An Introduction to Mechanics of Materials

Mechanics I

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CAL POLY

An Introduction to Mechanics of Materials

Stress Concentrations

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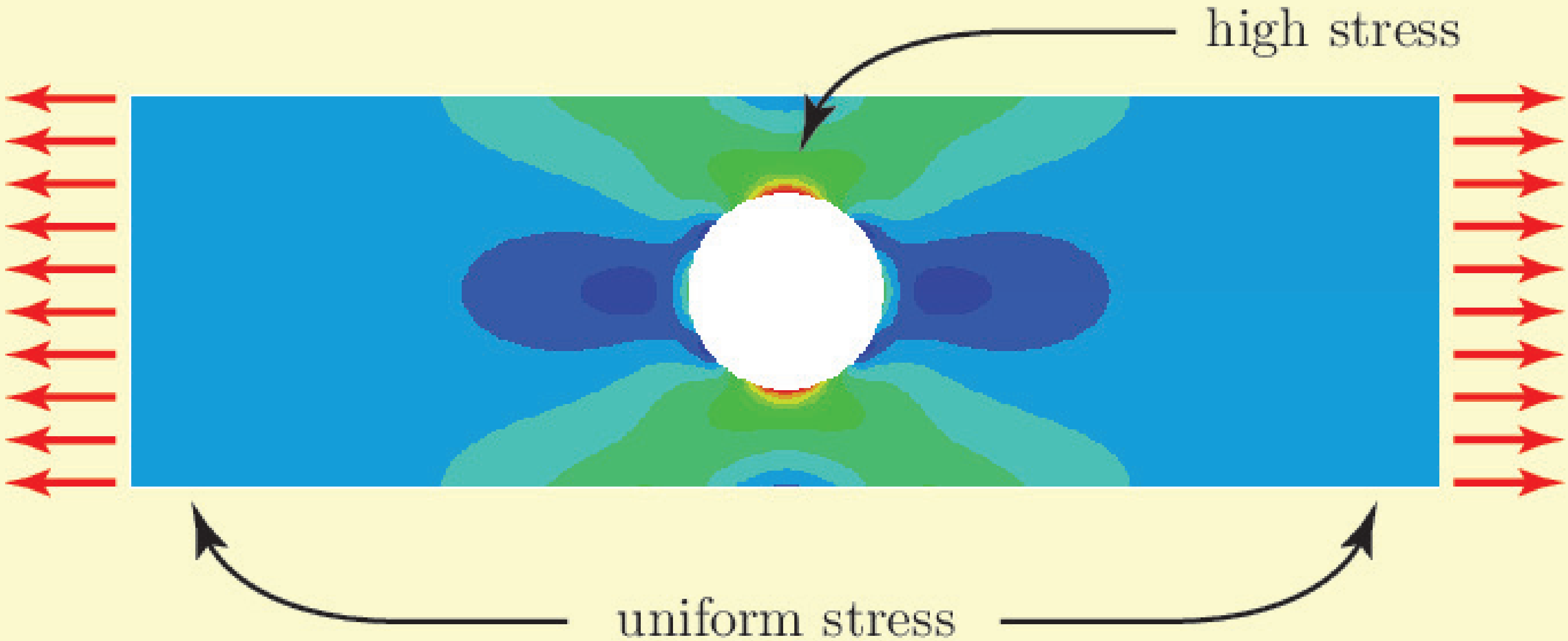
Stress Concentrations

Axial Stress Concentrations

- **High stress gradients exists when there are**
  - Localized boundary/loading conditions
  - abrupt changes in geometry
  - holes/cutouts in geometry
- **Basic stress relations do not apply,** $\sigma \neq \frac{P}{A}$
- **Example** $\rightarrow$

