DESIGN PRINCIPLES FOR STEEL STRUCTURES

1. What Is a Steel Structural System?

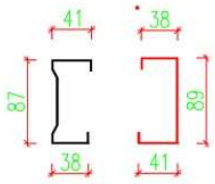
This system is a complete load-bearing structural system designed for the construction of residential, industrial and agricultural buildings.

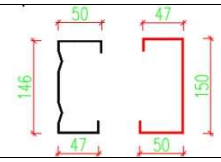
It is a framed (wall-based) load-bearing system in which the individual components — profiles made from galvanised steel sheet, with a C-shaped cross-section — are connected to one another using fasteners (self-tapping screws and bolts), thereby forming a relatively rigid wall structure.

The resulting frame structure is then filled with mineral fibre thermal insulation and clad on both sides with plasterboard, gypsum fibreboard or wood-based OSB (oriented strand board) panels. This creates a rigid core to which, in the next stage of construction, an external thermal insulation composite system (ETICS) is applied on the outside, while an internal finishing structure, generally consisting of plasterboard, is installed on the inside (an internal lining wall).

The cladding process is therefore essentially the same as that used in timber-frame construction. The only difference lies in the material used for the frame itself: the aforementioned steel sheet.

The profiles are manufactured by progressively forming a steel coil using a roll-forming machine. We supply two types of these C-profiles, corresponding to the depth (width) of the structure itself: **89 mm and 150 mm***. Their basic technical parameters are provided in the table below.

C-profile 89	Sheet thickness	Steel grade	Weight per linear metre	Zinc coating
	0.75 mm	S 550	1.107	Z 275
	0.95 mm	S 550	1.402	Z 275
	1.15 mm	S 550 / 350	1.697	Z 275
	1.55 mm	S 350	2.287	Z 275
	1.95 mm	S 350	2.878	Z 275

C-profile 150	Sheet thickness	Steel grade	Weight per linear metre	Zinc coating
	1.15 mm	S 350	2.390	Z 275
	1.95 mm	S 350	4.005	Z 275

2. Substrate Flatness

Requirements for the accuracy of execution, strength and dimensions of the concrete foundation

ČSN and EN standards do not provide a uniform approach to measuring local surface flatness.

This document establishes the criteria and requirements for measuring the flatness and local flatness of substrate surfaces, taking into account the requirements of the following standards: ČSN 73 0205, ČSN 73 0212-3, ČSN 74 4505, ČSN EN 13670 and DIN 18202.

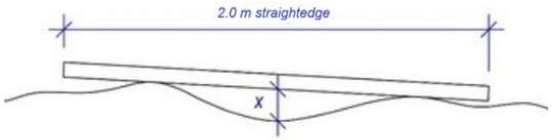
Local surface flatness is checked over a reference length of 2 m. Measurement using a 2 m straightedge is recommended.

All flatness requirements specified in this document are expressed as maximum permissible values, while requirements for substrate dimensions and strength are expressed as minimum values.

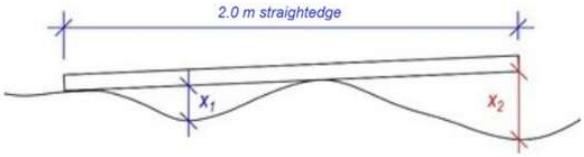
The specified requirements for the concrete foundation must be met before installation work begins.

2.1 Requirements for the Flatness of the Concrete Foundation Surface

The flatness of the upper surface of the foundation shall be measured at a minimum of five locations for every 100 m^2 of foundation area, specifically at locations beneath the future walls of the above-ground structure assembled from cold-formed steel profiles.
Substrate flatness shall be assessed using a 2.0 m straightedge, as illustrated in the following diagrams:



The measured deviation is dimension **x.**

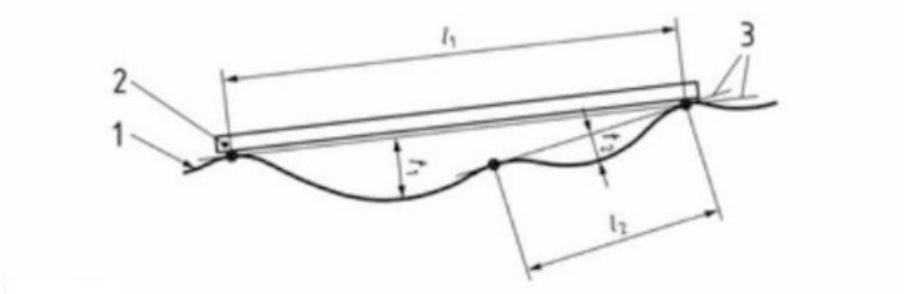


The measured deviation is dimension $\mathbf{x_1}$. Deviation $\mathbf{x_2}$ is not taken into account.

