Course Code	Course Title	L	T	P	C
17CE010	FRACTURE MECHANICS	3	0	0	3

Course Objectives:

1. To examine the concept of failure in members with pre-existing flaws.
2. To familiarize students in the field of fracture mechanics.
3. To expose the students about linear and nonlinear fracture mechanics.
4. To familiarize the students on fracture process of concrete.
5. To expose students about behavior of fracture for different materials and its testing methods.

Course Outcomes:

At the end of the course student will be able

1. To acquire basic skills in fracture mechanism of brittle materials like concrete.
2. To apply fracture mechanics theory to calculate stress areas.
3. To examine failure of structural components from both the mechanics and micro structural point of view.
4. To calculate the "energy release rate'' around crack tips
5. To examine crack growth due to fatigue.

ACTIVITIES:

1. Design based on linear elastic fracture mechanics.
2. Fracture toughness as a function of specimen thickness using experimental determination of fracture zone for concrete
3. Examine variation of plastic zone over the thickness using experimental analysis.
4. Slip planes in plane strain and plane stress using experimental evidence

Skills:

1. Able to design based on linear elastic fracture mechanics.
2. Able to find out the variation of plastic zone over thickness of various elements.
3. Able to know about the plane strain and plane stress in slip planes.

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 and 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, Concrete fracture toughness, Compact tension and three point bend specimens, Chevron notch – visualization exercise

TEXT BOOKS:

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

REFERENCES:

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