Axial Stress Concentrations

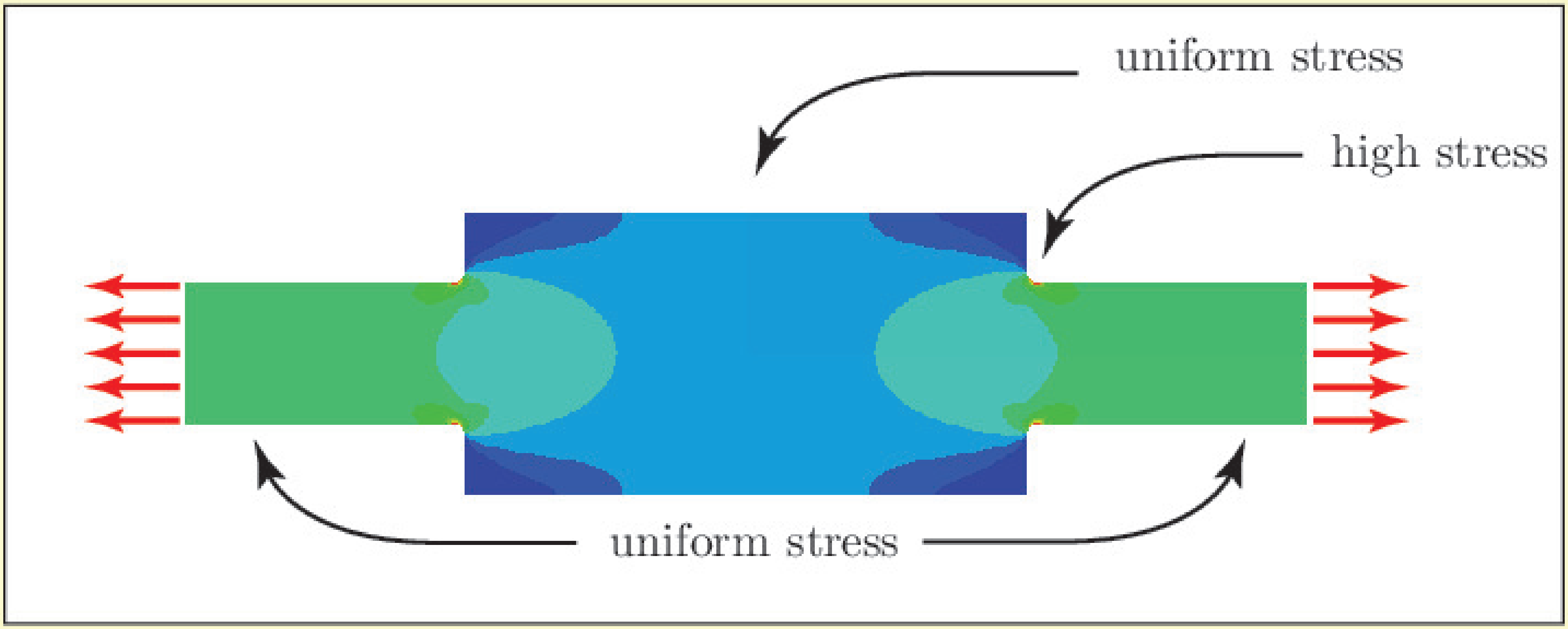
- **Example - strip plate with hole**



Stress Concentrations

Axial Stress Concentrations

- **Example - stepped plate**



Axial Stress Concentrations

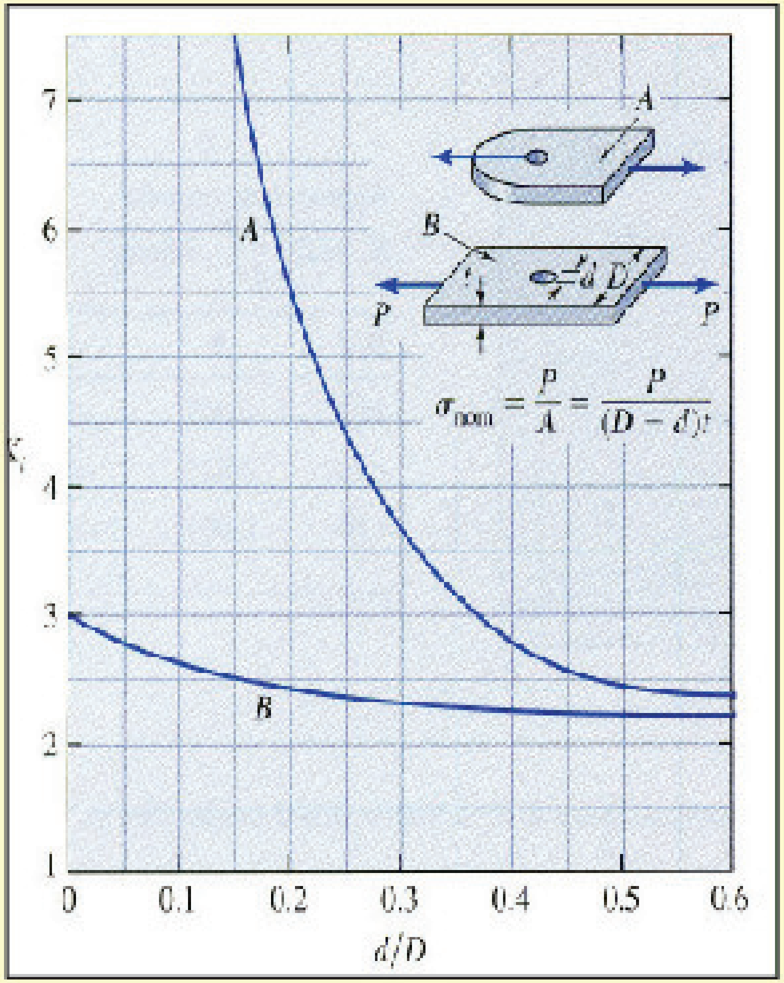
- **Maximum stress can be determined via stress concentration factor, K,**

$$\sigma_{max} = K\sigma_{avg}$$

- **K can be found experimentally or analytically**
- **High stress gradients are very important for brittle materials due to the nature of the material**
- **In ductile materials large stress gradients in local regions are important in**
  - fatigue calculations
  - localization/plasticity problems

