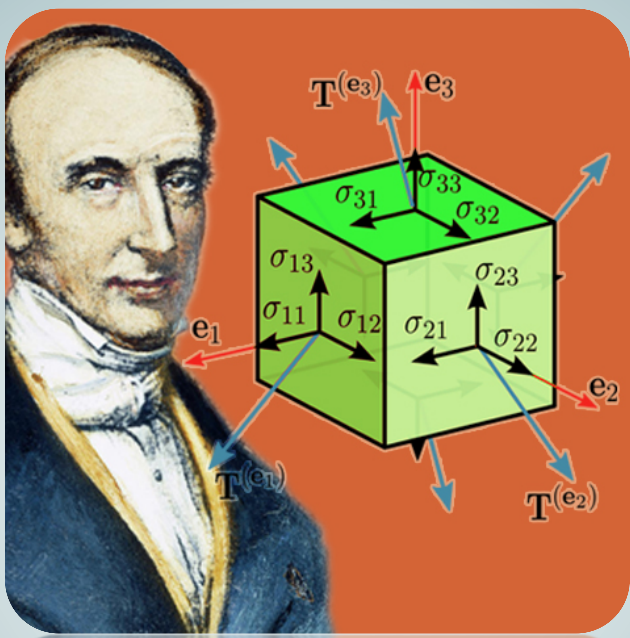
Mechanical Properties of Materials, Processing and Design

Fifth exam continuos evaluation



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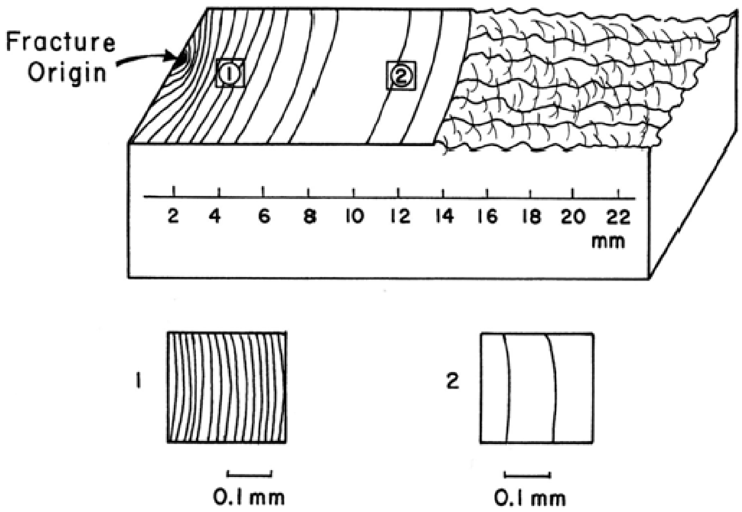
MECHANICAL PROPERTIES OF MATERIALS - CONTINUOUS EVALUATION - 5th TEST (17/05/2018)

The fatigue marks (also known as "beach marks") present in the scheme below were found in a broken component. The figure shows that the failure occurred for a = 14 mm; it also includes two details of the distance between marks for the crack lengths corresponding to a = 2 mm and a = 10 mm, respectively. As a reasonable hypothesis, it can be assumed that the distance between two successive marks is the growth experienced by the crack in one single cycle.



It is known that the geometry of the component can be identified by a semi-infinite plate, and that cracks were located on its edge (e.g., the geometric factor for K_I is 1.12). Moreover, the stresses applied ranged from -100 MPa and 300 MPa, with a frequency of f=10 Hz. With this information, answer the following questions:

a) How much is the crack growth rate for a = 20 mm and a = 10 mm, respectively? (Notice that da/dN can be approximated by $\Delta a/\Delta N$)

b) Knowing that the velocity of propagation is governed by the Paris law, obtain its parameters (C and m).

c) Determine the fracture toughness of the material.

d) Knowing that the original component did not exhibit any cracks and that the initiation consumes 90% of its fatigue life, obtain a relationship between the parameters of the Basquin model, (a and C_1). Notice that only a relation between the parameters is required (it is not possible to determine the parameters with the information available).

Basquin model: $\Delta\sigma \cdot (N_f)^a = C_1$.

Soderberg correction: $\Delta\sigma_{(\sigma_m \neq 0)} = \Delta\sigma_{(\sigma_m = 0)} \cdot \left(1 - \frac{\sigma_m}{\sigma_Y}\right)$.

Yield stress: $\sigma_Y = 500\ MPa$.

Fatigue threshold: $\Delta K_{th} = 4\ MPa \cdot m^{1/2}$.