Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

Dr. Wayne Whiteman
Senior Academic Professional and Director of the Office of Student Services
Woodruff School of Mechanical Engineering

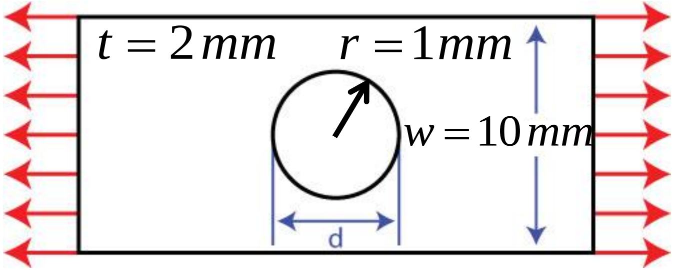
Georgia Institute of Technology

Module 28 Learning Outcome

- Calculate the maximum stress at a discontinuity in a structural member using Stress Concentration Factors

Worksheet: Axially Loaded Bar with a Hole

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

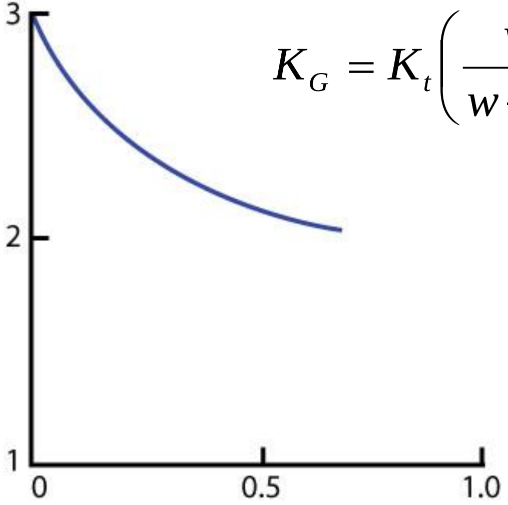


$$\sigma = \frac{N}{A} = 200\,MPa\,(T) = 0.2\,\frac{kN}{mm^2}\,(T)$$

$$K_G = K_t\left(\frac{w}{w-d}\right)$$

Stress Concentration Factor

K_t

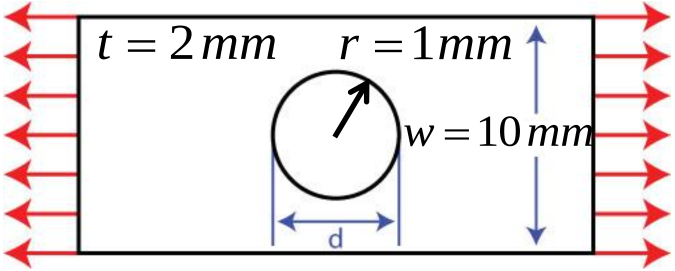


Ratio $\frac{d}{w}$

Adapted from "Photoelastic Studies in Stress Concentration," M.M. Frocht, Mechanical Engineering, August 1936.

