

České vysoké učení technické v Praze
Fakulta stavební
katedra betonových a zděných konstrukcí
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„Podpora projektové výuky betonových a zděných konstrukcí“



PRELIMINARY STATIC ANALYSIS
GENERAL DESCRIPTION

Vpracoval

Kolektiv

Preliminary static analysis – General description

- An architectural study, layout drawings, requirements for general dimensions of a structure etc. can serve **as input** for a preliminary static analysis.
- **The goal** of the preliminary analysis to determine the dimensions of all structural members and check if they are realistic.
 - Design of reinforcement is not required – will be included in detailed static analysis.
 - It is not required to optimise the dimensions of all structural members. The design of the most exposed structural members is sufficient. The same dimensions might be used for less exposed members.
- The preliminary analysis is mainly based on empirical equations for calculation of slab thickness or beam dimensions etc. and geometrical requirements (for stairways etc.)
 - Estimates are gradually updated according to newly obtained results.
 - Detailed calculations are used only if absolutely necessary.
 - **Common sense must be used instead of just blindly copy the calculations of other structures.** Each structure is unique and results valid for one cannot be easily transferred to the other. For example, the same structural element (slab with 5 m span) in library would have to be designed differently than the same element in an office building.
- **The calculations** are sorted **logically** according to the interaction between load-bearing and non-load bearing structural elements. The recommended order is as follows:
 - Horizontal structural members (slab → beam → girder). The area around openings in structural members shall also be checked
 - Stairways, ramps etc.
 - Vertical structural members (columns, walls, pillars)
 - Underground walls and retaining walls
 - Foundations
 - Assessment of overall structural stiffness, design of bracing (can be decisive in some cases, if so, it shall be moved to the top)
- **The output** of preliminary static analysis are preliminary layout drawings. The drawings then serve as a base for design of services and detailed static analysis.

The structure of preliminary static analysis

1. The scheme of the structure

- The general scheme of the structure under consideration shall be the base for every calculation
- Plan and typical sections shall be included.
- The drawings shall include general dimensions and description of materials used for each structural element.
- The orientation of the main reinforcement in cast-in-situ slab elements shall be indicated.
- The description of prefabricated elements shall be provided.

2. Definition of loads

- **Observe the generally accepted form of writing in the tables**
- In this section, only general values of loads are specified. The loads for each structural member under consideration are calculated during the assessment of the member (see section 3).
- Evenly distributed loads for each floor or its part (different loads for hallways, storage areas etc.).
- If not yet specified, an estimate of loads from floor surface or roofing shall be included.
- Loads from non-load bearing walls or other loads shall be specified.
- Snow loads, wind loads, earth pressure etc.
- Other loads not yet specified according to the type of structure under consideration.

3. Preliminary static analysis of structural elements

- The proposal of dimensions of **all** structural members.
- The proposed dimensions shall be **checked** for the most exposed, e.g. slab with greatest loading, cross section of the most loaded column etc.
- The load effects can often be specified using a simplified method:
 - Continuous beams or frames with approximately same spans. The value of bending moment is $M = 1/12 (g_d + q_d) l^2$
 - Calculation of internal forces at simplified scheme of entire structure using symmetry etc.
 - If there is a need to optimize the design of an element to minimize its dimensions, more complex calculations are in order.
- The description of means of increasing the horizontal stiffness of a structure or its parts (building cores, wind bracing etc.). A simplified check may also be included.

3.1 Cast-in-situ structures

- Slab thickness, cross sections of beams, girders or columns etc.
- The calculations for ultimate limit states is used when designing elements subjected to bending (control of the depth of compressed area of concrete, the reinforcement/concrete value, the resistance to shear or punching). Preliminary check of serviceability limit states, for example using the check of **ultimate slenderness** of an element.
- When designing a subtle structure, especially slabs, the vertical deflection and possibly the crack width shall be calculated.

- For elements subjected to compressive forces (walls, columns) the eccentricity of loads can usually be omitted. If the eccentricity is significant, more complex calculations are required.
- **Explanatory schemes** of each structural member shall be included.

3.2 Prefabricated and semi-precast structures

- The design of elements according to information from the manufacturer. The sources of information shall be included.
- Preliminary assumptions shall be made regarding the process of installation, temporary load-bearing structures, handling mounts. It do not have to be assessed in detail, but rather only check their feasibility.
- Always consider the tolerances in dimensions of an element.

3.3 Other structures

- Elements of complex shapes. During design the requirements for geometry, load bearing capacity, acoustics and construction process shall be adhered to.
- Elements, whose geometry has to be coordinated with more construction details due to acoustic, heat transfer or other requirements, e.g. balconies or terraces.
- Elements, for which it is necessary to ensure consistency with the standard production program (the dimensions of iso-elements, acoustic separation devices etc.)

3.4 Masonry structures

- Assess the most exposed elements (underground walls, pillars between windows etc.)
- For assessment of compressed elements (e.g. pillars) include an approximate of the influence of eccentricity of loads.
- For the pillars suggest a brick layout.