Mechanics of Material
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Stresses and displacement due to torsion or inflation
Lecture – 84
Example problems: Thin walled closed sections

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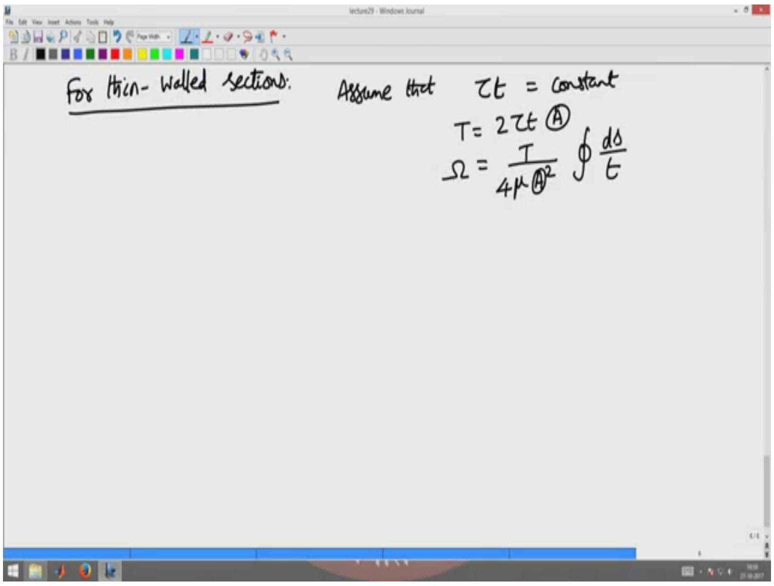

Now, let us go back and in the remaining time.

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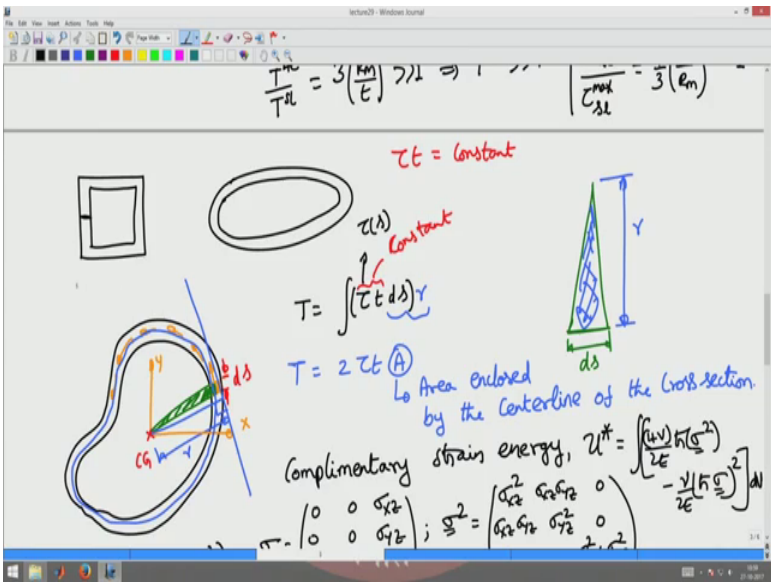

See what is the stress distribution or how is the torque and the angle of twist related, and how is the maximum shear stress and torque related for this square cross section thin walled square cross section.

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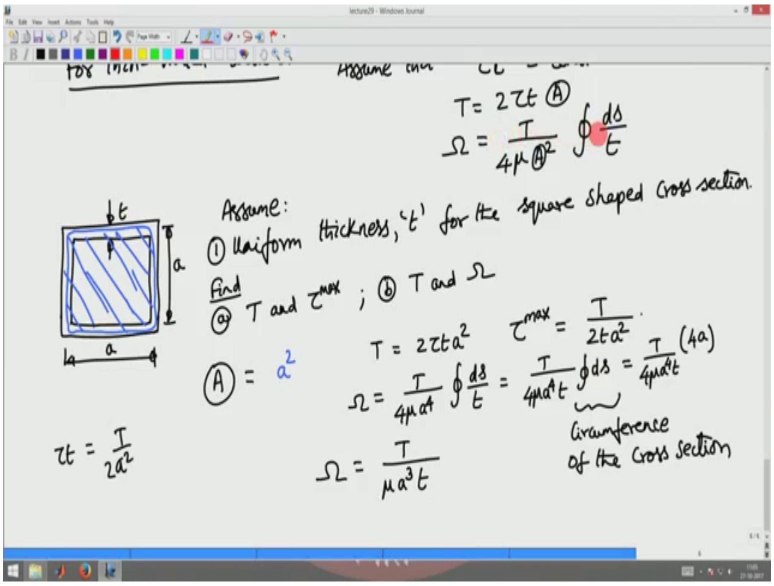

So, I am interested in finding the let us assume the section has uniform thickness, and med dimension is a, med dimension is a, thickness is t. Assume one uniform thickness t for the square shape cross section and I am interested in finding one (Refer Time: 01:32) T and tau max relationship the (Refer Time: 01:39) shear stress and the torque relationship, and I am interested in finding the torque and angle of twist per unit length relationship.

Now, for this the enclosed area are to use these expressions essentially; are to use these expressions essentially now the enclosed area for this cross section is would be this area would be this area ok. Which is a square which will be a square because area of the squared cross section is centerline dimensions what I give it as a this will be a square then my torque is related as 2 times tau t a square ok. Now thickness is same in the cross section. So, tau max are the maximum shear stress are the uniform stresses in the cross section would be T by 2 t a square.

Similarly, the angle of twist is now given by T by 4 mu a power 4 the line integral d s by t, t is uniform in this cross section. So, I pull that out. So, this will be T by 4 mu a power 4 into t the line integral of d s. D s is the circumferential this is nothing, but the circumference of the cross section of the cross section ok. So, that is nothing, but for square you know the circumferential length is what? Is 4 a this 4 a and hence omega would be related through as mu a cube t ok.

So, this is a relationship between tau max and the angle of twist per unit length. If the thickness you have to change, then I have to integrate this line integral over each leg of the square with the different thickness that is what will change ok. And similarly if the thickness changes tau max would be tau t is T by a square to a square then tau max would be for the branch which has the least thickness will give me the maximum shear stress ok. So, I have to use that fact that t is a function of s and tau is a function of s and the branch that has a least thickness will give me the maximum shear stress.

So, with this we conclude or discussion on torsion what we have seen is, we have seen how to analyze closed sections subjected to a twisting moment or torsional moment that we saw in the last class, we derived a torsion equation T by J equal to tau by r equal to mu omega and then in today's class we saw what happens when there is warping, we did not go into detail analysis of analysis structures with warping. But we saw that for a rectangular section how you can generate a generic solution and I presented the final result alone and we used that to find the relationship between torque and a twist and the angle of twist per unit length or torque and the maximum shear stress.

So, that the section will see and then we went ahead and solve problems where and we had thin walled sections closed sections, which will also warp it is not open sections it is closed essence there is no discontinuity in the geometry which will also warp and how to analyze your structures. We saw that the torque is given by 2 times the shear stress times the thickness times the enclosed area of the cross section and the angle of twist per unit length also we found it to be given by this expression in here to be given by that expression in that.

So, in the next class we will look at a different boundary problem.

Thank you.