Reinforced Concrete 2011

Topics of the lectures

1. Sequence of design and check, modelling of structures, the notion of safety, the design concept of partial factors of safety, loads of r.c. structures, behaviour of r.c. structures, comparison with elastic structures, history of r.c. construction, the role of statndardisation, the EUROCODE.

2. Materials used for r.c., characteristics of concrete, making concrete, designation of concrete, variation of compression strength in time. Effect of creep and shrinkage, time dependent daformations. Characteristics of reinforcing steel, designation, comparison of structural materials. Modelling r.c. beams, basic suppositions, 1st, 2nd and 3rd state of stresses, moment-curvature (load-deflection) relationship. Basic relationship in 1st state of stresses, basic relationships in 2nd state of stresses. Determination of the inertiaof rc sections int he 1st and 2nd state of stresses.

3. Basic suppositions and relationships in 3rd state of stresses. Resistance moment of simply reinforced r.c. sections, normally reinforced, over reinforced and under reinforced sections, relationship between resistance moment and steel quantity. Resistance moment of general section, doubly reinforced sections. Costructional rules of beams.

4. Elastic and plastic moments of statically indeterminate r.c. beams (example: two-span continuous beam, simple supported beam with fixed ends), moments of continuous beams, method of substitutive loading. Flanged beams, effective width, design and check of T-sections, brittle failure of under-reinforced sections, minimum and maximum reinforcement.

5. Reason of deflection check, loads to be applied, comparison of elastic and r.c. analysis, stiffness of cracked sections, approximate calculation, role of the cracked concrete zone. The way of simplified check of deflections. Limitation of the crack width. Characteristic crack patterns. Approximate control of the crack width.

6. Lattice model of Mörsch used to investigate shear behaviour, shear capacity of the concrete section, equilibrium along inclined section, shear capacity of links and bent-up bars, plastic lattice model, capacity of concrete compression struts. Shear design according to EUROCODE, constructional rules, steps of check and design. Torsional resistance of beams. Use of bent-up bars and ″mustache-bars″ in continuous beams.

7. Detailing of reinforcment in continuous beams. Shifting of the moment diagram, co-action of concrete and steel investigation of the beam end (anchorage of the reinforcement). Bending radius and hooks. Design of cross-sectional dimensions of beams. Special topics: suspended loading, short cantilevers.

8. Axially and excentrically compressed r.c. section. Basic suppositions. Exact calculation. The M_R-N_R capacity diagram. M_R-N_R capacity diagram of plane concrete sections. Simplified capacity diagram of symmetrically reinforced sections. Approximate check of sections subjected to compression with double eccentricity.

9. R.c. column. Explanation and calculation of the additional eccentricities. Effect of creep and axial force on second order deformation of columns. Axially loaded r.c. column. Effective length of separated columns and of columns in frames, limits of the slenderness ratio. Constructional rules, detailing of the reinforcement.

10. Slabs. Basic notions of the theory of slabs, one- and two-way slabs. The method of Marcus. Elastic theory of slabs, solution methods, moment distribution in rectangular slab panels. Design and check of the reinforcement of r.c. slab sections. One-way slabs. Constructional rules. Reinforcement systems of one-way continuous slabs. Different models of stair slabs, calculation and detailing of the reinforcement.

11. Notions of the yield-line theory, „optimal” reinforcement. Plastic design of continuous slabs. Plastic design of balony slab, corner slab, circular slab, triangular slab. Corner top reinforcement of two-way rc slabs with impeded lifting at the corners. Distribution steel, reinforcement along free edges, reinforcement around holes.

12. Flat slabs. Column heads. Calculation methods of flat slabs, approximate method (column strips and middle strips). Load combinations, substitutive loading. Investigation of punching by axial support reaction. Solutions of the shear reinforcement at the column head. Reinforcement system of flat slabs. Deflection check, Concentrated and linear loading of rc. slabs.

13. Structures with composite materials. Structures subjected to compression: r.c. columns with rigid steel perfils, steel tube filled with concrete, brickwork wall with r.c. columns, hollow concrete blocks filled with r.c.. Structures subjected to flexure: steel beam with monolithic r.c. slab, r.c. beams with rigid steel perfils, r.c. floors with ceramic blocks, timber and concrete floors.

14. Bracing methods of structures. Design requirements concerning bracing. Design of bracing wall for eccentric compression. Minimum number of bracing walls, design principles of the arrangement of elements of the bracing system. Design and detailing of floors. Investigation of overturning, loss of stability. Distribution of horizontal loads between elements of wall systems. Detailing and costructional rules of r.c. walls. Effective length of walls.

15. Prefabricated r.c. structures, advantages and disadvantages, methods, materials used. Tearing up. Shrinkage and creep. Constructional rules. Lifting, storage and transportation. Connections of prefabricated members, supports.

16. History, aim and methods of prestressing. Materials used. Investigation in elastic state, losses of prestress, anchorage solutions. Prestressing and post-tensioning. Investigation of shear. Danger of brittle failure. Crack width, losses of prestress, relaxation, deformations and deflections. Prefabrication of prestressed members.

17. General design principles of foundations. Methods of foundation, shallow and deep foundations. Design of pad and strip foundation. Characteristics of the foundation beside neighbouring buildings. Underpinning of existing foundations by high pressure injection of cement paste. Characteristics of slurry walls and of pile foundations.

18. Design theory of structures, development of the design criteria (empiric design, method of permissable stresses, method of permissable loads, limit state design, method of partial factors of safety. Statistical evaluation of loads and strengths, normal distribution curve of loads and strengths, relative occurance, mean value, scatter and characteristic value. The design requirement. Optimal safety level for ULS and SLS. Development trends.

19. Fire resistance design of rc structures. Fire resistance rating, fire impact, anflammability classes, combustibility, escape route. Fire safety requirements of Eurocode 1991-2-2: fire capacity, space isolation and thermal insulation. Methods of fire resistance check. Behaviour of structural materials in fire. Constructional rules. Fire endurance requirements for diff. structures of a building. Some examples for the fire resistance of structural members. Methods of improving the fire resistance.