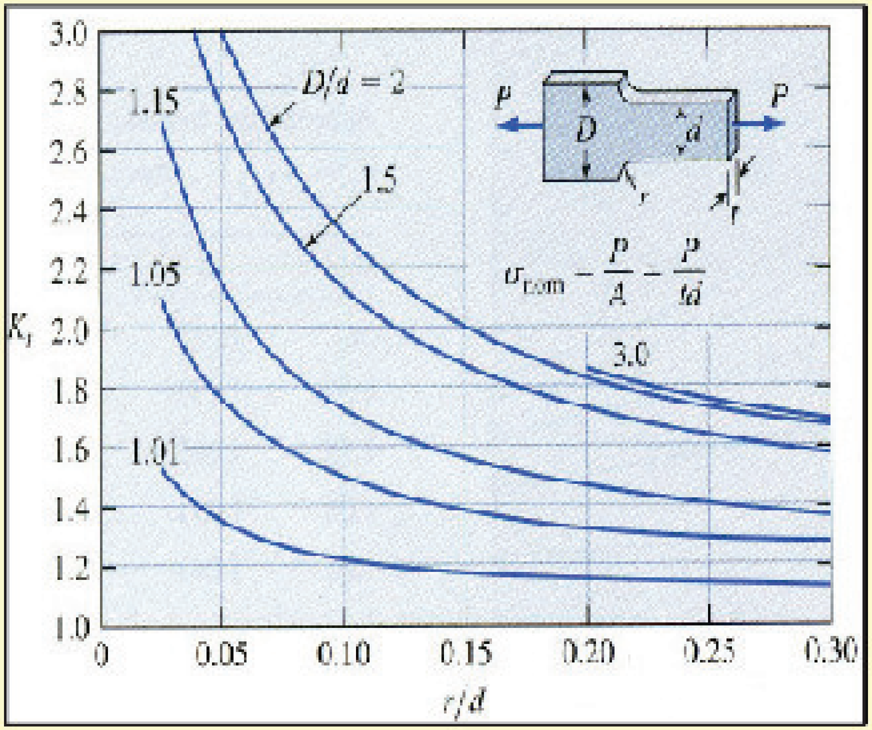
Axial Stress Concentrations

- **Monograph for strip plate with hole**



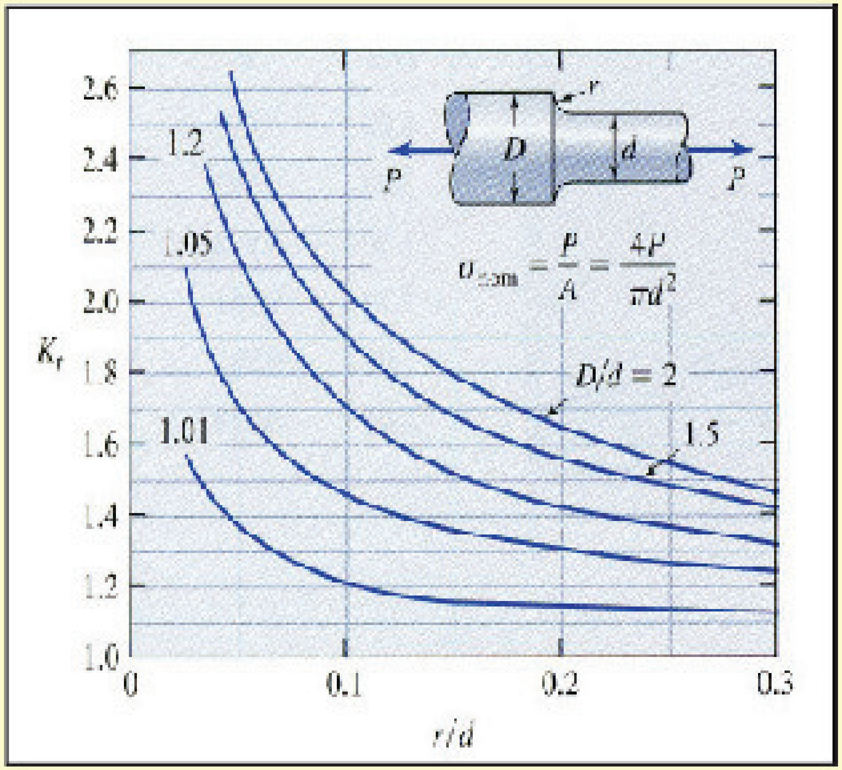
Axial Stress Concentrations

- **Monograph for stepped strip plate**



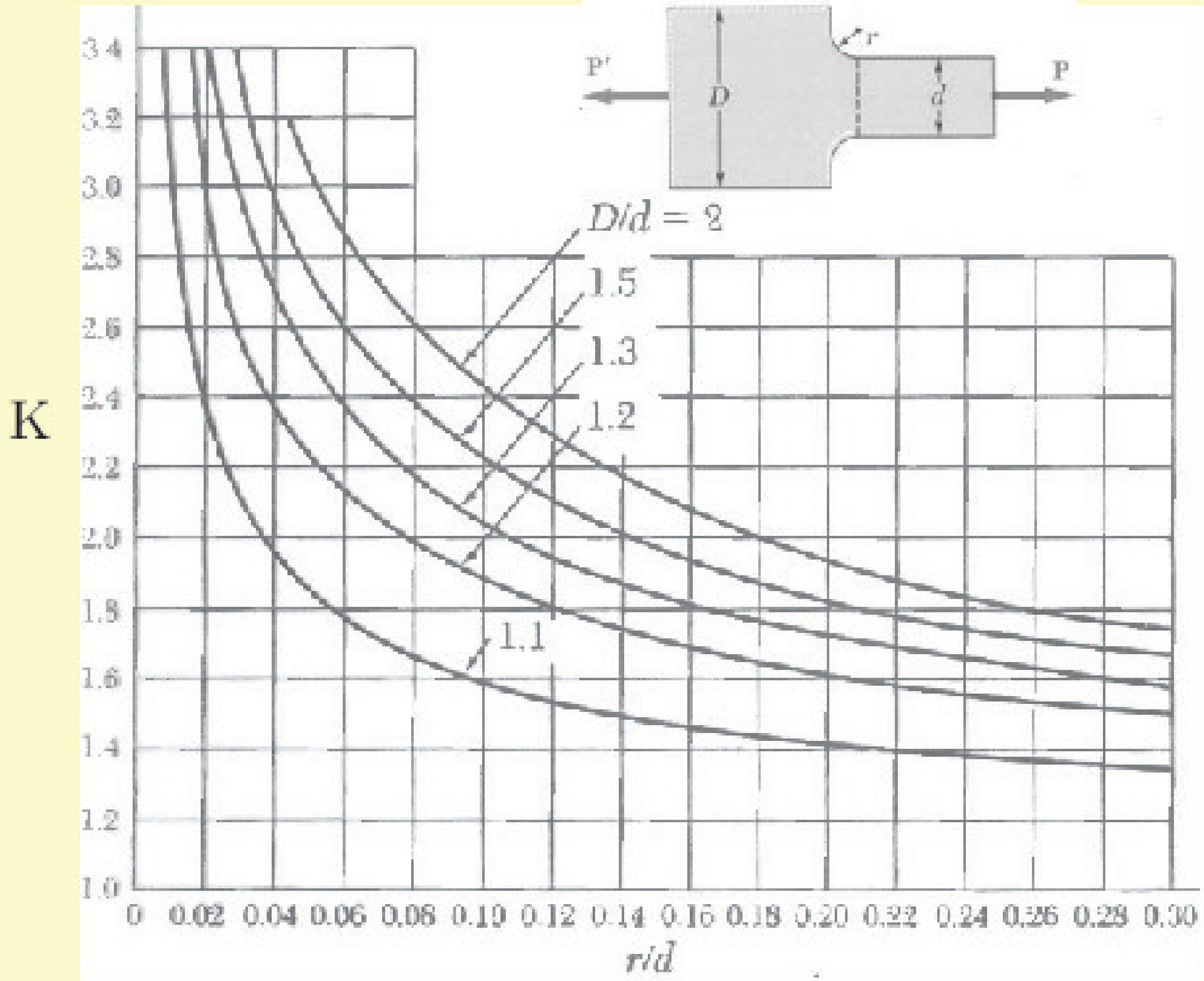
Axial Stress Concentrations

- **Monograph for stepped circular bar**



Stress Concentration Example: #1

