Interdisciplinary Approach to Strength and Fracture of Materials

Special Subjects
Elective 2 credit

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1. Course Description

Generally, apparatus and structures are used under different loading conditions and various environments. Therefore, when designing them, it is necessary to consider the possibility of failure in different ways.
Throughout the lectures, the different types of fracture such as yielding, brittle fracture, fatigue, creep, corrosion, and the interaction among them, are discussed, mainly using metallic materials as examples. The unified concept on fracture, which pays attention to metals, ceramics, polymers and composite materials is discussed. For these materials, the common features and differences of characteristics of fractures are explained.

2. Course Objectives

“Strength and fracture of materials” is the learning about the fracture of materials. Strength of materials is a key issue for designing apparatus and structures. Problems of failure and faulty apparatus not only cause large economic loss, but may affect human life. It is indispensable to an engineer to design structures and apparatus in which such accidents do not occur.
In this course, I discuss the basic concept of the strength and fracture of materials, in which the influences of the microstructure in an atom-nano measure, and the macroscopic factors, such as size of the specimen and shape of components, are fused non-linearly. Moreover, a unified concept of strength and fracture of materials, which can be applied to various classes of materials, are discussed. The lectures aim to make the student aware of interdisciplinary approach to strength and fracture of materials.

3. Grading Policy

The participating situations in class and reports will be evaluated.

4. Textbook and Reference

Reference
Takeo YOKOBORI Strength and Fracture of Materials (2nd Issue) Iwanami Shoten (1974) in Japanese
The 129 Committee on Strength and Fracture of Advanced Materials, Japan Society for the Promotion of Science Strength of Materials and Fractorogy Gihodo-Shuppan (1999) in Japaneses

5. Requirements(Assignments)

Please read the reference books and the textbooks of the courses in the undergraduate course to understand the basis of the subject.
Since, in this subject, either "material science" or the "strength of materials" are related, it is desirable for students to learn these subjects in the undergraduate course.

6. Note

7. Schedule

[1] Introduction to interdisciplinary approach to strength and fracture of materials
What is “strength and fracture of materials"? ; Types of fracture; Specter of fracture

[2] The mechanics for an elastic-plastic body
Stress and strain; Combined stress; Yield criteria;
Constitutive equation for elastic-plastic body

[3] Strength and fracture of metals -Ductile fracture- (Part1)
Ductile fracture; Brittle fracture; Dislocations (characteristics and role)

[4] Strength and fracture of metals -Ductile fracture- (Part2)
Nonlinear mechanics for a notched body and a cracked body;
Macro-micro fracture mechanics

[5] Strength and fracture of metals -Brittle fracture-
Brittle fracture; Linear elastic fracture mechanics;
Embrittlement at low temperature; Ductile-brittle transition

[6] Strength and fracture of metals -Fatigue- (Part1)
Macroscopic approach to fatigue

[7] Strength and fracture of metals -Fatigue- (Part2)
Microscopic approach to fatigue

[8] Strength and fracture of metals -Creep- (Part1)
Continuum mechanics approach to creep

[9] Strength and fracture of metals -Creep- (Part2)
Deformation mechanisms and fracture mechanisms of creep

[10] Strength and fracture of metals -Creep- (Part3)
Creep crack growth; Estimation method of life at high temperatures;
Creep-fatigue interaction

[11] Strength and fracture of metals -Corrosion-
Environmental effects on fracture; Corrosion; Stress corrosion cracking; Corrosion fatigue

[12] Strength and fracture of ceramics
Microstructure of ceramics; Mechanical properties of ceramics; Statics of strength of ceramics and Weibull distribution

[13] Strength and fracture of polymers
Microstructure of polymers; Mechanical properties of polymers; Visco-elasticity; Crazing of polymer

[14] Strength and fracture of composite materials
The kinds of composite materials; Mechanical properties of composite materials

[15] Concluding remarks