CONCEPT

Reinforced Concrete Design: Industrial Foundations, Pipe Racks and Detailing

14 – 25 November 2027
Riyadh - KAFD district five-star



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Ref: 188_15196 **Date:** 14 – 25 November 2027 **Location:** Riyadh - KAFD district five-star **Fees:** 35100 SAR

Introduction:

Reinforced concrete design errors surface late on industrial and building projects: undersized footings, cracked containment walls, resonating compressor blocks and congested reinforcement that cannot be placed on site. This Core Concept course takes structural and civil engineers from materials, durability and limit state design under ACI 318 and Eurocode 2 through beams, slabs, columns, shear and torsion, then into foundations, equipment foundations, pipe racks, retaining walls and detailing. Participants produce an Industrial Structure Design Calculation Package for an element set drawn from a plant or building project.

Course Objectives:

- Select concrete cover, exposure class and mix requirements that protect reinforcement against carbonation and chloride attack
- Derive factored load combinations and design beams, one-way and two-way slabs, columns and flat slab punching zones to ultimate and serviceability limit states
- Design shear and torsion reinforcement and check crack widths and long-term deflection for members under sustained load
- Size and reinforce isolated, combined, mat and piled foundations and check block foundations for rotating equipment against resonance
- Design concrete pipe racks, retaining walls and liquid-retaining structures and prepare reinforcement drawings and bar bending schedules
- Assemble and defend a design calculation package for an industrial structure element set, including software output validation

Target Audience:

- Engineers who carry out structural calculations for plant, utility and building projects
- Design engineers in engineering, procurement and construction teams who size foundations, pipe racks and equipment supports
- Checking engineers who review and approve calculation packages and reinforcement drawings
- Plant civil engineers who assess existing concrete structures and specify repairs
- Detailers and drafting leads who convert design output into reinforcement drawings and schedules

Course Outline:

Day 1: Concrete Materials, Durability and Exposure Design

- Concrete Mix Constituents, Characteristic Strength and Stress-Strain Models for Design
- Reinforcing Steel Grades, Bond Mechanism and Development Length Principles
- Carbonation, Chloride Ingress and Freeze-Thaw Deterioration Mechanisms
- Exposure Classification and Nominal Concrete Cover Selection Sheet
- Durability Design Checklist for Aggressive Industrial Environments

Day 2: Loads, Load Combinations and Limit State Design Basis

- Dead, Live, Wind, Seismic and Thermal Load Take-Down Sheet
- Ultimate and Serviceability Limit State Definitions in ACI 318 and EN 1992-1-1
- Factored Load Combinations and Partial Safety Factor Comparison Table
- Strength Reduction Factors and Design Resistance Verification
- Continuous Beam Analysis, Moment Redistribution and Envelope Diagrams

Day 3: Flexural Design of Beams and Slabs

- Rectangular Stress Block and Singly Reinforced Section Design
- Doubly Reinforced and Flanged T-Beam Section Calculations
- One-Way Slab Strip Design and Minimum Reinforcement Checks
- Two-Way Slab Design Using the Direct Design Method and Coefficient Tables
- Flat Slab Punching Shear Control Perimeter Check at Columns

Day 4: Shear, Torsion and Column Design

- Stirrup Design: Concrete Contribution and Variable Strut Inclination Method
- Combined Shear and Torsion Reinforcement for Spandrel and Edge Beams
- Short Column Axial Design and Interaction Diagram Construction
- Biaxial Bending Check Using a Column Interaction Spreadsheet
- Slender Column Second-Order Effects and Moment Magnification

Day 5: Serviceability Checks and Guided Building Frame Case

- Crack Width Control through Bar Diameter, Spacing and Distribution
- Short-Term and Long-Term Deflection with Creep and Shrinkage Effects
- Span-to-Depth Ratio Checks and Deflection Limit Table
- Guided Case Study: Multi-Storey Frame Beam, Slab and Column Design
- Calculation Package Peer Check Using a Design Review Checklist

Day 6: Foundations: Isolated, Combined, Mat and Piled Systems

- Geotechnical Report Interpretation and Allowable Bearing Pressure for Footing Sizing
- Isolated Pad Footing Design: One-Way Shear, Punching and Bending
- Combined and Strap Footing Design for Boundary and Closely Spaced Columns
- Mat Foundation Analysis Using Winkler Springs and Plate Models
- Pile Cap Strut-and-Tie Model and Pile Group Behaviour at Overview

Day 7: Equipment Foundations and Vibration Control in Industrial Plants

- Static Equipment Foundations for Vessels, Tanks and Exchanger Saddles
- Anchor Bolt Design, Grout Pads and Embedment Detailing
- Rotating Machine Block Foundation Dynamic Loads and Unbalanced Forces
- Natural Frequency, Frequency Ratio and Resonance Avoidance Check
- Vibration Amplitude Limits and Soil-Structure Stiffness Modelling

Day 8: Pipe Racks, Retaining Walls and Containment Structures

- Pipe Rack Load Cases: Operating, Friction, Anchor and Thermal Pipe Loads
- Concrete Pipe Rack Portal Frame Design and Expansion Joint Layout
- Cantilever Retaining Wall Design: Earth Pressure, Sliding and Overturning Checks
- Liquid-Retaining and Containment Structure Design under EN 1992-3
- Bund Walls and Sumps: Restraint Cracking and Watertightness Detailing

Day 9: Detailing, Analysis Software and Existing Structure Repair

- Reinforcement Detailing Rules: Laps, Anchorage, Hooks and Congestion Review
- Bar Bending Schedule Preparation and Reinforcement Drawing Conventions
- Structural Analysis Software at Overview: Finite Element Input Checks and Output Validation
- Existing Concrete Condition Assessment: Core Testing, Cover Surveys and Strength Evaluation
- Repair and Strengthening at Overview: Patch Repair, Section Jacketing and FRP Wrapping

Day 10: Capstone: Industrial Structure Element Set Design

- Capstone Brief: Compressor Shelter, Pipe Rack Bay and Pump Foundation Scope
- Analysis Model and Load Combination Build for the Element Set
- Member and Foundation Design Calculations with Serviceability Verification
- Reinforcement Detail Sketches and Bar Bending Schedule for the Capstone Set
- Industrial Structure Design Calculation Package Presentation and Technical Review Panel

Skills You Will Gain:

- Durability and Cover Design
- Limit State Verification
- Flexural and Shear Design
- Column Interaction Analysis
- Foundation Design
- Machine Foundation Dynamics
- Reinforcement Detailing
- Calculation Package Checking

Why Attend This Course:

- Return with an Industrial Structure Design Calculation Package for an element set from a plant or building project
- Move beyond member design in week two to foundations, vibrating equipment supports, pipe racks and containment walls
- Catch congested reinforcement, weak anchorage and resonance risks before drawings reach site
- Compare design practice with engineers from oil and gas, power, water, manufacturing and commercial building projects

Conclusion:

Concrete structures in plants and buildings perform when durability, strength, serviceability and constructability are designed together. Week one covers materials, loads, limit state principles, beams, slabs, columns, shear, torsion and serviceability, closing with a guided building frame case. Week two applies that base to foundations, equipment foundations under dynamic loads, pipe racks, retaining and containment structures, detailing, software validation and repair. Participants leave with an Industrial Structure Design Calculation Package ready for checking on their next project.