



MINISTERSTVO ŠKOLSTVÍ,
MLÁDEŽE A TĚLOVÝCHOVY

Drafting Principles for Layout and Reinforcement Drawings

Podpora projektové výuky betonových a zděných konstrukcí

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Preamble

There are numerous ways of drafting concrete structures. Drafting styles vary between countries or even between design companies. Despite the differences the technical drawings must always be clear and evident to all who work with them. This document is an aid for students on Faculty of Civil Engineering of Czech Technical University in Prague. It contains a simplified of drafting concrete and masonry structures. The information contained herein is based on current Czech standards for technical drawings in building construction.

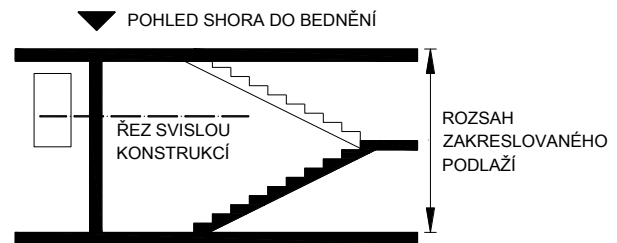
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1. Technical drawings of concrete structures

1.1. Terminology

Layout drawing – A layout drawing of a particular floor contains a drawing of vertical load-bearing structural elements of the floor (drawn as a horizontal section below the ceiling (see figure) and load-bearing elements of the ceiling rested on the vertical elements (drawn as a top view to the formwork). In complex cases two drawings can be used; one for vertical load-bearing elements and the other for ceiling structure. If a ceiling is composed of prefabricated elements, an additional cladding plan is usually required.



Reinforcement drawing – A reinforcement drawing shows the positions of all reinforcing elements in a particular structure or a structural element.

Details drawing – Structural details are included in a separate drawing or in an original drawing as a special information (always in proper scale).

1.2. Basic requirements

Technical drawings serve as specific means of communication. Certain principles shall be adhered to:

- **Explicitness and clarity**
The drawing shall have only one possible meaning. It has to be understandable for all its users.
- **Completeness**
The drawing must contain all the necessary information needed for manufacturing and checking of the built structure. There's no additional data except the drawing and associated documentation.
- **Proportionality**
All drawings and details shall be drafted in an appropriate scale. The scale shall be visibly noted.

1.3. Scales

The choice of proper scale depends on the overall dimensions and complexity of a structure that is being drafted. All information shall be clearly readable. Scales of 1:50 or 1:100 are typically used for outlines drawings; 1:20 or 1:50 for reinforcement drawings; 1:5 or 1:10 for details.

1.4. Basic line types

Typically multiple line weights are used for drafting building structures, for example thin lines 0.25 mm, thick lines 0.50 mm, very thick line 0.70 mm. The usage of line types for technical drawings is defined in the tables below.

Table 1 Line types used in outlines drawings (cast-in-situ structure)


| Description and example | Usage |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thin continuous line ————— | Diagonals indicating holes and openings, dimension lines, slope arrows in inclined surfaces, extension lines, leaders, visible outlines of structures in elevation, windows, stairs, doors etc. |
| Thin continuous break line ———  ——— | Borders of partial or interrupted elevations or sections |
| Thin dashed line - - - - - | Outlines above the section plane excluding vertical load-bearing elements; edges or openings in vertical load-bearing elements |
| Thin dash-dot line - . - . - . | Section planes, axes, framing of magnified details, reference lines |
| Thick continuous line <u>—————</u> | Visible outlines of structure in section |
| Thick dashed line <u>- - - - -</u> | Outlines of superstructure above the section plane |

Table 2 Line types used in outlines drawings (prefabricated structure)





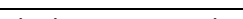

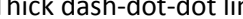

| Description and example | Usage |
|---------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thin continuous line ————— | Diagonals indicating holes and openings, dimension lines, slope arrows in inclined surfaces, extension lines, leaders, visible outlines of structures in elevation, windows, stairs, doors etc. |
| Thin continuous break line ———  ——— | Borders of partial or interrupted elevations or sections |
| Thin dashed line - - - - - | Hidden outlines of structures |
| Thin dash-dot line - . - . - . | Section planes, axes, framing of magnified details, reference lines |
| Thick continuous line <u>—————</u> | Visible outlines of structure in section |
| Thick dashed line <u>- - - - -</u> | Outlines of superstructure above the section plane |

