

REINFORCED CONCRETE **WALL ELEMENTS**

AS Tartu Maja Betoontooted manufactures wall elements according to the requirements of standards EVS-EN 14992 Precast concrete products – Wall elements and EVS-EN 13369 Common rules for precast concrete products:

- 1) three-layer thermo-insulated exterior wall elements, i.e. sandwich-wall elements (hereinafter referred to as SW-wall elements), to the bearing interior layer of which a non-bearing exterior layer has been hung by stainless steel anchors;
- 2) solid wall elements.

M A T E R I A L S

The following materials are used for manufacturing wall elements:

- normal-weight concrete with the strength class of at least C25/30 in the interior layer, which manufacturing process and qualities correspond to the requirements of standard EVS-EN 206-1 Concrete - Specification, performance, production and conformity;
- designed concrete with the strength class of at least C30/37 in the exterior layer, the manufacturing process and characteristics of which correspond to the requirements of standard EVS-EN 206-1 Concrete - Specification, performance, production and conformity;
- reinforcing steel for reinforcement, the characteristics of which conform to standard EVS-EN 10080 Steel for the reinforcement of concrete - Weldable reinforcing steel - General;
- non-combustible glass or mineral wall sheets are used for thermal insulation of SW-wall elements, which are supplied with ventilation grooves in order to avoid the condensation of moisture from rooms in the infilling. Basement wall elements are usually thermo-insulated with polystyrene foam.



P R O D U C T I O N A N D S U R F A C E F I N I S H

Wall elements are cast on heated inclinable steel stands (moulds) by moulding with formwork. Wooden bearers and veneer are used as formwork, the formworks are fixed to steel stands with magnetic locking devices.

Wall elements are usually reinforced as follows:

- 1) bearing interior layer of SW wall elements with welded fabric in two layers;
- 2) non-bearing exterior layer with welded fabric in one layer;
- 3) peripheral bars around the slab and the perimeter of the openings.

Wall elements, which have been designed as a concrete structure, shall be reinforced only with peripheral bars. The reinforcement also depends on the fact, whether the exterior layer is considered to be co-operative or not.

Fresh concrete is compacted with high-frequency vibration. The demoulding strength of hardened concrete is at least 15 MPa.

The facade surface of wall elements is usually formed against a smooth steel mould, the interior surface is finished manually by steel rubbing.

Finishing possibilities of the facade layer of wall slabs:

- 1) mould surface;
- 2) exposed aggregate surface concrete
 - a) exposed aggregate surface (depth over 2 mm)
 - b) fine exposed aggregate surface (depth under 2 mm);
- 3) brushed surface;
- 4) rolled surface;
- 5) painted surface;
- 6) coloured concrete surfaces (pigment concrete);
- 7) lazure finished surface;
- 8) white concrete surface;
- 9) terrazzo surface
- 10) impregnated surface.

In the case of exposed aggregate surface concrete, it is possible to obtain different colours by using crushed stones of different colours. The requirements for surface finish are listed in Appendix 2 (by 40 class A).

Q U A L I T Y

The quality of wall elements is secured by designing methods and factory production control. The factory production control includes regular control of the used equipment and the production process itself and testing of raw materials.



PRODUCTION TOLERANCES

The values of the production tolerances indicated in figure 1 and presented in Tables 1a, b and c, correspond to the requirements of standard EVS-EN 14992 Precast concrete products - Wall elements.

Table 1a.

Tolerances of positioning of openings (e), inserts, connectors and junction boxes (t)

Class	Tolerance limit, mm
A	+/- 10
B	+/- 15

In case there are special requirements for the position tolerance of inserts and connectors, they are shown on product blueprint.

Table 1b.

Tolerances of dimensions (L, l), height (H, h), thickness (B) and rectangularity (d₂-d₁)

Class	Tolerance limit, mm				
	Length, m				
	0-0,5	0,5-3,0	>3,0-6,0	>6,0-10,0	>10,0
A	+/- 3 ^a	+/- 5 ^a	+/- 6	+/- 8	+/- 10
B	+/- 8	+/- 14	+/- 16	+/- 18	+/- 20

a +/- 2 mm when finishing with small cladding

Special requirements for tolerances must be indicated in the technical records. The nominal measurement of the concrete cover of the reinforcement must be at least the minimal thickness of the concrete cover according to its durability plus minimal tolerance limit.

Table 1c.

