MSE-424

Fracture of materials

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Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.
Materials Science and Engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course covers elementary fracture mechanics and its application to the fracture of engineering materials.

Content

Recap of Continuum Mechanics and Mechanics of solids with dynamics. Wave equation in 1D bars. Dispersion relation, limit of continuum model; 3D wave propagation. Helmholtz decomposition; Reflection and refraction of planar waves; Rayleigh waves.
The ideal strength, stress concentration factors, Griffith's (thermodynamic) analysis of fracture; *G* and *R* Irwin's analysis; the stress intensity factor *K*, equivalence between Irwin's and Griffith's approaches to LEFM Brittle fracture, Weibull statistics, subcritical crack growth in brittle solids.
Influence of crack tip plasticity: small scale yielding, embrittlement of metallic materials, Irwin and Dugdale process zone size estimates: COD and J-integral approaches, cohesive zones, *R*-curve behavior and its consequences for the onset of crack instability Cyclic loading: parameters and cyclic plasticity; crack nucleation, crack growth, fracture mechanics applied to fatigue; Paris's law, damage tolerant design, crack tip plasticity under cyclic loading
Overview of testing methods for fracture toughness and fatigue crack growth. Dynamic crack propagation.

Keywords

Elastic waves, Cracks in materials, Fracture mechanics, Fatigue.

Learning Prerequisites

Required courses

Continuum mechanics or equivalent, MSE-203, MX, Drezet
Materials mechanics or equivalent, MSE-205, MX, Bourban Deformation of materials or equivalent, MSE-310, MX, Logé

Learning Outcomes

By the end of the course, the student must be able to:

- Analyze wave propagation in linear elastic solids
- Decide on the structural viability of structures containing defects
- Deduce the largest defect that can be tolerated in a structure under load
- Predict the lifetime of structures susceptible to gradual crack growth

- Design tests to assess the resistance of materials to fracture
- Analyze causes for mechanical failure
- Assess / Evaluate how, and how often a structure should be checked for defects
- Hypothesize the mechanical performance of materials knowing their structure

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Access and evaluate appropriate sources of information.
- Collect data.
- Demonstrate the capacity for critical thinking

Supervision

Office hours	Yes
Assistant.e.s	Yes

Resources

Bibliography

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J.G. Williams, Fracture mechanics of polymers, Halstead Press, New York, 1984.

Ressources en bibliothèque

- Find the references at the Library

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- https://go.epfl.ch/MSE-424