Table 3 Line types used in reinforcement drawings

| Description and example | Usage |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Thin continuous line  | Diagonals indicating holes and openings, dimension lines, slope arrows in inclined surfaces, extension lines, leaders, visible outlines of structures in elevation, windows, stairs, doors etc. |
| Thin continuous break line  | Borders of partial or interrupted elevations or sections |
| Thin dashed line  | Hidden outlines of structures |
| Thin dash-dot line  | Section planes, axes, framing of magnified details, reference lines |
| Thick continuous line  | Reinforcement bars |
| Thick dashed line  | Reinforcement bars in bottom (in plan) or far (in elevation) layer in cases when more layers of reinforcement are shown in a single drawing |
| Thick dash-dot-dot line  | Prestressing reinforcement (bars, wires, tendons) |

1.5. Title block

The title block is used for easy identification of a document. The title block should include the following:

- Required fields: name of document owner, number of the document, the date of issue, sheet number, document name, name of checker, name of drafter, document type
- Recommended fields: Revision number, number of sheets, document status, format, scale etc.

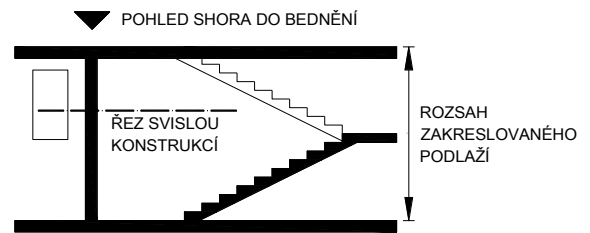
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| STAVEBNÍ OBJEKT Rodinný dům - Praha Dejvice | | KONTRLOVAL doc. Ing. Ota Jelínek, CSc. | | | | |
| | | KRESLIL Martin Severa | | | | |
| NÁZEV VÝKRESU Výkres tvaru 1.NP | | SKUPINA C3-102 | | | | |
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Figure 1 Simplified title block for use in school projects

2. Layout drawing

2.1. General rules

A layout drawing of a particular floor contains a drawing of vertical load-bearing structural elements of the floor (drawn as a horizontal section below the ceiling (see figure) and load-bearing elements of the ceiling rested on the vertical elements (drawn as a top view to the formwork). In complex cases two drawings can be used; one for vertical load-bearing elements and the other for ceiling structure. If a ceiling is composed of prefabricated elements, an additional cladding plan is usually required. Layout drawings of cast-in-situ structures shall clearly define following information:



- The position of structural members relatively to the main coordination axes
- The dimensions, shape and position of each element, opening, hole, aperture etc. incl. requirements for geometric accuracy of shape, position and orientation
- The technical properties of structural members according to the requirements defined in the design and static analysis (concrete strength class etc.)
- The specifications of all the materials and other elements or commercial products used in the drawing