Tolerances of surface undulation (f) and side warp (a, a₁)

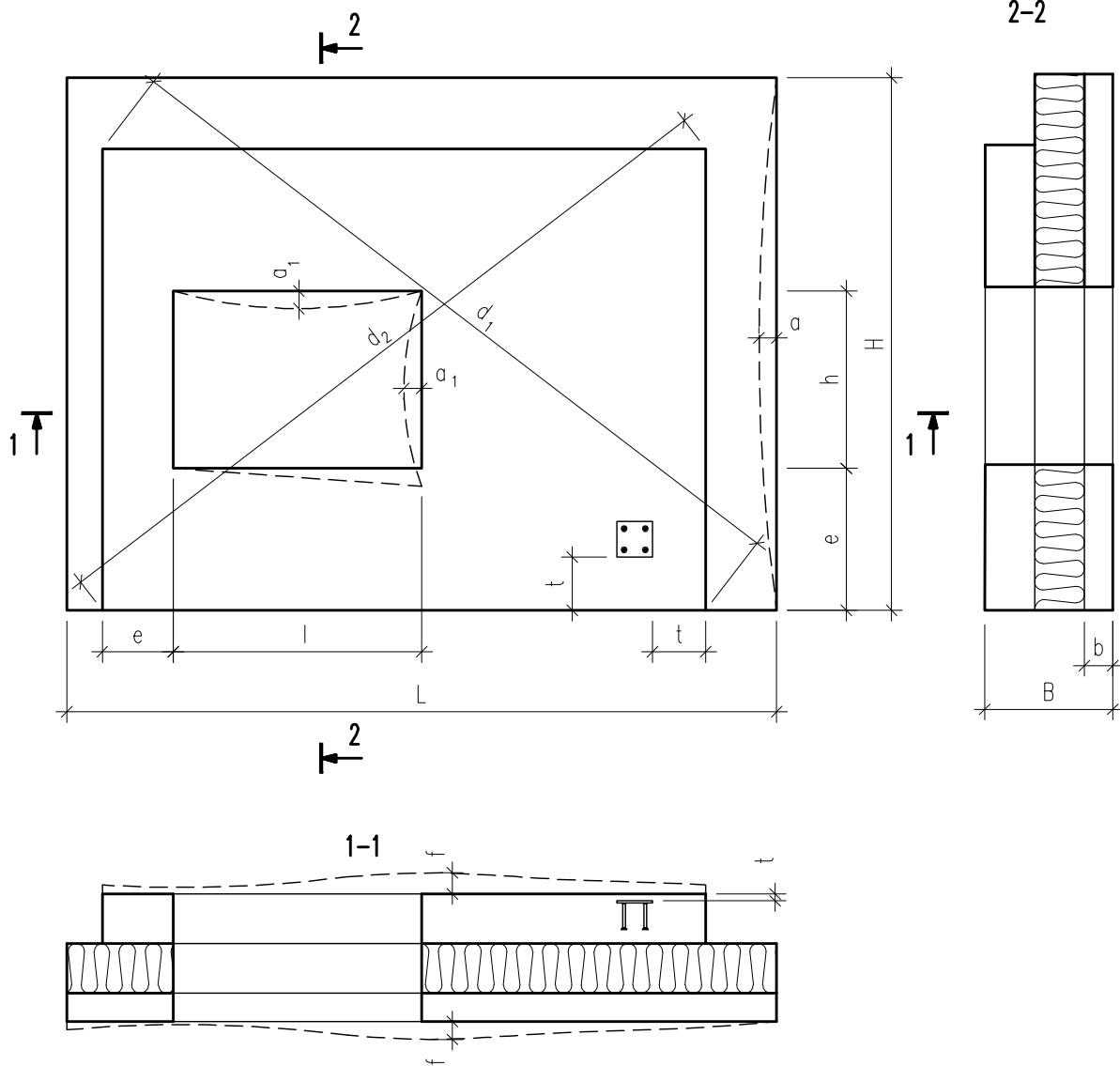
Class	Length of the reference ruler, m	
	0,2	3,0
A	2 mm	5 mm
B	4 mm	10 mm

Class A - mould surfaces

Class B - other surfaces: steel-rubbed, rolled, brushed

Figure 1.

Symbols in tolerance tables





**FIRE RESISTANCE,
SOUND AND THERMAL INSULATION
QUALITIES**

Fire resistance, sound and thermal insulation qualities of the wall elements correspond to the requirements of standards EVS-EN 14992 Precast concrete products - Wall elements.

