Mechanics of Material
Dr. U. Saravanan
Department of Civil Engineering
Indian Institute of Technology, Madras

Stresses and deflection in homogeneous beams loaded about one principal axis
Lecture – 54
Variation of axial stress

Now, sigma x x is given by M z by I z z minus into y minus y naught.

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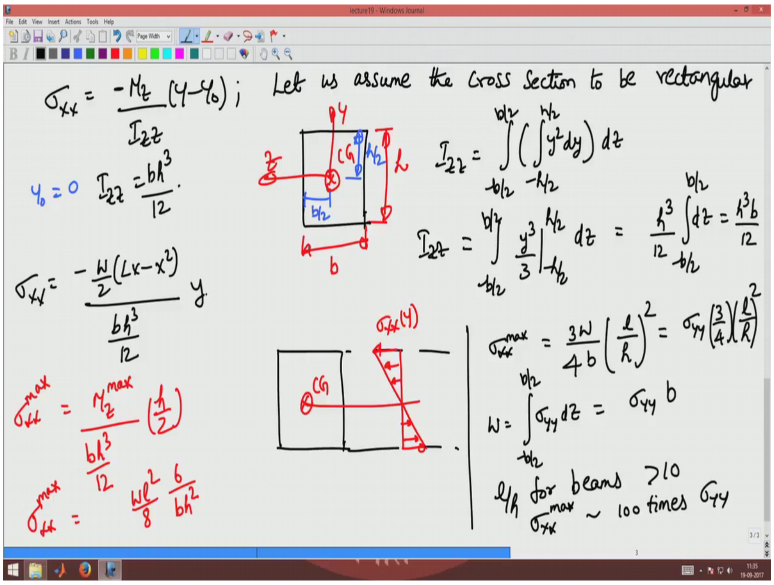

M z we have found before, I z z for a given cross section let us assume, the cross section to be rectangular with the following dimensions this is y, this is z, this is b, this is h. Now, y naught should be the center or the cross section which means this is the C G cross section, you know that for the rectangular section is C G is set of the with and of the height of the cross section.

Hence, this distance is going to be b by 2 and this distance is going to be h by 2. Now, I am locating I am meshing y from the center or the cross section. So, y naught is 0, from here y naught is 0 because the original cross section coincide with the center of the cross section.

Now, what is I z z; now I z z for this cross section is integral y square d y minus h by 2 to h by 2 into d z minus b by 2 to b by 2. So, in z I am integrating from this point to this point, the width is the same. So, it does not matter how I integrate, y square d y is from this end to this end I have to integrate, y square d y I have to integrate from this end to this end. So, it is from minus h by 2 to plus h by 2.

The width is remaining constant, so it does not matter how I, the art of the integration is, what the art of the integration is. So, this integrates from minus b by 2 to plus b by 2 along the y direction. So, this will be integral minus b by 2 to b by 2; y square by 3 y q by 3 from minus h by 2 to h by 2 into d z which will be h cube by 12 into integral d z minus b by 2 to b by 2, which will be nothing but h cube into b by 12.

So, I z z is, from here you got I z z to be b h cube by 12. So, from the previous derivation you got M z to be W by 2 L x minus x square. So, sigma x x is now given by minus W by 2 to L x minus x square divided by b h cube by 12 into y.

Now, you find that across depth to the cross section the sigma x is varies linearly. So, across the depth of the cross section, the variation of sigma x x is linear; with what happens at the top, at the top y is positive bending moment is also positive. So, the stress has to be negative, so that is why it is in compression acting like this and the bottom surface y is negative; y is negative at the bottom; at this end y is negative and hence this stress has to be positive because the bending moment is positive, so it varies like this.

Now, this is just the sigma x x variation with respect to y and this point is the C G of the cross section this is the C G of the cross section, but what are we interested in? We are interested in where the maximum sigma x x occurs and what is the value of this maximum sigma x x.

Maximum sigma x x will occur, where the bending moment M z is maximum divided by b h cube by 12 and you know that since it is very linearly the extreme points is where the maximum occurs; from the sigma x x is wearing linearly extreme points is where the maximum stresses occur. So, it will be at h by 2.

We, just now saw that M G max is given by W l square by 8 and so this expression becomes into 6 by b h square, sigma x x max. Now, let us do an analysis now; I will rewrite sigma x x max as W 3 by 4 b into l by h the whole square. Now, the W is force per unit length, that is W by definition was integral sigma y y into d z from minus b by 2 to b by 2, that is sigma y y into b was W, so W by b is sigma y y.

So, this happens to be sigma y y into 3 by 4 into l by h the whole square. Typically, for a beam l by h for beams would be greater than 10; for those beams only what are we are doing is valid. If the beam is too short or too deep what are we are doing is not valid.

So, then you find that sigma x x max is roughly standard time sigma y y. So, even though the applied stress is sigma y y, the stress resultant the stress that is (Refer Time: 07:45) in the beam because of the application of sigma y y stress is 100 times more than the applied stress, that is why this important to compute what the stresses. It is not equal; just enough to find what is the stress that is applied the (Refer Time: 08:03) stress can be much more than the applied stress; this is the thing we will see repeatedly in this course now, so this is sigma x x.