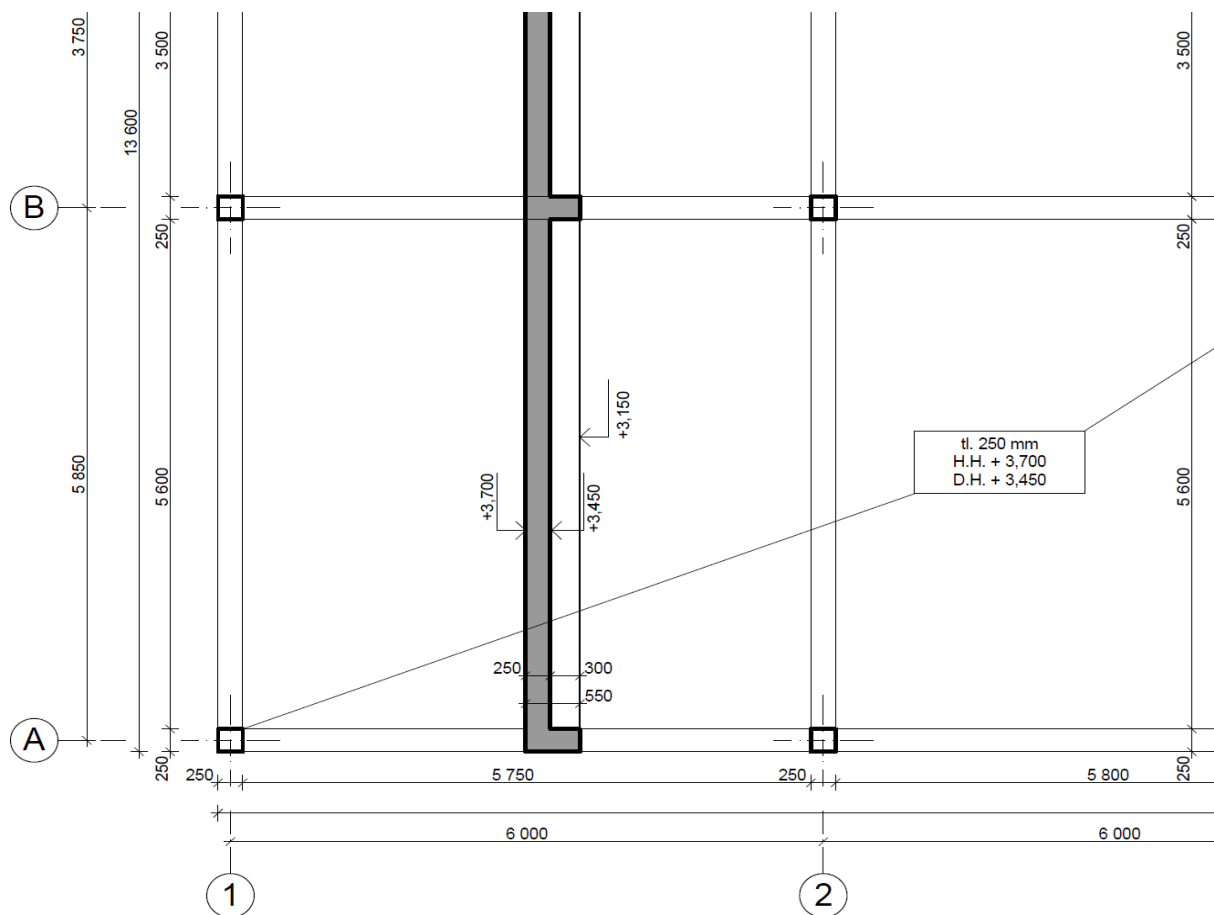
Note: The layout drawing contains only load-bearing structural elements (concrete structures, masonry structures) and optionally some non-load-bearing structures which are needed to be installed before concreting the load-bearing structure (e.g. heat insulation installed into formwork etc.). All drawings shall always be understandable to all who work with them.

2.2. Principles of drafting

2.2.1. Plan

- The shape of cast-in-situ structure is drafted as a top view of the framework supplemented with vertical sections of the ceiling structure drafted directly into the plan (rotated to horizontal plane) or drafted separately for more clarity. The dimensions and elevations of the structure shall be included
- All outlines, notches, openings and other embedded elements visible inside the formwork shall be drawn in thin continuous lines. Outlines and openings in vertical structures are drawn in thin dashed line
- Outlines of vertical load-bearing structures are drawn in thick continuous lines
- If the position of a vertical load-bearing structure varies in upper and lower floor, the outlines of such structure below the drafted ceiling is drawn in thick continuous lines and the position of the same structure above the ceiling is drawn in thick dashed lines

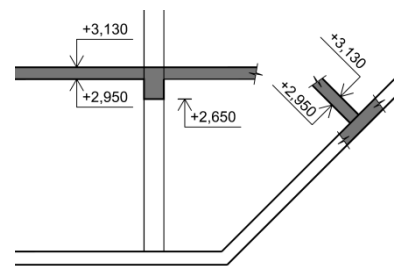
The plan of cast-in-situ stairway is drafted as top view onto the formwork; the stairs are drafted in thin continuous lines. The exact dimensions of stairs shall be presented in the separate detailed drawing.