Fire resistance classes have been determined according to standard EVS-EN 1992-1-2 Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design; the acoustic qualities are determined according to standard EVS-EN 12354-1 Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 1: Airborne sound insulation between rooms and the thermal insulation qualities are determined according to standards EVS-EN ISO 6946:2004 Building components and building elements – Thermal resistance and thermal transmittance. Calculation method and EVS-EN ISO 10456 Building materials and products - Hygrothermal properties - Tabulated design values and design thermal values.

The results are indicated in Tables 2 and 3.

Table 2.

Fire resistance and acoustic qualities of single-layer non-bearing interior walls

Thickness of the reinforced concrete wall element (mm)	Fire resistance class		Airborne sound insulation index R_w (dB)
	Non-bearing interior walls	Load-bearing interior walls	
80	EI 60	-	42
100	EI 90	REI 30	46
120	EI 120	REI 60	49
150	EI 180	REI 90	53
180	EI 240	REI 120	56
200	EI 240	REI 180	57

Table 3.

Thermal insulation qualities of three-layer sandwich-slabs

Thickness of the insulation layer (mm)	Thickness of the exterior and interior reinforced concrete layer of the wall element (mm)	Total thermal resistance R_T (m^2K/W)	Thermal conductivity U $W/(m^2K)$
Glass wool sheet ISOVER OL-E $\rho=0,037$ W/mK	Concrete that includes 2% of reinforcing steel $=2,5$ W/mK		
100	Exterior layer 80	3.09	0.32
120		3.63	0.28
140		4.17	0.24
150		4.44	0.23
180		5.25	0.19
Polystyrene foam EPS 100 $\rho=0,037$ W/mK	Interior layer 140 ¹		
50		1.58	0.63
75		2.26	0.44
100		2.93	0.34
125		3.47	0.29
150	4.28	0.23	

¹ In calculations, the thickness of interior layer is 140 mm. In the case of different thicknesses of interior layer, the difference of thermal resistance and thermal conductivity is under 2%.

BASIC OF WALL ELEMENTS

Wall elements can be divided as follows:

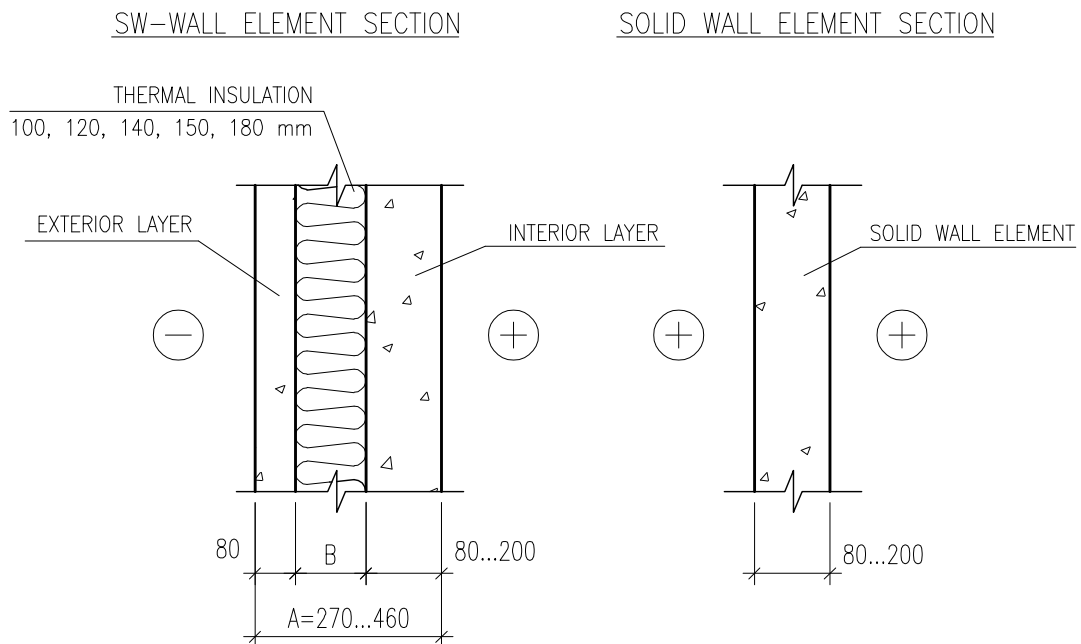
- 1) load-bearing elements;
- 2) non-bearing elements;
- 3) elements reinforcing the load-bearing structures of a building, i.e. diaphragms of structure.

The approximate thicknesses of wall elements are 80–460 mm (Figure 2).

The determining factors at the selection of the thickness of interior wall elements are sound insulation, fire resistance and structural requirements, in some cases also load-bearing capacity. The most important requirement for SW-wall elements is thermal transmittance.

