

Design of Anchorages in Concrete Construction and their Role in Structural Strengthening

Course Times:

Forenoon: 10AM to 11:30 AM & 11:45 AM to 1:15 PM

Tea Break: 11:30 AM to 11:45 AM, Lunch: 1:15 PM to 2:15 PM

Afternoon: 2:30 PM to 4:30 PM

Schedule

Day 1: 22nd July, 2019

Introduction to anchorage in concrete construction

Lecture 1 (AS): [1.5 hr] Course introduction and overview: Cast-in-place systems, post-installed mechanical anchors, adhesive anchors, and post-installed reinforcing bars;

Lecture 2 (KVLS): [1.5 hr] Overview of Concrete Fracture Mechanics: Part 1

Lecture 3 (SP): [1.5 hr] Overview of Strengthening Techniques and Need for Anchorages

Day 2: 23rd July, 2019

Behaviour and design of anchors under tension loads

Lecture 3 (AS): [1.5 hr] Behaviour of concrete in tension, basic concepts of load-transfer mechanism, types of loads on anchors, Anchorage in cracked concrete; Installation of different type of anchors in concrete with hands-on experience

Lecture 2 (KVLS): [1.5 hr] Overview of Concrete Fracture Mechanics Part 2

Lab Visit (SP): [2 hrs]

Day 3: 24th July, 2019

Behaviour and design of anchors under tension loads

Lecture 1 (AS): [1.5 hr] Load-displacement behavior and modes of failure of anchors in concrete under tension loads, the influence of cracks and crack width on the anchoring behavior under tension loads; Evaluation of failure load corresponding to steel failure, concrete cone breakout, local blow out, pull-out and concrete splitting;

Lecture 2 (AS): [1.5 hr] Design of anchorages under tension loads by concrete capacity design method; anchorages with headed studs, post-installed mechanical anchors, adhesive anchors, anchor channels; analytical and numerical models for anchorages under tension loads; laboratory experiments on anchors under tension loads.

Lab Demonstrations (SP): Testing of Anchors [2 hrs]

Day 4: 25th July, 2019

Behaviour and design of anchors under shear loads

Lecture 1 (AS): [1.5 hr] Load-displacement behavior and modes of failure under shear loads, the influence of cracks and crack width on the anchoring behavior under shear loads; Evaluation of failure load corresponding to steel failure, concrete edge breakout, pry-out failure;

Lecture 2 (AS): [1.5 hr] Design of anchorages under shear loads by concrete capacity design method; anchorages with headed studs, post-installed mechanical anchors, adhesive anchors, anchor channels; analytical and numerical models for anchorages under shear loads; laboratory experiments on anchors under shear loads.

Day 5: 26th July, 2019
Anchorage with supplementary reinforcement

Lecture 1 (AS): [1.5 hr] Configurations of the supplementary reinforcement for anchorages under tension loads and under shear loads; the influence of supplementary reinforcement on the behavior of anchorages under tension loads and under shear loads;

Lecture 2 (AS): [1.5 hr] strut-and-tie model for the design of anchorages with supplementary reinforcement, consideration of reinforcement failure, the contribution of hooks, strut failure; advanced numerical models for anchorages with supplementary reinforcement

Day 6: 27th July, 2019
Behaviour and design of anchors under inclined loads

Lecture 1 (AS): [1.5 hr] Load-displacement behavior and modes of failure of anchors in non-cracked concrete under inclined loads,

Lecture 2 (AS): [1.5 hr] Interaction equations for anchorages under inclined loads, interaction equations for anchorages with supplementary reinforcement under inclined loads.

28th July, 2019: Day off: Sunday

Day 7: 29th July, 2019
Seismic behavior, qualification, and design of anchors

Lecture 1 (AS): [1.5 hr] Influence of seismic loads on anchor performance, the behaviour of different types of anchors under seismic loads; Qualification tests and assessment criteria, load cycling, crack cycling; criteria for selection of suitable anchorages for seismic loads;

Lecture 2 (AS): [1.5 hr] Design principles and methodologies for anchorages under seismic loads, laboratory experiments on anchors under seismic loads

Lab Demonstrations (SP): Testing of Anchors [2 hrs]

Day 8: 30th July, 2019
Design of anchorages for the strengthening of structures

Lecture 1 (AS): [1.5 hr] Usage of anchorages in strengthening, principles of strengthening, selection of suitable strengthening method; Demands on anchorages used for strengthening, the influence of simultaneous load and crack cycling, the influence of anchor performance on the performance of strengthening;

Lecture 2 (AS): [1.5 hr] Design of anchorages for steel bracing, the design of anchorages for haunch retrofit solution, case studies; Enhanced design models.

Lecture 3 (GR): [2 hr] Case Studies in Structural Strengthening

Day 9: 31st July, 2019
Anchorage in special concretes and under special loads

Lecture 1 (AS): [1.5 hr] Anchorages in fiber reinforced concrete; anchorages in lightweight concrete; anchorages in high strength concrete;

Lecture 2 (AS): [1.5 hr] Behaviour of anchorages under fire loads, the behavior of anchorages under impact loads

Examination, Certificate Distribution, and Feed-Back Session
Examination: 2.15 pm to 3:15 pm on 31.07.2019