The following maximum permissible deviations in local flatness apply to the upper edge of the foundation over a length of 2.0 m:

- **X = 3.0 mm**, where the base track of the assembled structure is anchored at finished floor level.
- **X = 5.0 mm**, where the base track of the assembled structure is anchored at the top surface of the foundation before the floor is installed.
  To compensate for minor surface irregularities, it is recommended that the base track of the assembled structure be installed over a strip of modified bitumen membrane.

For the flatness of the upper edge of the foundation over a length of 10.0 m, the maximum permissible deviation between the ends of the straightedge is specified.



Legend
1 Surface of the area being measured
2 Measuring straightedge
3 Plane of the underside of the measuring straightedge
l_1, l_2 Length of the measuring straightedge
t_1, t_2 Deviation between the measured surface and the underside of the straightedge

Maximum permissible deviation over a length of 10 m:

- **t = 20 mm** for an unfinished upper foundation surface (rough surface).
- **t = 15 mm** for a finished upper foundation surface (smooth concrete surface).
- **t = 12 mm** for a surface with the finished floor in place.

2.2 Requirements for the Compressive Strength of the Concrete Foundation Surface

The concrete at the foundation surface shall have a **minimum compressive strength of 25 MPa.**

2.3 Requirements for the Thickness of the Concrete Foundation

The **minimum required thickness of the foundation structure is 180 mm.**

The required foundation thickness is determined by the need to anchor the above-ground structure using mechanical or bonded anchors with diameters of Ø10 mm or Ø12 mm. The anchor dimensions and lengths shall be specified by the structural engineer.

The foundation thickness shall be designed by the structural engineer in accordance with the required load-bearing capacity; however, the minimum thickness must be **180 mm**.

To optimise the anchoring arrangement and increase the load-bearing capacity of the anchors (or potentially allow shorter anchors to be used), reinforcement of the foundation structure at both the bottom and top surfaces using reinforcing steel is recommended.

3. Principles for the Structural Design of the Steel System

As mentioned above, once the individual profiles have been assembled together (see Fig. 1), they form planar (2D) frames — walls and floor or roof trusses (see Fig. 2).

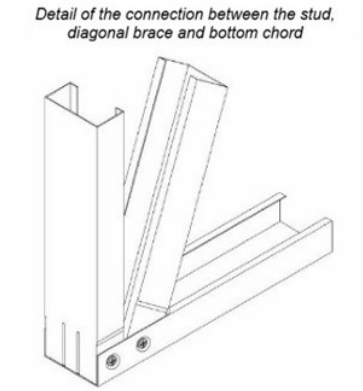


Fig. 1 – Detail of the connection between profiles at the corner of a framed wall