Figure 2.

Cross-sections of wall elements



The maximum overall dimensions of wall elements are 4,000 x 11,000 mm and the maximum weight is 12 tons. The minimum thickness of the exterior layer is 80 mm. It is recommended to avoid designing elements that are over 6 m long or to divide the exterior layer into smaller sections by dummy joints in order to avoid possible formation of cracks in the exterior layer caused by volume shrinkage or temperature changes.



U S A G E

Wall elements are used mainly at the construction of dwelling houses but also non-residential buildings. The building speed will increase considerably by building from precast wall elements, whereas it is possible to produce the exterior enclosures of a building with an adequate heat retention, which is very important in terms of energy conservation. Also, the exterior facade of a building with exterior walls made of SW-wall elements does not need any supplementary finishing.

It is also possible to install electric and communication installation channels into wall elements already in the factory. The upper edges of wall elements can be supplied with erection anchors (VEMO), where later the safety barriers can be attached.

T R A N S P O R T A T I O N A N D S T O R A G E

Wall elements can be hoisted and transported only in the vertical position, hoisting them from hoisting eyes. A special so-called slab-comb or storage trestle is used for storage. SW-wall elements must not be supported by a non-bearing exterior layer.

A S S E M B L I E S

Figures 3–9 show the typical solutions for connecting two wall elements or wall elements with ceiling slabs by using corner assemblies.

Figures 10–13 show the example of wall elements (three-layer SW-wall element or solid wall element) with reinforcement.

Figure 3.

Corner assembly of SW-wall elements

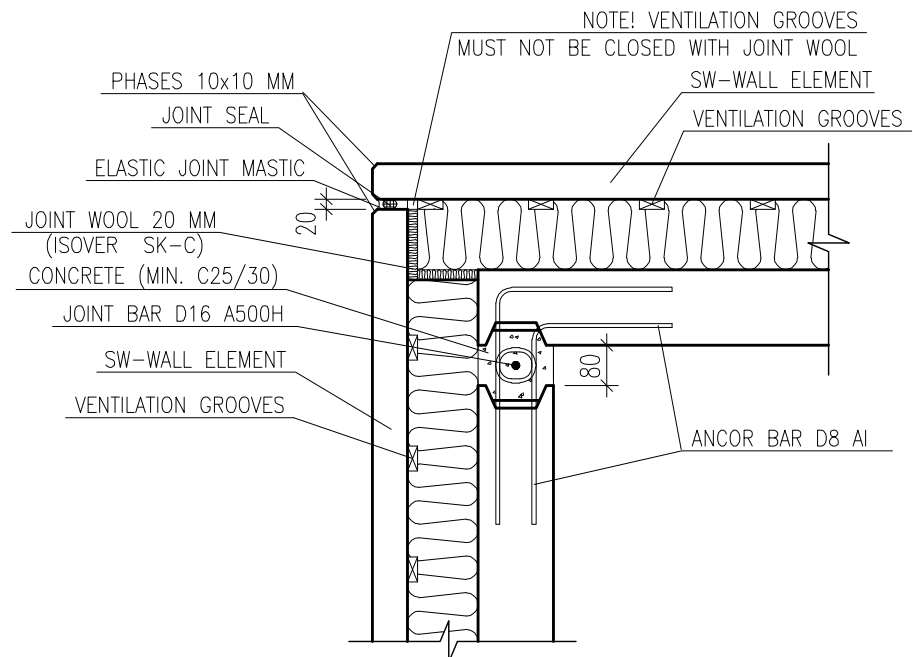


Figure 4.

Connection assembly of two SW-wall elements

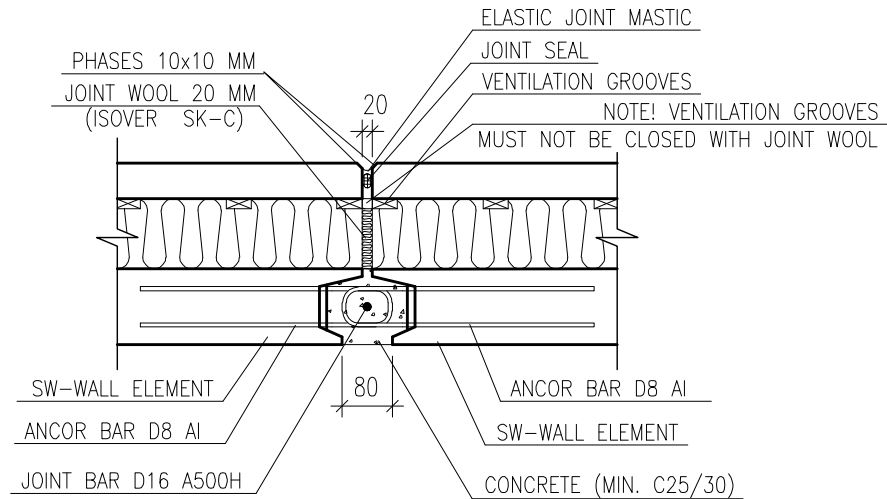


Figure 5.

