and the area of the object, and our forces can all be described on this object too. This concludes this section.