

Durability Design of Concrete Structures

Code	Credit Hours	Category
CE-813	3	Elective

Course Description:

The increasing importance placed on the whole-life performance of structures means that there is a growing demand for long service lives with minimal maintenance requirements. Furthermore, the operation of infrastructure beyond the originally intended service life is becoming an increasingly common scenario. Thus, the durability of construction materials is of more concern to civil engineers than ever before. Concrete structures are frequently required to function in a wide range of aggressive environments for long periods of service. Moreover, measures to optimize the durability performance of concrete structures often find themselves in conflict with structural and aesthetic design requirements. Therefore, improved procedures for quality control and quality assurance during concrete construction are also very important. This course on 'Durability Design of Reinforced Concrete Structures' focuses on the various issues related to the durability of concrete and materials. The focus will be on understanding various mechanisms of deterioration in concrete structures and tests involved to assess the durability of concrete. Moreover, the specification will be discussed to design a durable concrete based on these durability issues. In addition, the construction of durable concrete and the probabilistic approach to predict the life cycle of concrete will also be introduced.

Text Book:

Durability of Concrete Design and Construction, by Mark Alexander, Arnon Bentur, Sydney Mindess CRC Press, Taylor & Francis Group, 2017.

Reference Books:

- Fundamentals of Durable Reinforced Concrete. by Mark G. Richardson, Spon Press, Taylor & Francis Group, 2002.
- Concrete Durability, by Thomas Dyer, CRC Press, Taylor & Francis Group, 2014.
- Alkali-Aggregate Reaction in Concrete, by Ian Sims and Alan Poole, CRC Press, Taylor & Francis Group, 2017.
- Mechanisms of chemical degradation of cement-based systems. by K.L Scrivener and J.F. Young, Taylor & Francis Group, 1995.
- Durability of Engineering Structures, Design, Repair and Maintenance, by Jan Bijen, CRC Press, Woodhead Publishing Ltd, 2003.

Prerequisites:

- BE (Civil, Architecture, Construction Engineering & Management)

Assessment System

Component	Percentage Range
Quizzes	10-15%
Assignments	10-15%
Mid Terms	20-30%
ESE	40-50%
Project (optional)	10-15%

Teaching Plan:

Week No	Topic
1	Introduction/Overview
2	Physical Mechanisms of concrete Deterioration: Introduction, Shrinkage, Cracking.
3	Physical mechanisms of concrete Deterioration: Freeze and Thaw, Erosion and assessment techniques.
4	Chemical mechanisms of concrete deterioration: Introduction, sulphate attack, Acid attack and AAR.
5	Chemical mechanisms of concrete deterioration: AAR and durability testing.
6	Corrosion of Reinforcement: Introduction, Carbonation and Chloride induced steel corrosion.
7	Corrosion of Reinforcement: <i>In situ</i> testing, electro-chemical test methods.
8	Specifications and Design of Durable Concrete: Introduction, Design of durable concrete mixture.
9	Mid Term Exam/ OHT, (As per NUST Exam Policy)
10	Specifications and Design of Durable Concrete: special concretes.
11	Probabilistic approach to durability design: Introduction, Design life.
12	Probabilistic approach to durability design: Introduction, Design life.
13-14	Probabilistic approach to durability design: Life time safety factor and design methods.
15	Life 365 training to estimate the service life of the concrete mixtures
16	Construction of durable concrete structures: Introduction, surface protection systems.
17	Construction of durable concrete structures: Cathodic protection systems, review.
18	ESE

Software Tools

Life-365 to estimate the service life of the reinforced concrete exposed to aggressive environmental conditions.