

## **(CE509) FRACTURE MECHANICS**

### **Objective of the Course:**

To examine the concept of failure in members with pre-existing flaws. The purpose of this course is for the student to acquire basic skills, to work professionally as an engineer. This means applying fracture mechanics theory and to calculate stress areas and the "energy release rate" around crack tips and crack growth due to fatigue. Failure of structural components will be examined from both the mechanics and micro structural points of view.

### **UNIT-I**

#### **Introduction to fracture mechanics of concrete**

Structural failure based on material performance; Concepts of linear elastic fracture mechanics; Fracture mechanics of concrete.

### **UNIT-II**

#### **Principles of linear elastic fracture mechanics**

Airy stress functions for problems in elasticity; Complex stress function; Elastic stress and displacement fields at crack tip; Stress intensity factors and crack opening displacements for useful geometries; Superposition of stress intensity factors; Plastic zone at crack tip; Griffith's fracture theory; Strain energy release rate for crack propagation; Relationship between stress intensity factor and strain energy release rate; Design based on linear elastic fracture mechanics.

### **UNIT-III**

#### **Principles of non-linear fracture mechanics**

Energy principles for crack propagation in non-linear materials; J-integral for nonlinear elastic materials; Fracture resistance (R curve); Crack tip opening displacement.

### **UNIT-IV**

#### **Structure and fracture process of concrete**

Constituents and microstructure of concrete; Fracture behaviour and strain localization of concrete; Fracture process zone and toughening mechanisms; Experimental determination of fracture zone; Influence of fracture process zone on fracture behaviour of concrete.

## **UNIT-V**

### **Fracture behavior of different materials. Test methods.**

Variation of plastic zone over the thickness, Slip planes in plane strain and plane stress, Experimental evidence, Minimum thickness for fracture toughness specimen based on plastic zone, Fracture testing – early attempts, Fracture toughness as a function of specimen thickness, Requirements of the test, Candidate fracture toughness, Compact tension and three point bend specimens, Chevron notch – visualization exercise.

### **TEXT BOOKS:**

1. Elements of fracture mechanics by Prashant Kumar, Wheeler Publishing, 1999
2. Rock and Other Quasi-Brittle Materials by Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang, Publisher :Wiley , 1995.
3. David Broek, Elementary Engineering Fracture Mechanics, 3rd Rev Edition, Springer, June 1982.

### **REFERNCE BOOKS:**

1. Analysis of Concrete Structures by Fracture Mechanics by by L. Elfgren, Publisher: Routledge, 1990.
2. Fracture mechanics – Applications to concrete , Edited by Victor C.Li and Z.P.Bazant, ACI SP118.
3. CT Suri and ZH Jin, Fracture Mechanics, 1st Edition, Elsevier Academic Press, 2012