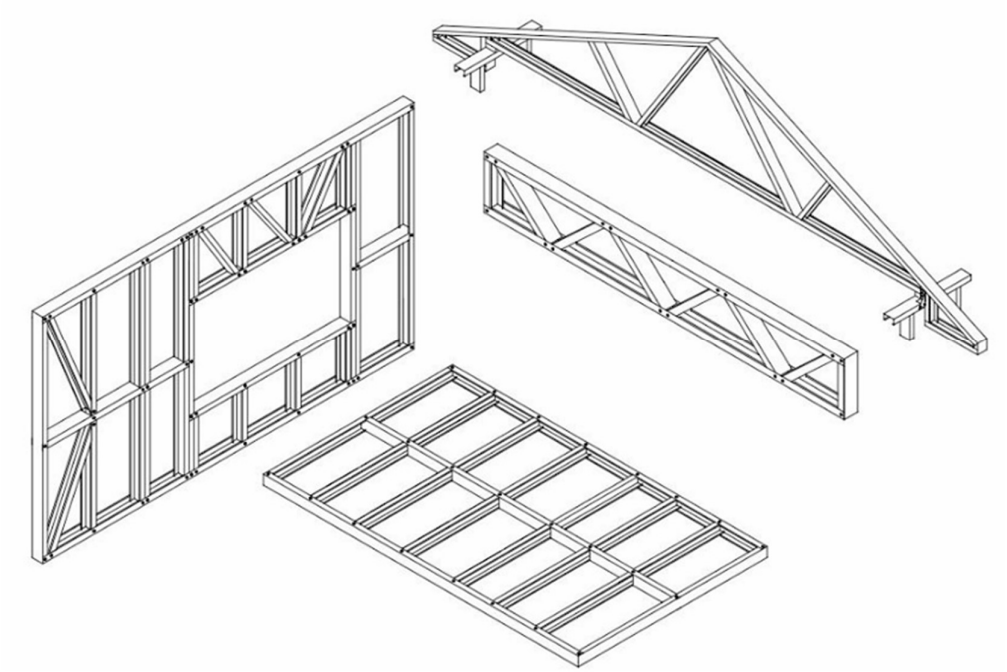


Fig. 2 – Range of planar (2D) frame elements: walls, floor and roof trusses, smart panels, etc.

The individual frames are then connected to one another using flat connecting elements (splice plates) (see Fig. 3) or bolts, thereby forming three-dimensional (3D) structures. Once clad with structural panels (OSB or gypsum fibreboard), these structures become highly rigid.

These structures can therefore generally be designed for multi-storey buildings of up to six above-ground storeys. The specific structural design and selection of the profile series must always be determined on the basis of a structural analysis.

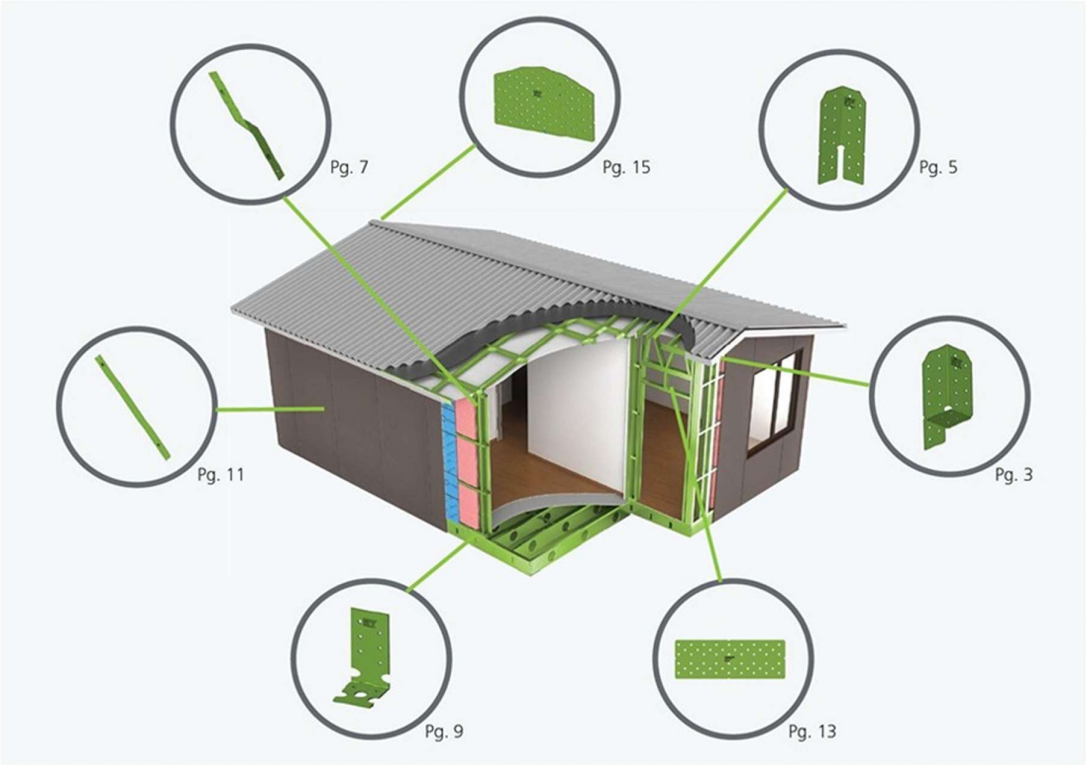


Fig. 3 – Range of 2D and 3D connection hardware supplied by Framecad, including proprietary splice plates

