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المركز العالمي للتدريب والتطوير
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CC019
Advanced Techniques in Structural Engineering

Course Introduction:

An advance in structural engineering provides a major publication channel for research in the area of structural engineering and an international forum for the exchange of innovative ideas. It covers all aspects of the analysis, behavior, design and construction of civil engineering structures such as buildings, bridges, towers and masts, storage structures, and offshore platforms.

This course presents the basic concepts and principles of advanced techniques in structural engineering. Characteristics of reinforced concrete, advanced concrete additives, and modern materials used to increase the strength and bonds of reinforced concrete will be covered. Properties and use of fiber reinforced polymers, carbon-FRP and glass FRP polymers are presented. Repair schemes using FRP for reinforced concrete slabs and concrete columns are reviewed. Stress-Strain model of Rectangular Concrete Columns Confined by FRP and seismic structural analysis for different repair schemes using FRP are also covered are also covered.

Course Objectives:

- Recognize and understand the engineering properties of materials used in the construction
- Select the appropriate technique to achieve particular design goals
- Understand the advantages, disadvantages and limitations of such techniques
- Create informed design decisions to select materials for enhancing the structural performance, serviceability and durability of such structural designs
- Identify the basic properties of reinforced concrete, advanced additives, and modern reinforced concrete materials and the basic properties of the fiber reinforced polymers FRP
- Enumerate the different types of slabs using FRP under seismic load
- Discuss reinforced concrete beams using FRP under seismic load
- Discuss reinforced concrete columns using FRP under seismic load
- Explain the behavior of rehabilitated reinforced concrete structures under seismic loads and selective rehabilitation scheme of reinforced concrete structures

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Who Should Attend?

This course is intended for construction engineers, maintenance engineers, design structural engineers, supervision engineers and planners. It is also suitable for civil and structural engineers whose work is related to reinforced concrete design and repair. Hence, this course can be potentially useful to those responsible for Reinforced Concrete Structures Rehabilitation by FRP.

Course Methodology:

A variety of methodologies will be used during the course that includes:

- (30%) Based on Case Studies
- (30%) Techniques
- (30%) Role Play
- (10%) Concepts
- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionaires
- Group Work
- Discussion
- Presentation

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Course Certificate:

International Center for Training & Development (**ICTD**) will award an internationally recognized certificate(s) for each delegate on completion of training.

Course Fees:

To be advised as per the course location. This rate includes participant's manual, Hand-Outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Outline:

Day 1:

Structural 1: Concrete Materials

- Properties of concrete in fresh and hardened states
- Specifications
- Mix design
- Testing techniques
- Strength and deformation under generalized stress states
- Deterioration mechanisms

Structural 2: Reinforced Concrete 1

- Design for bending and combined bending and axial force
- Shear: topics include fundamental behavior and standard and VSI methods of EC2
- Design and behavior of continuous beams
- Deflections
- Design of building structures

Structural 3: Pre-stressed Concrete

- Design for bending and combined bending and axial force
- Design and behavior of continuous beams
- Deflections
- Design of building structures

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Day 2:

Structural 4: Finite Element Structures

- Introduction to the finite element method
- General properties of finite elements and accuracy considerations
- Shape functions and continuity requirements
- Discrete system analysis
- One-dimensional plane stress/strain formulations; constant strain triangular element; rectangular element
- High order formulations, including isoparametric family; numerical integration
- Modelling of common plane stress/strain problems

Structural 5: Structural Dynamics

- Dynamic loads
- Single-degree-of-freedom models
- Free-vibration: natural frequency, initial conditions, maximum displacements and internal forces, effect of damping, motion caused by collision or impact
- Forced vibrations: dynamic magnification factor and response spectra; harmonic loading and resonance, short-duration pulse loads, maximum displacements and internal forces
- Multi-degree-of-freedom models
- Free vibrations: mass and stiffness matrices, natural frequencies and natural modes

Structural 6: Plastic Analysis of Framed Structures

- Ductility in reinforced concrete beam-columns
- Interaction between bending moment and axial force
- The plastic hinge concept and plastic hinge rotation capacity
- Plastic limit analysis of framed structures and the collapse load factor
- The mechanism method
- Kinematic description of collapse mechanisms
- Rate of work and rate of plastic energy dissipation; load factor required to mobilize a given mechanism
- The mechanism method of calculating the collapse load factor as a linear program
- The equilibrium method
- Static description of the structure prior to collapse
- Yield conditions

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Day 3:

Structural 7: Steel Components

- Introduction to design philosophy, structural analysis and basis of codes of practice
- Design of steel components: local buckling, cross-section classification, design of tension members, compression members, beams and beam-columns
- Design of steel connections: general consideration of bolts and welds, analysis and design of connections

Structural 8: Structural Stability

- Elastic stability of discrete systems: potential energy and equilibrium approaches, degree of freedom (DOF), non-linear responses, bifurcation and limit points, imperfection sensitivity
- General theory: systematic post-buckling analysis of single and multiple DOF systems by the perturbation method; elimination of passive coordinates, non-trivial fundamental equilibrium paths, introduction to mode interaction
- Approximate energy methods: Rayleigh-Ritz and Timoshenko methods
- Buckling phenomena in common structural components: Euler buckling in struts and columns, lateral-torsional buckling in beams; beam-columns, stability functions and post-critical behavior of frames, critical and post-buckling of plates

Structural 9: Reinforced Concrete 1

- Crackling
- Yield line and Hillerborg strip methods for design of slabs
- Design for torsion and combination of shear, torsion and bending
- Shear walls
- Design of slender columns and unbraced frames
- Design of beam-column joints
- Strut and tie modelling

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Day 4:

Structural 10: Nonlinear Structural Analysis

- Sources of non-linearity is structural behavior
- Geometric non-linearity: buckling, large displacements
- Large displacement analysis of framed structures
- Non-linear solution procedures
- Material non-linearity
- Dynamic analysis: explicit and implicit time integration schemes
- Introduction to ADAPTIC: static loading (proportional, time-history), and dynamic loading (earthquake, explosion)
- Project related to a practical non-linear structural analysis problem

Structural 11: Time and Temperature Dependent Behavior of Concrete Structures

- The influence of time and temperature on the properties of concrete and steel is described
- Theories are then introduced to predict the service life behavior of pre-stressed concrete structures subjected to sustained loading and various states of temperature
- Application of the methods to design precise pre-stressed concrete composite bridges is made

Day 5:

- Concrete Properties
- Modern Materials used to Increase the Strength and Bonds of Reinforced Concrete
- Advanced Concrete Additives
- FRP Types
- FRP Properties
- Seismic Repair Schemes for Reinforced Concrete Slabs
- Seismic Repair Schemes for Reinforced Concrete Beams
- Seismic Repair Schemes for Reinforced Concrete Columns
- Stress-Strain Model of Rectangular Concrete Columns Confined by FRP
- Seismic Structural Analysis for Different Repair Schemes Using FRP
- Selective Rehabilitation Scheme of Reinforced Concrete Structures

Course Timings:

Daily Course Timings:

08:00 - 08:20	Morning Coffee / Tea
08:20 - 10:00	First Session
10:00 - 10:20	Coffee / Tea / Snacks
10:20 - 12:20	Second Session
12:20 - 13:30	Lunch Break & Prayer Break
13:30 - 15:00	Last Session