Obr.2 Příklad zakreslování výkresu tvaru

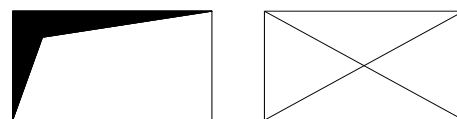
2.2.2. Rotated vertical sections

- Vertical sections are drawn in the plan or outside it for more clarity (if possible in the same sheet)
- Dimensions and elevations shall be included in the section. Relative or absolute elevation of top and bottom surface of concrete shall be provided.
- Lines of plan are not interrupted by the rotated vertical section.
- Rotated vertical sections are drawn perpendicular to the direction of walls, beams etc.
- Various materials are differentiated in the section by shading or hatching.
- The section goes through entire structure or only through interesting parts of structure to increase clarity of the drawing.



2.2.3. Openings and embedded elements

- Visible outlines of openings in horizontal structure are drawn in thin continuous lines with shaded top left corner (see figure) or the opening is crossed through with thin continuous line. Openings in vertical structures are marked with thin dashed



- b) Extents of a slab can be marked with a diagonal line
- c) If a marking is used on a drawing, the same marking shall be used on other drawings to avoid confusion.
- d) The definition of materials is usually a part of drawing notes above the title block.

4. Reinforcement drawing

A reinforcement drawing shall demonstrate the following:

- a) Position of reinforcing bars or other reinforcing elements and the position of other elements embedded in the structure
- b) Shape, dimensions and number of reinforcing and other elements
- c) Material of reinforcement
- d) Other specifications of reinforcement
- e) Concrete cover thickness
- f) Definition of prestressing reinforcement for a prestressed structure (type of reinforcement, conditions required for prestressing, type of ducts, transport and storage conditions etc.)
- g) Type of weld and reinforcement welding technology if welded reinforcement is designed

The reinforcement of a structure (or a single element) is projected in a reinforcement drawing generally in elevations and cross sections with the addition of detail of shape and specification of each reinforcement element.

4.1. General principles of drafting of reinforcement

Outlines of the drafted structure or elements are drawn in thin continuous (visible edges) or dashed (invisible edges) lines. The following table offers a guide on drafting of reinforcement.

| Reinforcement type | | Graphical representation | |
|--------------------|-------------------------------------------|--------------------------|--------------|
| | | In cross section | In elevation |
| Standard | Bar, wire | ● | ————— |
| | Mesh | ● — ● — ● | ● — ● — ● |
| Prestressed | Rod, Bar, Wire, Strand (pre-tensioned) | + | - . - . - |
| | Strand (post-tensioned) | ⊕ | |

Tab.4 Značení betonářské a předpínací výztuže

4.2. Drafting principles

4.2.1. Elevations and longitudinal sections

- a) If arrangement of the reinforcement is simple enough, a simplified method of drafting can be adopted. If bars or other elements are placed in a regular pattern, only one such element can be drawn and dimensional lines and text note can be used to indicate the position and arrangement of the same bars.

- b) Prestressing and standard reinforcement can be drawn in the same drawing or (in complex cases) prestressing reinforcement can be drawn separately without standard reinforcement.
- c) Starter bars that are a part of another drawing are drawn in thick dashed line with proper notation.