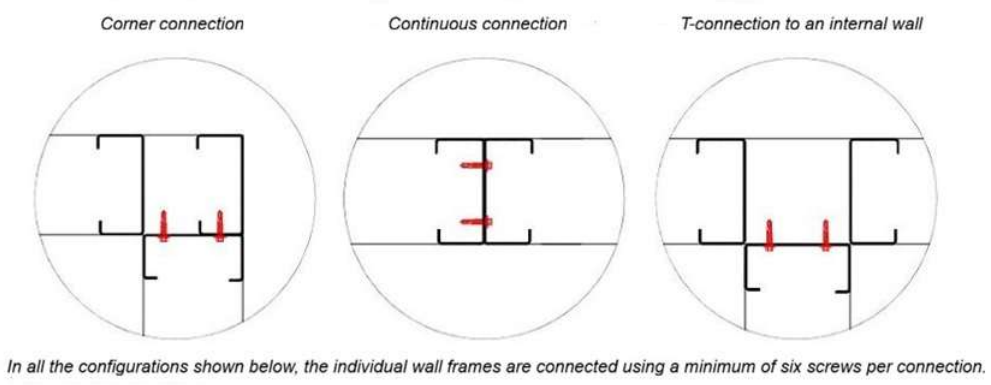


Fig. 4 – Detailed view of a typical connection between individual wall frames using self-tapping screws.

This system allows the truss-based structural system to be used to construct columns, walls, floors, roofs and frames for industrial or commercial buildings such as halls.

Anchoring Walls to the Substrate

Wall frames must always be anchored to a load-bearing substrate (concrete or reinforced concrete) using anchoring brackets with washers and suitable concrete anchors (see Fig. 5).

The type and number of anchors, as well as their embedment lengths, shall be determined individually by the structural engineer and specified in the fabrication documentation for each project.

As a general guideline, anchoring brackets with washers and concrete anchors are positioned adjacent to the studs of the wall frame and spaced no more than **900 mm apart**. The ends of each wall frame must also be anchored, as must both sides of every door opening.

The maximum distance between an anchor and the adjacent stud is **90 mm**.

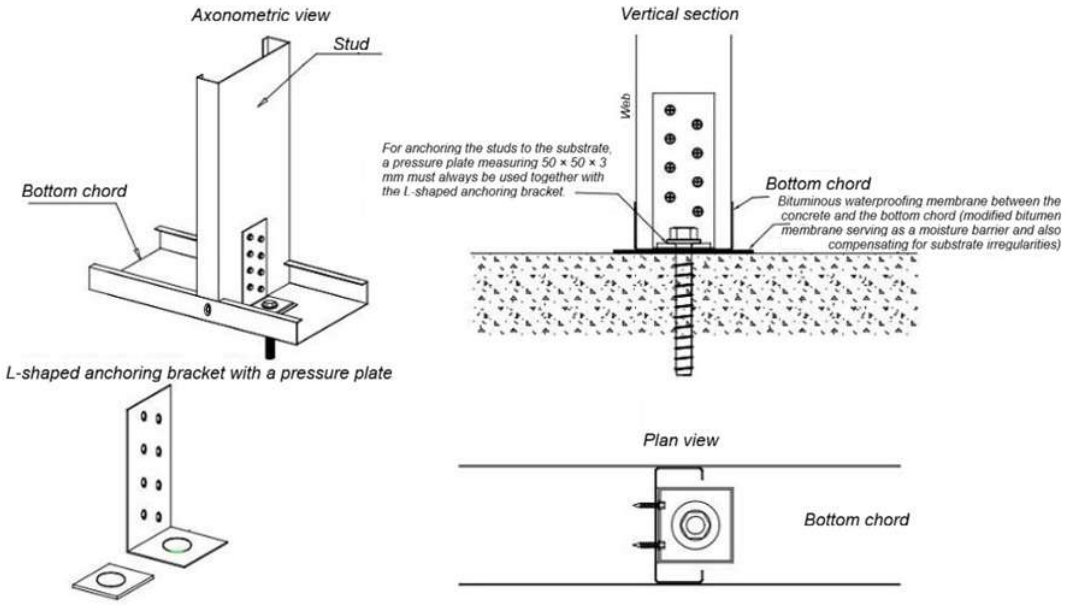


Fig. 5 – Axonometric view, vertical section and plan view of the anchoring of wall-frame studs

Wall Frames

Wall frames define the perimeter of the building and divide the internal space into separate areas. The dimensions of each wall frame are determined individually for each project, subject to the following maximum dimensions:

Maximum dimensions of a load-bearing wall frame:

- **Length:** 6.0 m
- **Height:** 3.0 m

These maximum wall-frame dimensions are limited by transportation constraints, handling restrictions in the workshop and on site, and, in particular, the panel dimensions prescribed for fire testing at an accredited testing laboratory, with panel height being the limiting factor.

