Class: 2 nd class
Subject: Strength of Materials
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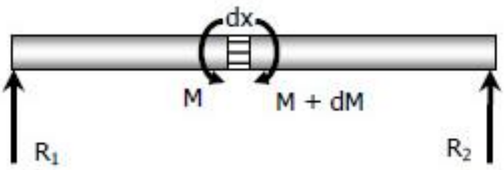
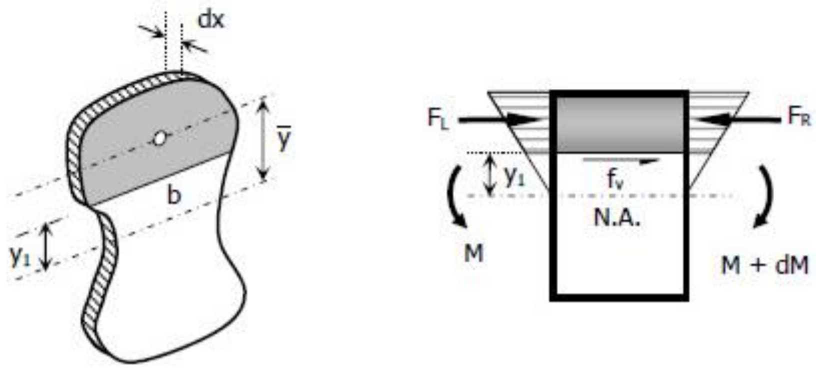
LECTURE NO. 8

SHEAR STRESS IN BEAMS

Introduction

Let us consider a differential length dx of the beam shown





For the upper shaded portion of the beam, the forces acting are the total normal forces FR and FL due to the bending stresses to the left and to the right of the beam. These forces will be resisted by the shearing force (τ b dx) acting at the boundary surface between the shaded and the unshaded portions.

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$\sum F_x = 0$: $\quad dF = H_2 - H_1 \quad = \int_{y_1}^{c} \sigma_2 dA - \int_{y_1}^{c} \sigma_1 dA$

Since $\sigma = \frac{My}{I}$, then

$$dF = \frac{M_2}{I}\int_{y_1}^{c} ydA - \frac{M_1}{I}\int_{y_1}^{c} ydA = \frac{M_2 - M_1}{I}\int_{y_1}^{c} ydA = \frac{dM}{I}\int_{y_1}^{c} ydA$$

From the above figure, $dF = \tau b dx$;

$$\tau = \frac{1}{b}\frac{dF}{dx} = \frac{1}{bI}\frac{dM}{dx}\int_{y_1}^{c} ydA$$

But $\frac{dM}{dx} = V$, then

$$\tau = \frac{V}{bI}\int_{y_1}^{c} ydA$$

The integration $\int_{y_1}^{c} ydA$ is the *first moment of area* of the shaded area A' about the neutral axis, then

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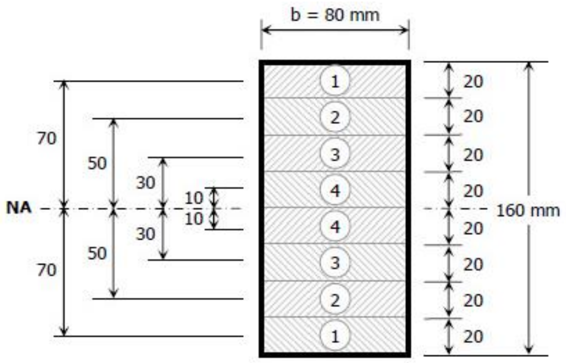
Example 1

A timber beam 80 mm wide by 160 mm high is subjected to a vertical shear V = 40 kN. Determine the shearing stress developed at layers 20 mm apart from the top to bottom of the section.

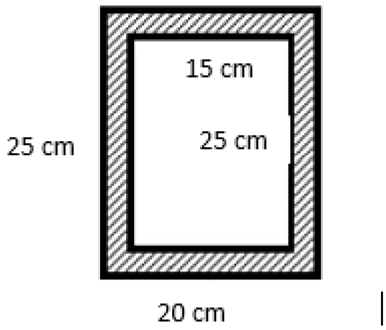


Example 2

Show that the shearing stress developed at the neutral axis of a beam with circular cross section is $\tau = (4/3)\ (V / \pi\, r^2)$. Assume that the shearing stress is uniformly distributed across the neutral axis.

Example 3

A uniformly distributed load of 3 kN/m is carried on a simply supported beam span. If the cross-section is as shown in Fig. , determine the maximum length of the beam if the shearing stress is limited to 550 KPa. Assume the load acts over the entire length of the beam.



Example 4

Determine the maximum and minimum shearing stress in the web of the wide flange section in Fig if V = 100 kN. Also, compute the percentage of vertical shear carried only by the web of the beam