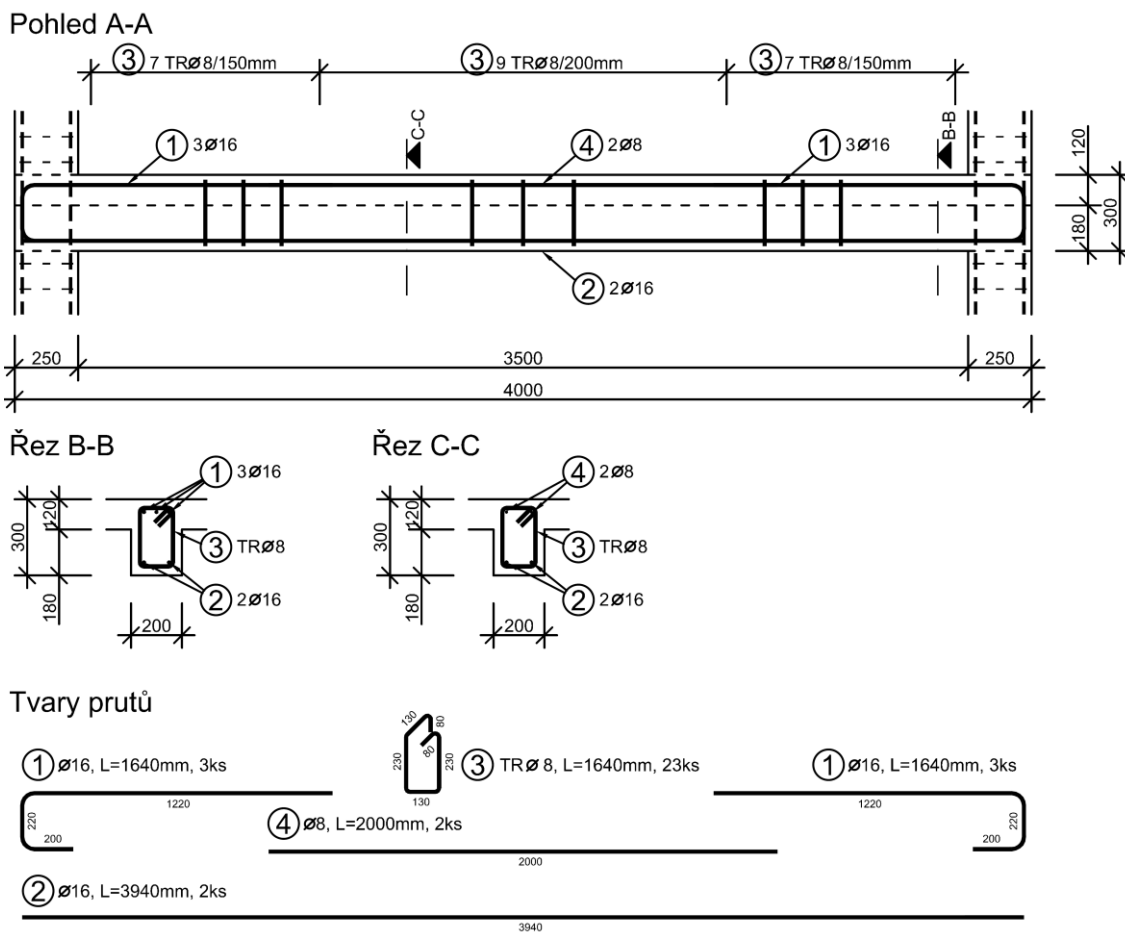
4.2.2. Cross sections

- a) Cross sections shall be provided especially for parts of a structure with a discontinuity, e.g. a change in cross section geometry or arrangement of the reinforcement, openings, gaps, corbels etc.
- b) A cross section contains longitudinal reinforcement, transverse reinforcement, and shear reinforcement.

4.3. Notation of the reinforcement

A unique bar mark shall be provided for each element of a drawing so a bar can be clearly identified across multiple sections or elevations. Other requirements shall be adhered to:

- a) A number of bars, bar diameter and distance between bars shall be provided.
- b) Required concrete cover can be specified by adding a note "COVER" and thickness in mm to the notation of a bar or it can be defined for each surface separately.
- c) Distance between bars or distance from concrete surface can be specified using a dimensional line if needed to assure correct positioning of bars.



Obr.4 Příklad výkresu výztuže trámy

4.4. Bar bending schedule

Bar bending schedule according to appropriate standard is usually required by the manufacturer of the reinforcement. The format and other requirements vary between countries. No further information is provided within this text.

4.5. Typical notes in reinforcement drawings

Notes are typically placed above the title block of a drawing. Notes should contain the following:

- Principles of overlapping of the reinforcement – minimal lap lengths according to bar diameter
- Notes for bending of reinforcement – for example radii of curvature for all bar diameters used and other information. This might be replaced with a reference to an appropriate technical standard.
- Reference to other relevant drawings in case when the reinforcement is drafted at multiple sheets.
- Specification of the reinforcement (B500B etc.)
- Specification of concrete (strength class, aggressivity of the environment, maximum diameter of aggregate, required concrete cover etc.)