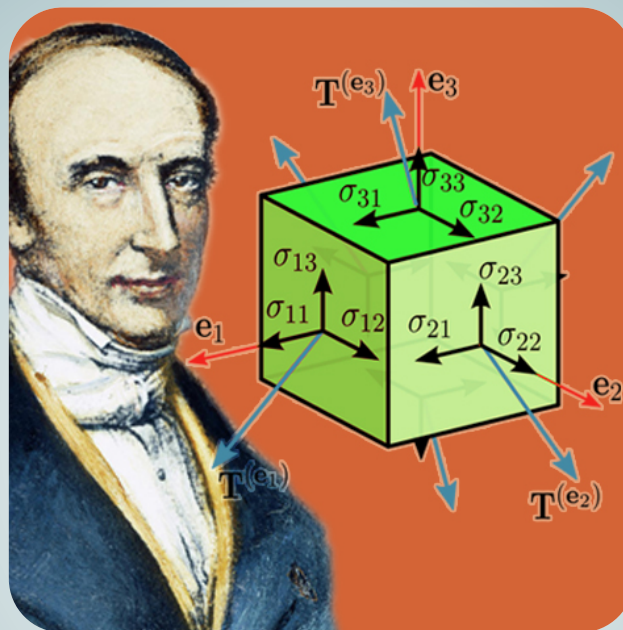


Mechanical Properties of Materials, Processing and Design

Fourth exam continuous evaluation



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MECHANICAL PROPERTIES OF MATERIALS - CONTINUOUS EVALUATION - 4th TEST

(03/04/2020)

For the design of a thin-walled cylindrical pressure vessel three different materials (A, B and C) are being considered. Their mechanical and fracture properties are shown in the table provided below. The relevant dimensions of the vessel are: $R = 3 \text{ m}$, $e = 3 \text{ cm}$.

| Material | σ_Y (MPa) | K_{Ic} (MPa·m ^{1/2}) |
|----------|------------------|----------------------------------|
| A | 200 | 100 |
| B | 300 | 75 |
| C | 500 | 60 |

The design code states that, in the analysis the failure assessment diagram shown below must be used. As can be seen, on the diagram, a pair of lines which delimit the different failure mechanisms that can occur have been superimposed

Moreover, the same code requires that for the calculations a crack with the following characteristics must be postulated: semi-elliptically shaped, oriented in the most unfavourable way (either perpendicular to the longitudinal or to the hoop stress), located in the inside wall of the vessel with an initial depth equal to $\frac{1}{4}$ of the thickness of the vessel. For this worst configuration the expression of the stress intensity factor is:

$$K_I = 1.17\sigma\sqrt{\pi a}$$

From this information, answer the following questions:

- a) Select the orientation of the crack, justifying the answer. **(2 points)**

- b) Using the FAD, determine the failure mode of the vessel under the conditions set above for each of the materials of the table; consider a process of continuously increasing loading. Represent on the diagram the lines that define the behaviour of the component under these conditions. **(4 points)**



c) Knowing that the pressure inside the vessel oscillates between 1.2 and 1.6 MPa, determine, for each of the materials, if leak before break takes place. **(4 points)**