Both the perimeter frame and the internal vertical studs of the wall are made from C-profiles, positioned at a maximum centre-to-centre spacing of **625 mm** (or less). This spacing is determined by the standard dimensions of the sheet materials used to clad the walls, floors and roofs of the structure.

Floor, Ceiling and Roof Trusses (Trussed Frames)

The trussed frames used for floors, ceilings and roofs are essentially constructed in the same way as wall frames, but have a significantly reduced depth, typically starting at approximately 300 mm.

The perimeter frame of each truss, as well as its internal diagonal braces, is also made from C-profiles. The slope and number of braces are determined by structural calculations.

The spacing between individual truss elements installed on top of the wall frames is also **625 mm**, or preferably twice this distance (**1,250 mm**). In the latter case, the structure is supplemented with so-called **smart panels** (horizontal frame elements connected to a trussed frame, forming a T-shaped assembly). This arrangement provides optimum bracing for the ceiling or roof when the trusses are spaced at twice the standard distance.

When designing the trussed frames for floors, ceilings and roofs, it is recommended that the centre lines of these elements align with the centre lines of the studs in the wall frames to ensure optimum transfer of internal forces.

Connecting (Trussed) Frames

As explained in the previous section, the high rigidity of the load-bearing steel structure is ensured by the proprietary splice-plate connection hardware used to join the individual frame elements, together with the associated fasteners.

A comprehensive overview of the components and the connections between the individual frame elements is provided in Figures 6, 7 and 8.

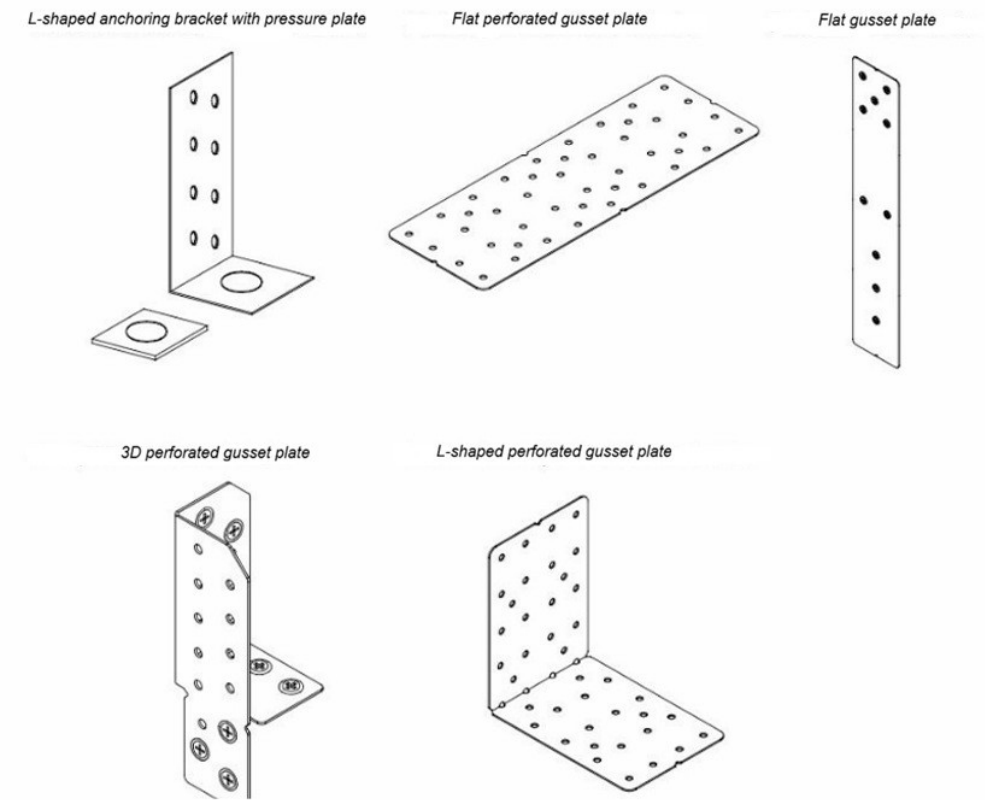


Fig. 6 – Detailed view of the range of splice-plate connection hardware supplied by Framecad