Worksheet: Axially Loaded Bar with a Hole

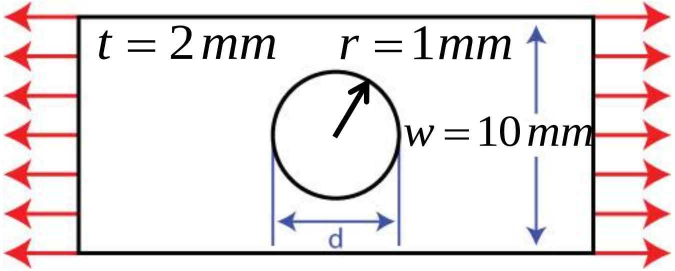
$$\sigma = \frac{N}{A}$$



$$\sigma = \frac{N}{A} = 200\,MPa\,(T) = 0.2\,\frac{kN}{mm^2}\,(T)$$

Worksheet: Axially Loaded Bar with a Hole

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

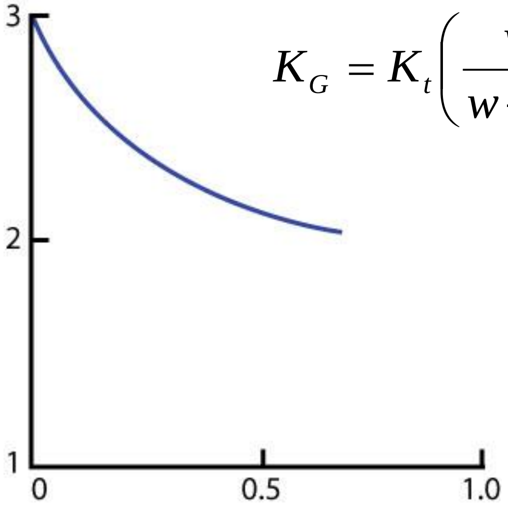


$$\sigma = \frac{N}{A} = 200\,MPa\,(T) = 0.2\,\frac{kN}{mm^2}\,(T)$$

$$K_G = K_t\left(\frac{w}{w-d}\right)$$

Stress Concentration Factor

K_t

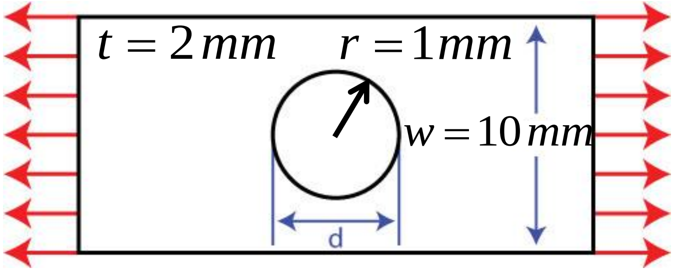


Ratio $\frac{d}{w}$

Adapted from "Photoelastic Studies in Stress Concentration," M.M. Frocht, Mechanical Engineering, August 1936.

Worksheet: Axially Loaded Bar with a Hole

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



$$\sigma = \frac{N}{A} = 200\,MPa\,(T) = 0.2\,\frac{kN}{mm^2}\,(T)$$

$$N = \sigma\, A_G = 0.2\,\frac{kN}{mm^2}\left(20\,mm^2\right) = 4kN$$

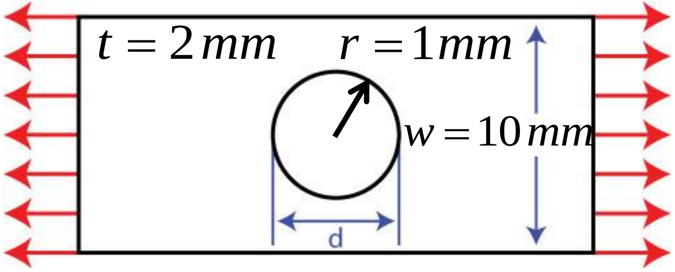
$$K_t = 2.5 \qquad A_t = 16 \;\; mm^2$$

$$\sigma = K\left(\frac{N}{A}\right) \qquad A_G = 20 \;\; mm^2$$

Net Area Method

Worksheet: Axially Loaded Bar with a Hole

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



$$\sigma = \frac{N}{A} = 200\,MPa\,(T) = 0.2\,\frac{kN}{mm^2}\,(T)$$

$$N = \sigma\,A_G = 0.2\,\frac{kN}{mm^2}\left(20\,mm^2\right) = 4kN$$

$$K_t = 2.5 \qquad A_t = 16 \;\; mm^2$$

$$\sigma = K\left(\frac{N}{A}\right) \qquad A_G = 20 \;\; mm^2$$

Gross Area Method

$$K_G = K_t\left(\frac{w}{w-d}\right)$$

Stress Concentrations

The same concept is used for other types of loading: torsion, bending, etc.

Stress concentrations are not as significant in static loading of ductile material (for example, steel). The material yields in the region of high stress and the stress is redistributed and equilibrium is established.

For brittle materials (for example, glass), stress concentrations may cause fracture.