Introduction into design engineering week 3

Dr. Yukari AOKI

ANALYSIS and DESIGN

Analysis

- Considering again the structure of *Fig.1.1*, let us assume that rod ***BC*** is made of a steel with a maximum allowable stress σ_{all}***=165MPa.***
- Can rod ***BC*** safely support the load to which it will be subjected?

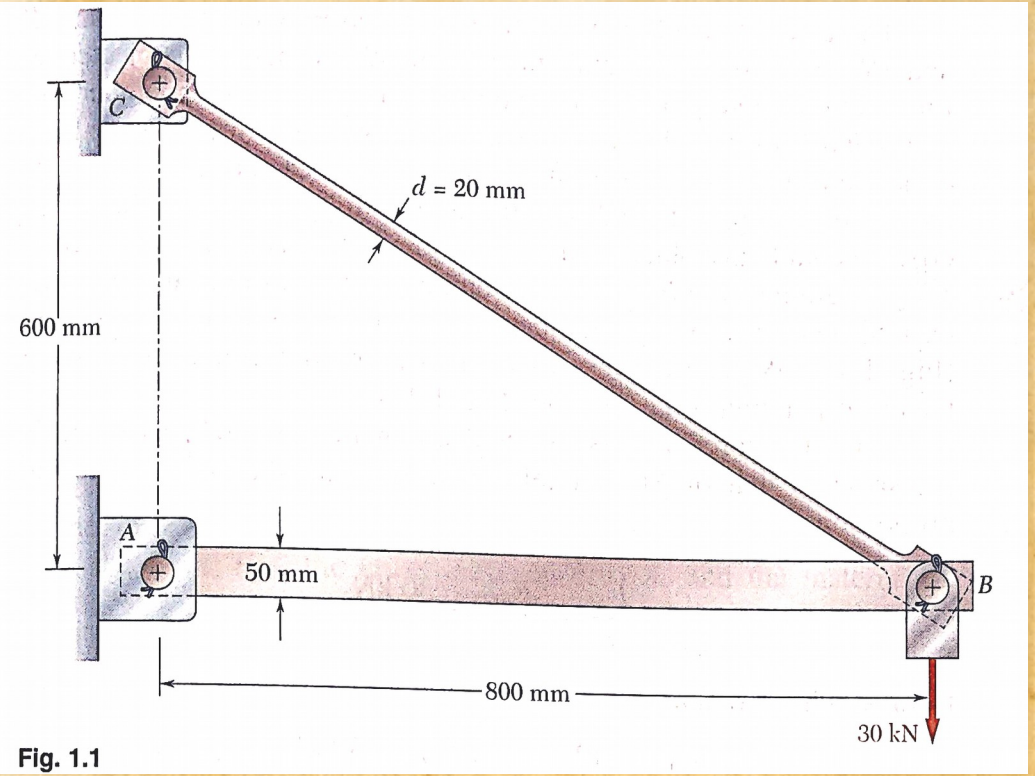

Fig. 1.1

- Find ***P*** in N.

$$P = F_{BC} = +50\,\text{kN} = +50 \times 10^3\,\text{N}$$

- Determine ***A*** in mm^2.

$$A = \pi r^2 = \pi\left(\frac{20\,\text{mm}}{2}\right)^2 = \pi(10 \times 10^{-3}\,\text{m})^2 = 314 \times 10^{-6}\,\text{m}^2$$

- Finally find $\boldsymbol{\sigma}$ in Mpa (N/mm^2).

$$\sigma = \frac{P}{A} = \frac{+50 \times 10^3\,\text{N}}{314 \times 10^{-6}\,\text{m}^2} = +159 \times 10^6\,\text{Pa} = +159\,\text{MPa}$$

- Since the value obtained for ***σ (=159 MPa)*** is smaller than the value ***σ_{all} (=165 Mpa)*** of the allowable stress in the steel used, it is concluded that rod ***BC*** can safely support the load to which it will be subjected.
- To be complete, this analysis of the given structure should also include the determination of the *compressive stress* in boom ***AB***, as well as am investigation of the produced in the pins and their bearings.

Design

- The engineer's role is not limited to the analysis of existing structures and machines subjected to given loading conditions.
- Of even greater importance to the engineer is *the design of new structures and machines*, that is, the selection of appropriate components to perform a given task.

Example of Design using Fig.1.1

- Now let's assume that *aluminum* with an allowable stress $\sigma_{all}=100MPa$ is to be used.
- Since the force in rod ***BC*** will still be

