Summary

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

Content

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, large scale yielding: 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
Large-strain ductile failure and the limitations of elastic-plastic fracture mechanics: the essential work of fracture (EWF):
fracture of hyper-elastic materials and very soft materials
Kinetic and dynamic effects in fracture, rapid crack propagation (RCP) and crack arrest: high-speed fracture testing
Time-dependent fracture: viscoelastic fracture mechanics: special case of creep fracture: slow crack growth in polymers
under long-term static and dynamic loading: stress-corrosion cracking: thermal fatigue.
Fracture in highly heterogeneous and highly anisotropic media: bi-materials interfaces: specific test methods for rigid,
viscoelastic and hyper-elastic substrates: testing of soft adhesives.

Learning Prerequisites

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

Recommended courses
Surfaces and interfaces, MSE-304, MX, Ceriotti
Building materials + Laboratory work, MSE-322, MX, Boehm Courjault Scrivener Sofia
Ceramics, structures and properties + TP, MSE-231, MX, Damjanovic Stolichnov
Metals and alloys + Laboratory Work, MSE-236, MX, Drezet Weber
Composites technology, MSE-440, MX, Bourban Michaud
Materials selection, MSE-474, MX, Michler Siegmannm Vaucher
Polymères, structures, propriétés, MSE-230, MX, Plummer

Learning Outcomes

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

Expected student activities
Attendance at lectures, completion of exercises

Assessment methods
Written exam

Supervision
Office hours Yes

Resources
Bibliography

Ressources en bibliothèque

- Mechanical Properties of Solid Polymers / Ward
- Deformation and Fracture Mechanics of Engineering Materials / Hertzberg
- Fracture Mechanics / Ewalds
- Elementary engineering fracture mechanics / Broek
- Application of fracture mechanics to composite materials / Friedrich
- Mechanical Properties of Ceramics / Wachtman
- Fracture Mechanics / Anderson
- Fracture and fatigue control in structures: applications of fracture mechanics / Barsom
- Mechanical behavior of materials / Courtney
- Mechanical metallurgy SI Metric ed. / Dieter
- An introduction to the mechanical properties of ceramics / Green
- Comportement mécanique des matériaux Vol.2 / François
- Advanced Fracture Mechanics / Kanninen
- Strong Solids / Kelly
- Adhesion and Adhesives / Kinloch
- Fracture of Brittle Solids / Lawn
- Mechanical Behavior of Materials / Meyers