Connection assembly of two SW-wall elements and an solid wall slab

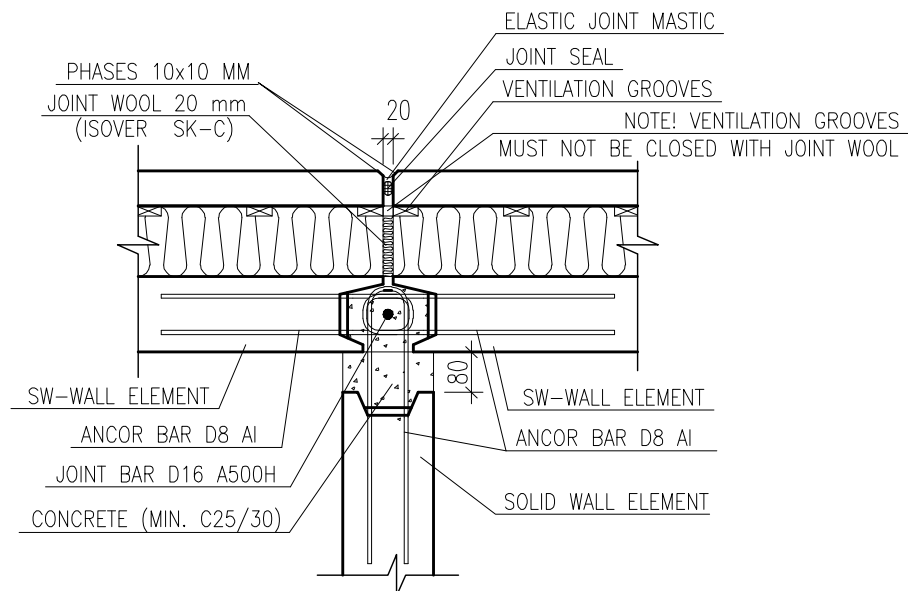


Figure 6.

Connection assembly of
solid wall and ceiling slab

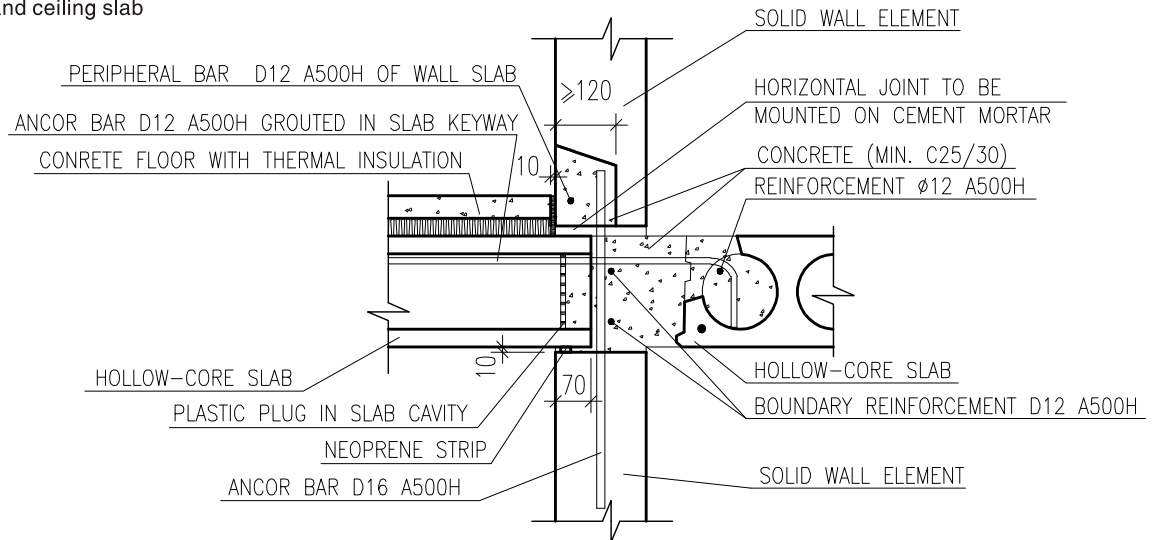


Figure 7.

