



UNIVERSITY OF ŽILINA  
Faculty of Civil  
Engineering

## Special Discourse

Study program: **Civil Engineering Structures**  
Field of Study: **Civil Engineering**

### State Exam

#### Department of Structural Mechanics and Applied Mathematics

##### Strength and Elasticity

1. Basic principles of the theory of elasticity, linear elasticity, superposition principle internal forces and stresses
2. Spatial state of stress and strain, linear transformation of tensor components and its matrix formulation
3. Plane stress and strain state, line state of stress and strain, transformation equations for plane stress and strain states of an elastic body
4. Graphical representation of planar and spatial stress and strain, transformation of stress tensor components graphical
5. Differential equations of equilibrium, geometric equations, compatibility equations (compatibility of deformations)
6. Physical equations for anisotropic, isotropic and orthotropic material (material)
7. Basic system of equations of the theory of elasticity, boundary conditions
8. Plane stress, basic equations of the mathematical theory of elasticity in the plane
9. Plane strain, basic equations of mathematical theory of elasticity in the plane
10. Solution of load-bearing walls, derivation of the planar stress equation, effect of wall height on stress, inverse method
11. Plane problems in polar coordinates, elastic half-plane
12. Solution of planar stress by the differential method, differential relations, boundary conditions, determination of stresses
13. Bending of thin plates, plate equation, plate strip solution
14. Solution of thin plates by the differential method, differential relations, formulation of equations for the solution of deflections, solution of internal forces in plates
15. Circular plates, rotationally symmetric thin plate solution problems
16. Elastic half-space, solution of stresses and strains from basic types of surface load

##### Dynamics of Structures

1. Static and dynamic action of the structure. D'Alembert principle. Types of vibration.
2. Computational models. Damping and possibilities of its modelling.
3. Coordinate systems. Degrees of freedom. Complex dynamic calculation.
4. Vibration of systems with 1° of freedom.
5. Vibration of systems with n° of freedom.
6. Methods for estimating the basic natural modes.
7. Solution of forced vibration by an expansion into natural modes of vibration.
8. Vibrations of a beam with a continuously distributed mass.
9. Koloušek's deformation method.
10. Solution of the effects of impulse loading.

**Statics of Structures**

1. Deformation method. Variants of the method. Sign convention.
2. Types of equations in the simplified deformation method.
3. Solution of structures with immovable nodes by the simplified deformation method.
4. Solution of structures with movable nodes by the simplified deformation method.
5. Solution of the effect of temperature change and displacement of supports by simplified deformation method.
6. General deformation method. Sign convention. Stiffness matrix. Transformation relations.
7. Solution of truss structures by the general deformation method.
8. Computational models of the subsoil.
9. Beam on elastic substructure.

**Concrete and Steel Bridges**

1. General setup and arrangement of the bridges – basic requirements.
2. Actions on road and railway bridges in accordance with STN EN 1991-2, general rules for combinations of actions.
3. Bridge accessories – types and principles of bridge expansion joints, types and design principles of bridge bearings, safety devices on bridges.
4. Bridge abutments, wings and piers - principle of static behaviour and their structure.
5. Material for reinforced concrete and prestressed concrete bridges - basic physical/mechanical properties of concrete and reinforcement (metallic, non-metallic), prestressing and anchoring components.
6. Principle and types of prestressed concrete, prestressing losses - characteristics, types and influence of prestressing losses on the value of prestressing.
7. Behaviour of statically determinate prestressed structures - equivalent load, behaviour of statically indeterminate prestressed structures - secondary effects of prestressing.
8. Basic principles of verifications of reinforced concrete and prestressed concrete bridge cross-sections - ULS, SLS, detailing rules.
9. Culverts, reinforced concrete bridges in embankment - basic characteristics, principles of static behaviour, structural solutions.
10. Cast-in-place and precast slab bridges - basic characteristics, principles of static action, structural solutions.
11. Cast-in-place and precast girder bridges - basic characteristics, principles of static behaviour, structural solutions. Technologies of cast-in-place prestressed bridges – built on stationary scaffolding (span-by-span method), bridges built on movable scaffolding, incremental launching method.
12. Cast-in place RC frame bridges - basic characteristics, principles of static behaviour, structural solution. Technology of prestressed concrete bridges built by balanced cantilever method. Precast segmental constructions.
13. Arch concrete bridges - basic characteristics, principles of static behaviour, structural solution, methods of construction.
14. Cable-stayed and extradosed concrete bridges - basic characteristics, principles of static behaviour, structural solution.
15. Steel plate-girder road bridges for smaller spans and methods of global analysis.
16. Steel plate-girder railway bridges - general arrangement and global analysis. Plate-girder bridges without a bridge deck, with intermediate member deck, with bottom member deck.
17. Steel-concrete composite bridges - general arrangement and global analysis. The effect of rheology and temperature changes on composite bridges. Shear connection in composite bridges, structural solution.
18. Truss steel bridges - general arrangement and methods of analysis. Design and structural solution of elements of truss bridges.

19. Steel arch bridges - general arrangement and basis of global analysis, design and verification. Types of arch bridges. Bow-string arch bridges – design and structural solution.
20. Theoretical and structural problems of bridges with steel orthotropic bridge decks.
21. Bridges with a continuous ballast bed on plate bridge decks, bridges with a direct fixation of the railway track.
22. Design of structures from the point of view of material fatigue.
23. General arrangement and structural solution of continuous steel bridges.
24. Cable-stayed and suspension steel bridges - general arrangement and structural solution.
25. Diagnostics of existing bridge objects.
26. Defects and failures of existing bridges and their main causes.
27. Assessment of existing bridge objects.
28. Determining the load-carrying capacity of bridges, influence of defects on the load-carrying capacity.
29. Strategy for the maintenance and repair of bridge objects.
30. Reconstruction of bridges by strengthening elements. Renewal, rebuilding and replacement of bridges.