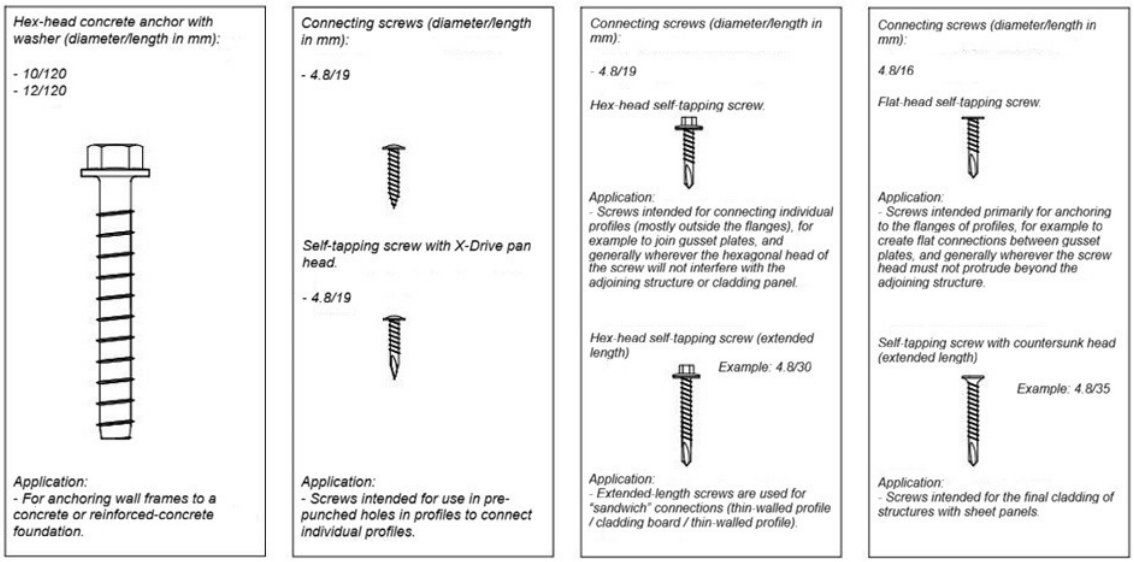


Fig. 7 – Range of fasteners used to connect frame elements and splice-plate connection hardware

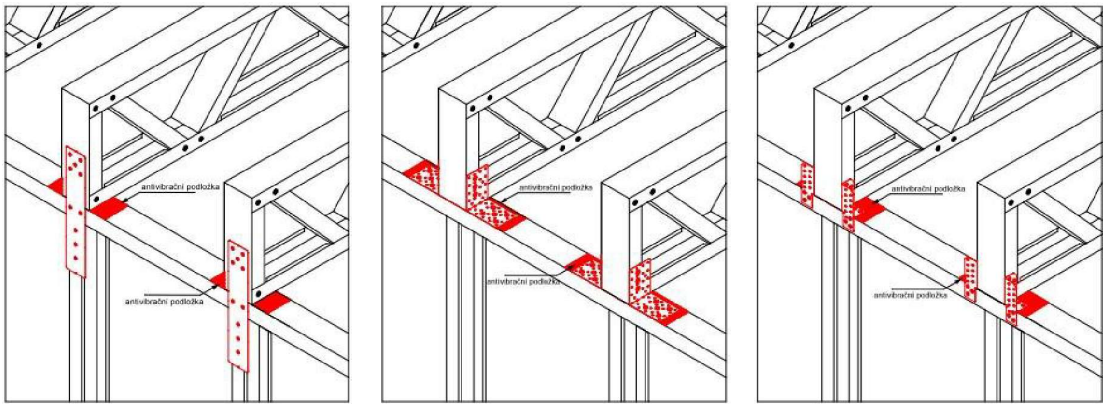


Fig. 8 – Possible applications of splice-plate connection hardware for connecting floor or roof trusses to wall frames

Sizing of Floor and Roof Trusses

The table below provides indicative depths (heights) for floor and roof trusses designed to span specific building widths. The actual dimensions of the structural members must always be verified by structural calculations.

The loads expressed in kPa correspond to uniformly distributed line loads per linear metre of truss length, including both permanent and variable loads (snow).

Permanent load (kPa)	Variable load (kPa)	System width (depth) (mm)	Material thickness / steel grade	Truss spacing (mm)	Object span (m)	Truss depth (mm)
1	2	89	1.15/ 350	625	6	300
1	2	89	1.15 / 350	625	7	350
1	2	89	1.15 / 350	625	8	450
1	2	89	1.15 / 350	625	9	600
1	2	150	1.15 / 350	625	8	450
1	2	150	1.15 / 350	625	9	550
1	2	150	1.15 / 350	625	10	650
1	2	150	1.15 / 350	625	11	750
1	2	150	1.15 / 350	625	12	900

*The truss depths listed above apply to trusses with reinforced top and bottom chords.