- **Given:**



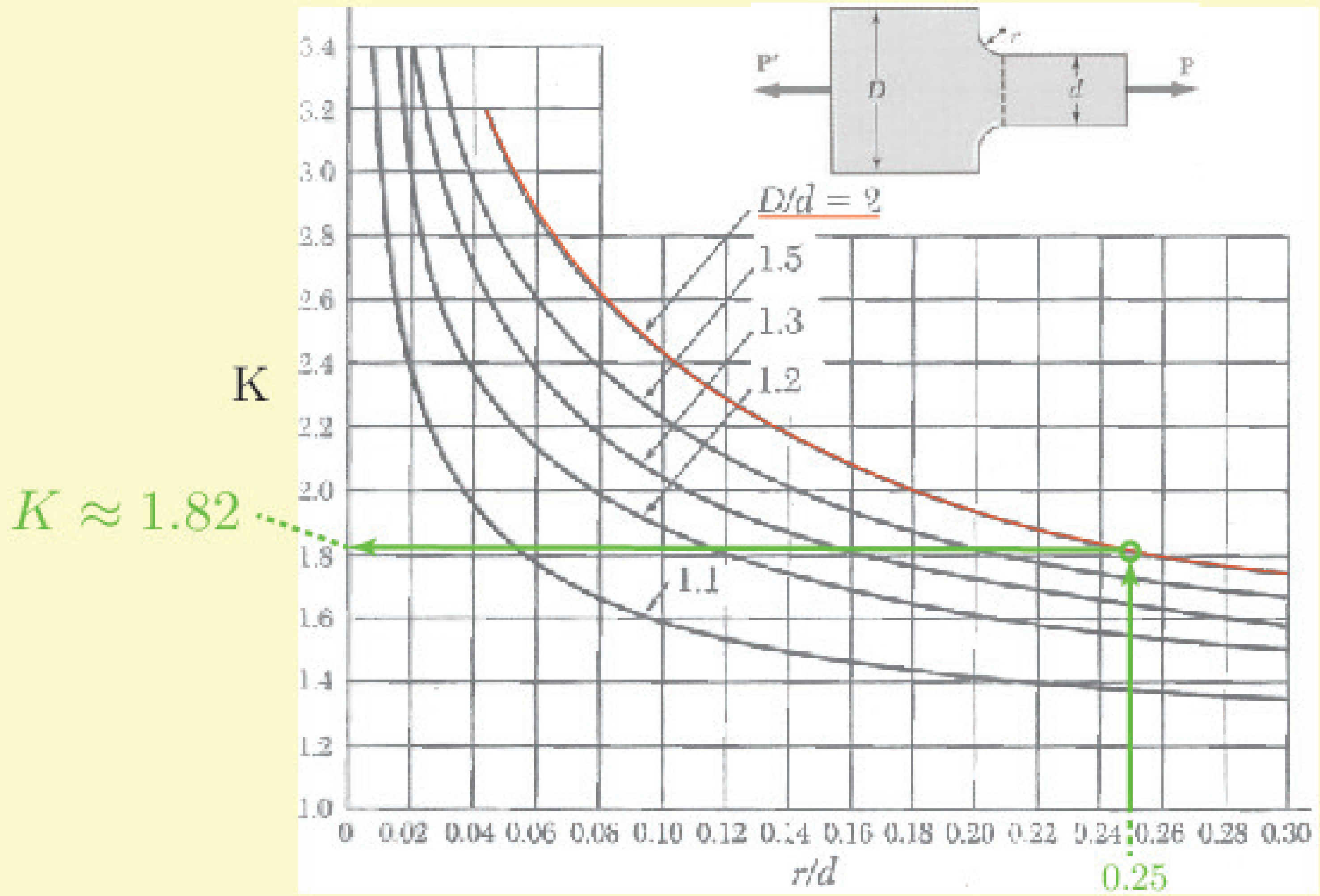
$D = 2\ in$, $d = 1\ in$, $r = 0.25\ in$, $t = 0.5\ in$ (thickness), and $\sigma_{all} = 16.2\ ksi$

- **Find:** The maximum allowable value for P.

Stress Concentration Example: #1

∘ Solution:

- Determine the stress concentration factor, K, given $r/d = 0.25$ and $D/d = 2.00$



Stress Concentration Example: #1

- **Solution:**
  - The stress concentration factor is $K \approx 1.82$
  - Recall stress concentration factor is defined as:

$$K\sigma_{avg} = \sigma_{max}$$

rearrange and set $\sigma_{max} = \sigma_{all} = 16.2\ ksi$ to get:

$$\sigma_{avg} = \frac{\sigma_{max}}{K} = \frac{16.2}{1.82} = 8.9ksi$$

  - Compute P

$$P = \sigma_{avg}A = (8.9)(1.0 \times 0.5) = 4.45kips$$

$$\boxed{P = 4.45\ k}$$