Engineering Mechanics
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Dynamics of rigid bodies

Let's look at another problem. Problem number 4. You have a weight, heavy weight. Usually in order to move a heavy weight, what do we do? We use some rollers. We lift it a little bit, insert the rollers. Sometimes two rollers are inserted and we push it so that it is possible for us to move. So let's say something like this. Let us say this body, this heavy mass is moving with a velocity when I push it. Let's say that velocity is given to us as some V. We want to find out what would be the angular velocity of these rollers. For now let's assume that they are rolling and not skidding at all.

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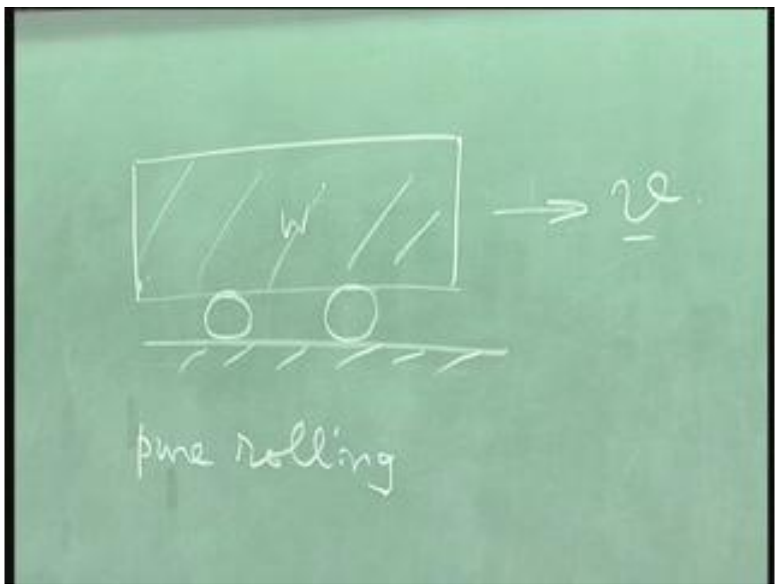

They are purely rolling which means what? I need to find out the angular velocity of this roller. Let's say the diameter of this roller is given. So let me just draw a zoomed picture of this. This is the point of contact with the body. This is the point of contact with the surface. Now at this point of contact of the cylinder and the weight, the velocity should be the same. Therefore I know that the velocity of this is V. What do I need to find out?
I need to find out what will be the angular velocity of this. What do I know about this particular point? I know the point at the bottom which is with the ground, the velocity is zero.

If I take a point on the roller or the cylinder that velocity also has to be equal to zero. The reason is there is no skidding occurring there, they are not relatively moving which means that the velocity of this and the velocity of that should be the same which means that the velocity of this point, let me call this as B, velocity of B is equal to zero.

Do I have enough information to solve the problem? Let's see. Diameter is given to me. So this is the diameter let me call this as d. If I take the direction, this is the direction. Can I write V_B in terms of V_A? The answer is yes. V_B is equal to V_A so let me call this as V_A plus omega cross r B with respect to A.

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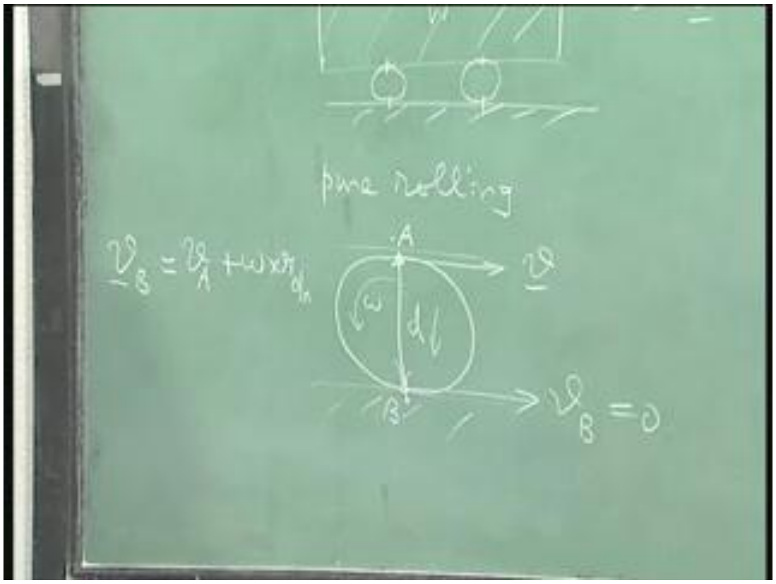

The rB with respect to A is d, downward direction. So if I need to find out this direction, it is nothing but this pointing this way. So this velocity is V along the I direction, V times I plus omega times diameter because that's the length of this times, what is the direction of this component? The direction of that component is like this. Remember is it this way or that way? If omega is like this it has to be counter clockwise which means that the point B should be moving in the counter clockwise which is this direction which means positive direction, omega times d times I vector. What do I know about V_B? V_B is equal to zero which means I get V plus omega d times I equals zero implies omega equals minus V by d.

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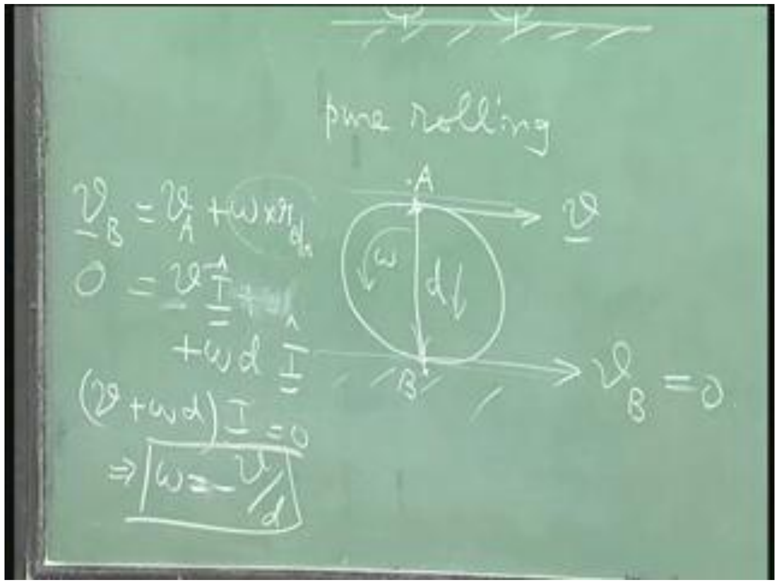

Or in other words it is having an angular velocity in the clockwise direction equal to V by d. V by d or V by 2 times radius, that’s the answer. So that’s how you solve it. If you notice there are two things that we have taken, one is this point and the other point. The top point we could find out the velocity because of the constraint that we have applied of pure rolling. Similarly at the bottom we applied the constraint of pure rolling and got the velocity and the magnitude of the velocities at top and bottom and that was enough to use in this relationship, relative velocity relationship in order to find out angular velocity. Again the tips that are used here are about the constraints that we apply.

Thank you.