Connection assembly of
solid elements and ceiling
slabs

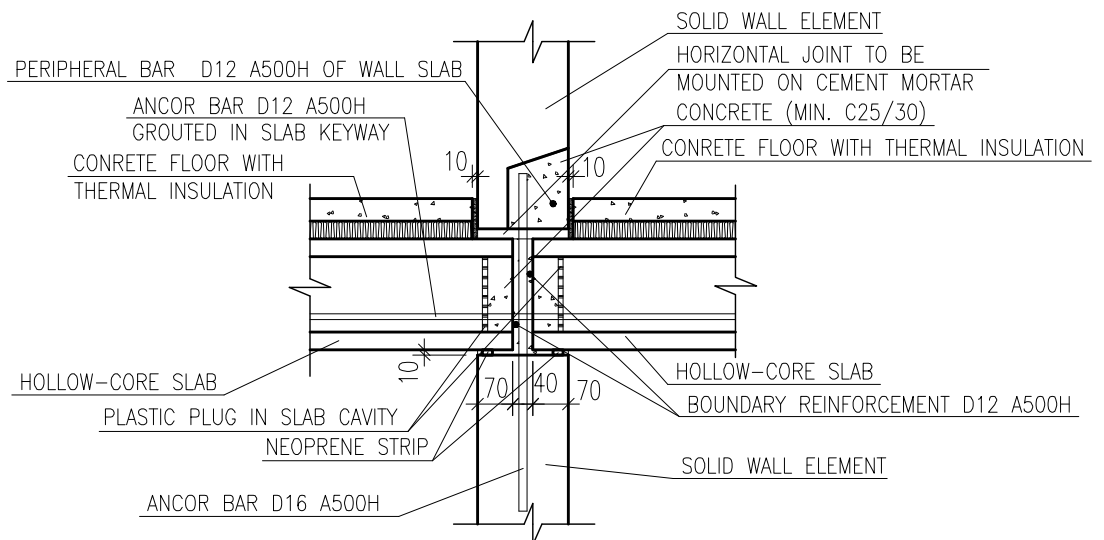


Figure 8.

Connection assembly of a non-bearing SW-wall element and a ceiling slab

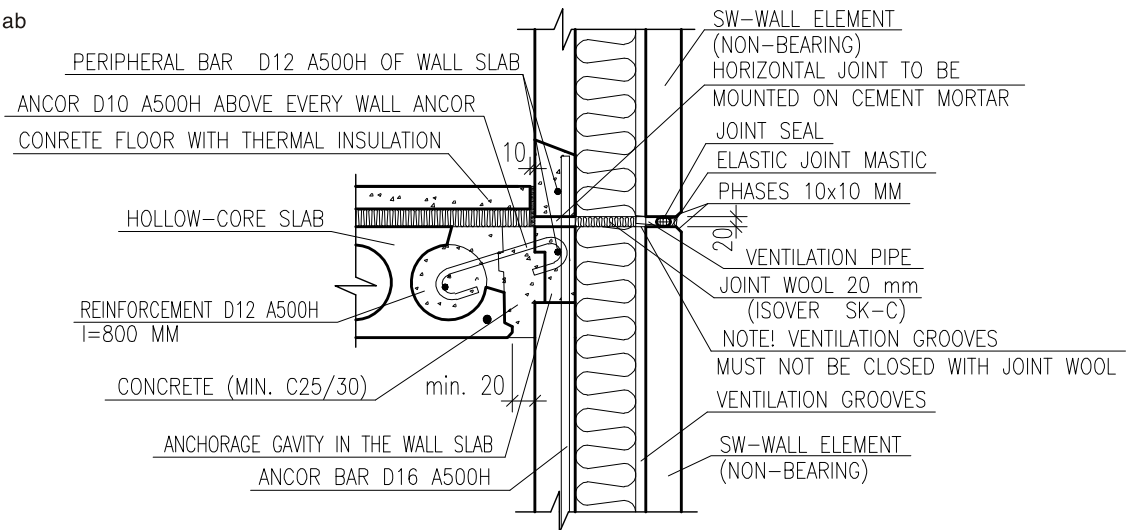


Figure 9.