$$P=F_{BC}=50kN$$

under the given loading applied,

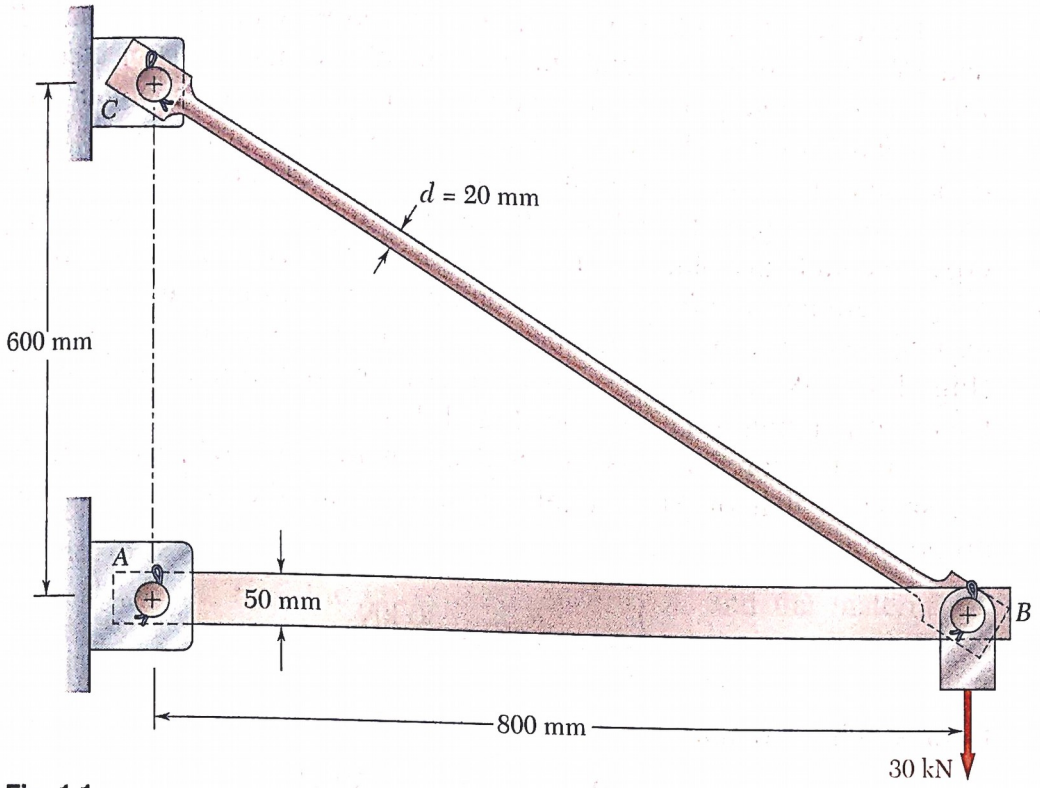

Fig. 1.1

- Since the value obtained for ***σ (=159 MPa)*** is bigger than the value ***σ_{all} (=100 Mpa)*** of the allowable stress in the aluminum used, it must be re-designed the ***Area of rod BC*** by the following equation;

$$\sigma_{\text{all}} = \frac{P}{A} \qquad A = \frac{P}{\sigma_{\text{all}}} = \frac{50 \times 10^3\ \text{N}}{100 \times 10^6\ \text{Pa}} = 500 \times 10^{-6}\ \text{m}^2$$

- Since ***A=πr²***,

$$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{500 \times 10^{-6}\ \text{m}^2}{\pi}} = 12.62 \times 10^{-3}\ \text{m} = 12.62\ \text{mm}$$

$$d = 2r = 25.2\ \text{mm}$$

- It is concluded that an *aluminum rod* ***26 mm or more in diameter*** will be adequate.

Question 1

Two solid cylindrical rods ***AB*** and ***BC*** are welded together at ***B*** and loaded as shown.

Determine the magnitude of the force ***P*** for which the tensile stress in rod ***AB*** is twice the magnitude of the compressive stress in rod ***BC***.

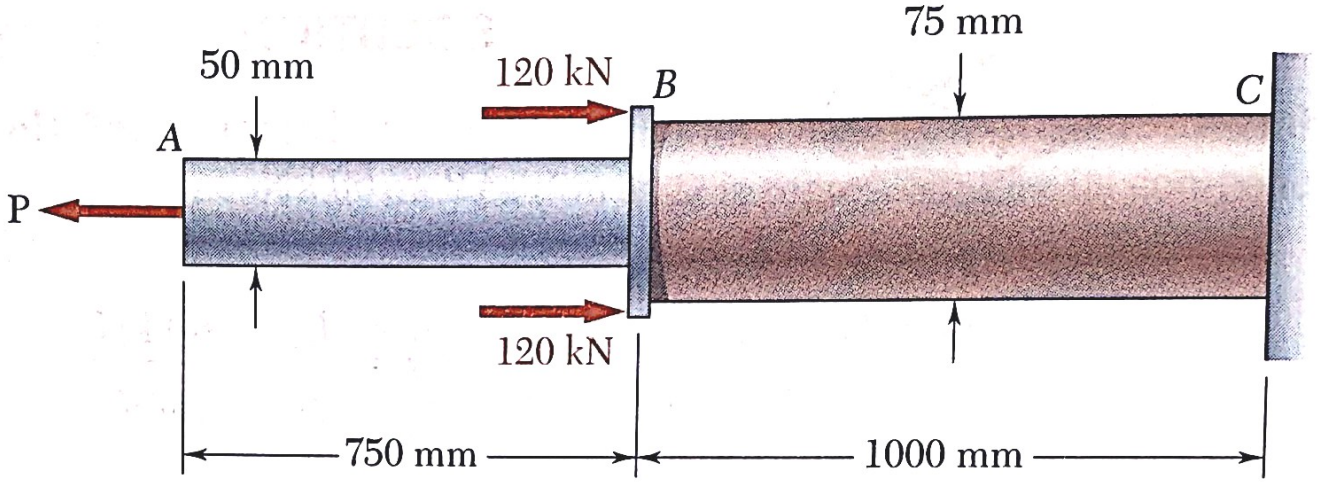

Fig. P1.1