Course Name:
Design of Concrete Structures I

Course Number:
20231

Credit:
3

Prerequisite:
Theory of Structures I; Construction Materials and Concrete Technology
Corequisite:
Loading

Course Description (Objectives):
In this course, students become familiar with the basic analysis and design methods of various reinforced concrete structural elements based on the international code ACI318M-14. In addition to design of individual elements like beams and columns, students become familiar with the design philosophy, different building structural systems, modelling techniques, and design of a real structures by utilizing available computer programs like SAP2000.

Course Content (outline):

- Mechanical Properties of Concrete

    Compressive strength; Effects of age, strain rate, multi-axial loading on compressive strength; strain-stress diagram; modulus of elasticity; Poisson's ratio; shrinkage; creep; tensile strength

- Mechanical Properties of Steel Reinforcement

    Plain and deformed bars; strain-stress diagram; standard rebar sizes; straight, coil rod, and WWF rebar reinforcement

- Design Philosophy

    Design objectives; structural design phases; limit states; ultimate limit states; serviceability limit states; special limit states; design approaches; margin of safety; loading and strength uncertainties; load types; load combinations and load factors; required design strength; design strength; strength reduction factors

- Flexure

    Flexural behavior of elastic beams; cracking moment; behavior of a reinforced concrete beam under different stages of loading; analysis assumptions of beams based on strain compatibility; brittle and ductile failures of beams; moment-curvature diagram; design requirements of beams; doubly reinforced beams, flanged beams

- Shear

  Shear behavior of elastic beams; tensile stress trajectories in beams; types of cracks in beams; types of shear failures in beams; shear capacity of concrete section; design requirements for shear

- Bond Stress, Development Length, and Cut-off

  Bond stress; bond strength; Types of bond failure; development length of bars in tension; development length of bars in compression; standard hooks; splice; cut-off of flexural reinforcement

- Torsion

  Torsion of elastic beams with circular, rectangular, and thin-walled sections; cracking torsion; threshold torsion; equilibrium and compatibility torsions; truss analogy; design requirements of longitudinal and transverse reinforcement; shear and torsion combination; flexure and torsion combination; reinforcement detailing

- Serviceability

  Serviceability limit states; types of cracks in concrete structures; design requirements for controlling crack width; effective moment of inertia; instantaneous deflection; long-term deflection; maximum permissible deflection

- Axial Force

  Types of columns; nominal strength of columns under axial compression and tension; plastic centroid; design requirements of columns under axial compression

References:
- Reinforced Concrete, Mechanics and Design, J. K. Wight and J.G. MacGregor, 6th Edition, Pearson Education Inc., 2012.
- Design of Reinforced Concrete, J. C. McCormac and J. K. Nelson, 9th Edition, John Wiley & Sons, 2014.
- Design of Concrete Structures, A. H. Nilson, D. Darwin, and C. W. Dolan, 14th Edition, McGraw Hill, 2008.