Connection assembly of a load-bearing SW-wall slab and a ceiling slab

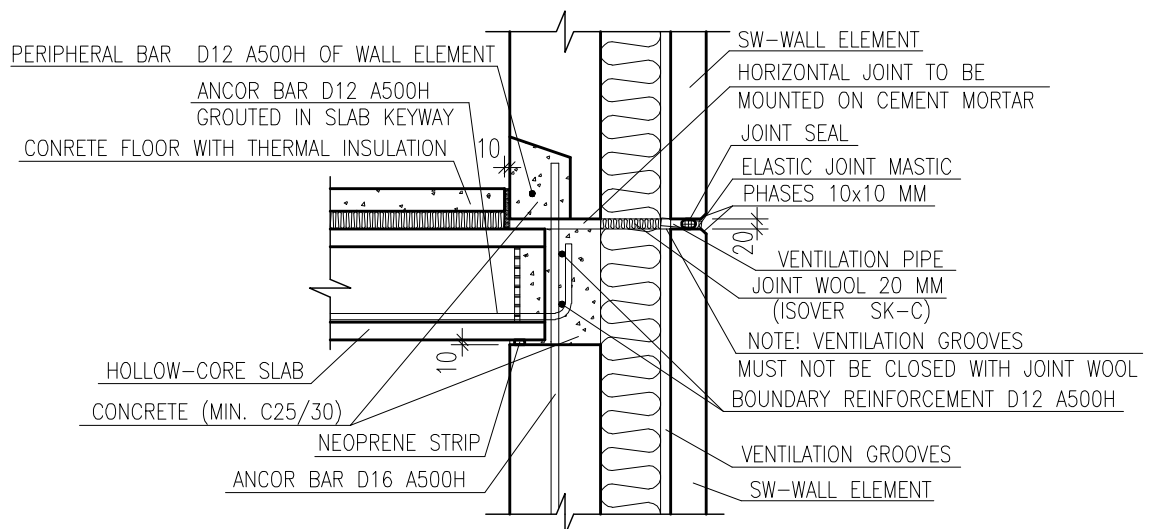


Figure 10.
Three-layer SW wall element

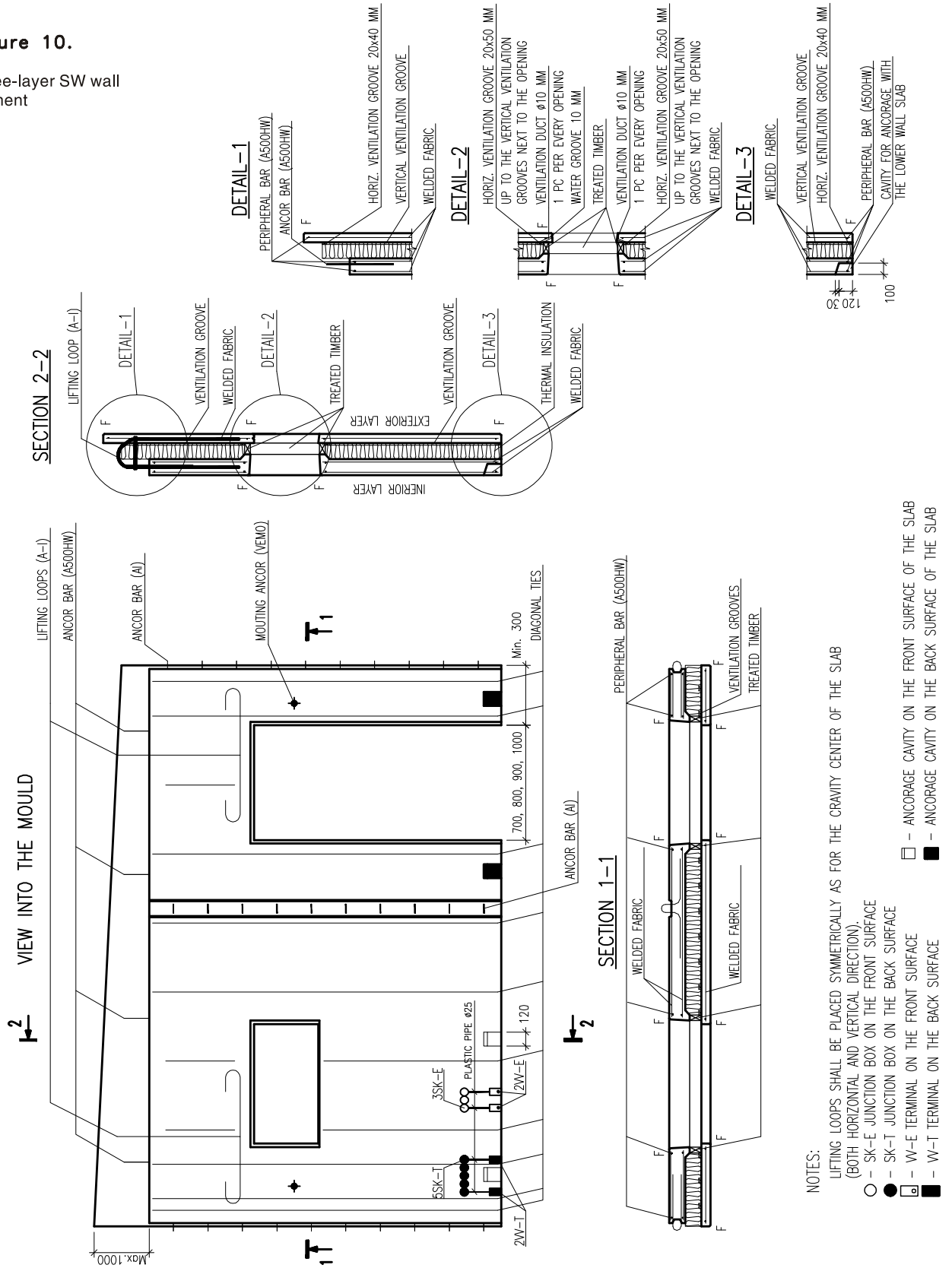
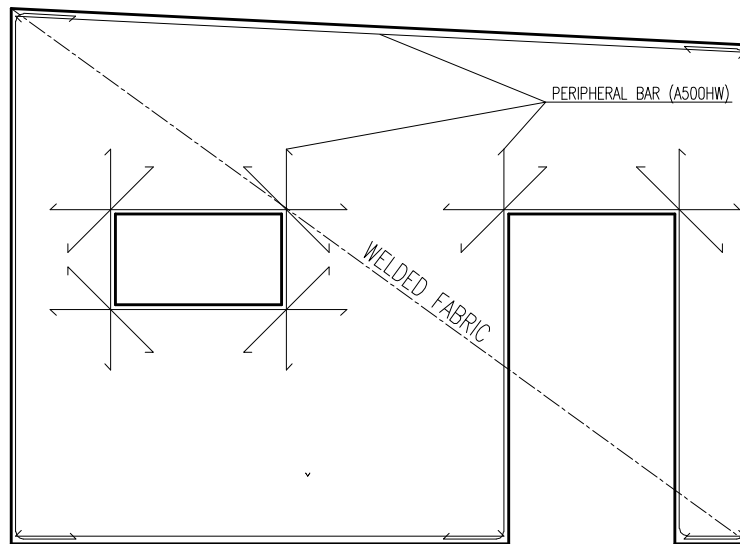


