Compulsory Exam / State Examination Topics
Reinforced Concrete Structures

1. Mechanical properties of structural concrete and reinforcing materials (bars, wires, tendons, cables) used in reinforced concrete structures. Strength classes of structural concrete, environmental classes, determination of concrete cover. Corrosion processes of concrete and reinforcement. Realistic and design stress-strain relationships for structural concretes and reinforcing materials.

2. Bending moment - curvature relationship for reinforced concrete cross-section. Defining the characteristic points of the bending moment - curvature relationship using the ideal cross-sectional properties. Characterization of the normally reinforced, the under reinforced and the over reinforced cross-section based on the bending moment - curvature relationship. Possibilities of the formation of intermediate states, possible equilibrium and moment equations.

3. Determination of the ultimate moment capacity for rectangular reinforced concrete cross-section in ULS, considering normally reinforced, under reinforced and over reinforced cross-sections. The process and possibilities of a "determined or given" reinforced concrete cross-section design and the "free" reinforced concrete cross-section design. Analysis and design of a "T" cross-section. Examples.

4. Design of reinforced concrete beams in shear. Shear capacity of reinforced concrete cross section with and without shear reinforcement, shear capacity of shear reinforcement, shear capacity of the compressed concrete strut. Determination of shear capacity according to MSZ EN 1992-1-1: 2010. Shear design procedure, detailing of shear reinforcement, detailing rules for shear reinforcement. Method of variable-angle strut model and its effect on the design value of shear force and shear resistance. Examples.

5. Shear design of beams with T section. Shear between web and flanges. Shear at the interface between concretes cast at different times. Shear between prefabricated reinforced concrete beam and in-site concrete work, design of the required shear reinforcement. Examples.

6. Torsional resistance of reinforced concrete cross section. Experimental experiences and design model. Determination of the torsional resistance for rectangular cross-section and for various forms of reinforced concrete cross sections. Detailing rules for the torsional reinforcements (longitudinal an transversal reinforcements). Examples.

7. Complex design of rectangular and T-shaped reinforced concrete beams for bending, shear and torsion. Detailing rules of RC beams. The process of design for torsional and shear reinforcement. Design and detailing rules for the longitudinal steel bars and for the stirrups, shifting rule. Possible shapes for longitudinal and transversal reinforcements. Examples.

8. Analysis of RC beams in the Serviceability Limit State. Determination process of deflection control, crack width control and stress limitation. Control processes with or without direct calculation. Examples.

9. One-way and two-way load bearing slabs. The differential equation of the slab. Internal forces of slabs: bending and torsional moments, shear forces. Approximation methods for determining the internal forces of one- and two-way load-bearing plates. Examples.

10. Design of one-way load-bearing slabs according to elastic and plastic method (plastic analysis without direct check of rotational capacity). Detailing rules for slab reinforcements. Examples.

11. Design of two-ways load-bearing slabs according to elastic method. Detailing rules for slab reinforcements. Examples.

12. Design for bending of point-supported slabs and slabs with column bases. Approximate methods for determining internal forces, typical reinforcing detail of longitudinal steel bars, detailing rules for longitudinal steel bars. Examples.

13. Design for punching of point-supported slabs and slabs with column bases. Load distribution and basic control perimeter. Punching shear calculation. Punching shear resistance of slabs and column bases without shear reinforcement. Punching shear resistance of slabs and column bases with shear reinforcement. Detailing rules for punching shear reinforcement. Examples.

14. Plastic analysis of reinforced concrete bar elements. Plastic hinge. Application of static and kinematic theorem. Determination of bearing capacity and design of RC beams based on plasticity. Examples.

15. Yield line theory of two-way load-bearing slabs. General rules for recording yield lines. Approximate and precise determination of yield lines using an illustrative example of a two-way load-bearing slab.

16. Horizontal and vertical loads acting on a reinforced concrete frame structure. Determination of seismic loads acting on reinforced concrete structures. Examples.

17. Typical reinforcing details for RC frame connections. Outer column - inner beam connections, inner column - intermediate beam connection, inner column - top beam. Internal forces of opening and closing RC frame corners. Examples.

18. Indicative strut models for opening and closing RC frame corners, RC corbels, RC half-joints. Design, detailing of reinforcements, general detailing rules. Examples.

19. Analysis of centrally and externally loaded RC cross-section. First and second order effects, geometric imperfections, slenderness of columns, method of nominal curvature, method of nominal stiffness. Design of centrally and externally loaded columns. Classification of columns, braced members, non-braced members, isolated members, non-isolated members. Use of N-M interaction curve in RC column design. Example.

20. Reinforced concrete walls and reinforced concrete shear walls. Determination of internal forces of RC walls and shear walls, design and detailing of reinforcement. Application of strut models for designing RC walls and shear walls. Examples.