Lecture No. 9

Combined Stresses

9.1 Introduction

Most often, a structural member is subjected to different types of stresses that acts simultaneously. Such stresses are axial, shear, flexure, and torsion. Superposition method is used to determine the combined effect of two or more stresses acting over the cross-section of the member.

Axial stress

$$\sigma = \frac{P}{A}$$

Shear stress

$$\tau = \frac{VQ}{Ib}$$

Flexural stress

$$\frac{\sigma_b}{y} = \frac{M}{I}$$

Torsional stress

$$\frac{T}{J} = \frac{\tau}{R}$$

Possible combinations are as follows:

1. axial and shear
2. axial and flexural
3. axial and torsional
4. torsional and flexural

5. torsional and shear
6. flexural and shear
7. axial, torsional, and flexural
8. axial, torsional, and shear
9. axial, flexural, and shear
10. torsional, flexural, and shear
11. axial, torsional, shear, and flexural

Combined Axial and Bending

Combined axial compression and bending

$$\sigma = \frac{P}{A} \mp \frac{M\,Y}{I}$$

Combined axial tension and bending

$$\sigma = -\frac{P}{A} \mp \frac{M\,Y}{I}$$

For the flexure quantity $\frac{M\,Y}{I}$, use (+) for fibers in tension and (-) for fibers in compression

EXAMPLE 1

A cast iron link is 40 mm wide by 200 mm high by 500 mm long. The allowable stresses are 40 MPa in tension and 80 MPa in compression. Compute the largest compressive load P that can be applied to the ends of the link along a longitudinal axis that is located 150 mm above the bottom of the link.

EXAMPLE 1

To avoid interference, a link in a machine is designed so that its cross-sectional area is reduced one half at section A-B as shown in Fig. P-904. If the thickness of the link is 50 mm, compute the maximum force P that can be applied if the maximum normal stress on section A-B is limited to 80 MPa.

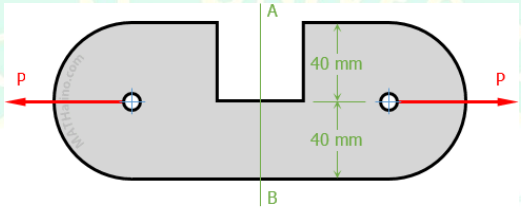

Figure P-904

EXAMPLE 1

A wooden beam 100 mm by 200 mm, supported as shown in Figure P-905, carries a load P. What is the largest safe value of P is the maximum stress is not to exceed 10 MPa?