Figure 11.

Reinforcement scheme of
a three-layer SW-wall
element

REINFORCEMENT OF THE EXTERIOR LAYER



REINFORCEMENT OF THE INTERIOR LAYER

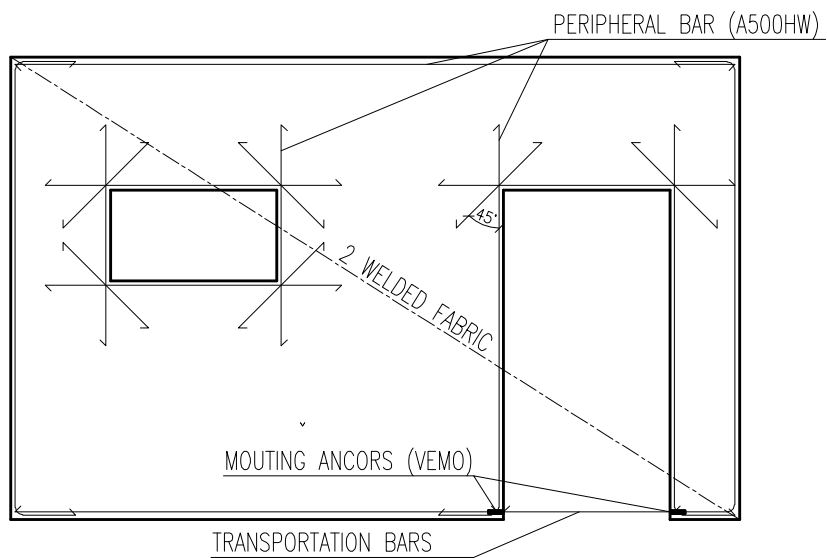


Figure 12.

Solid wall element

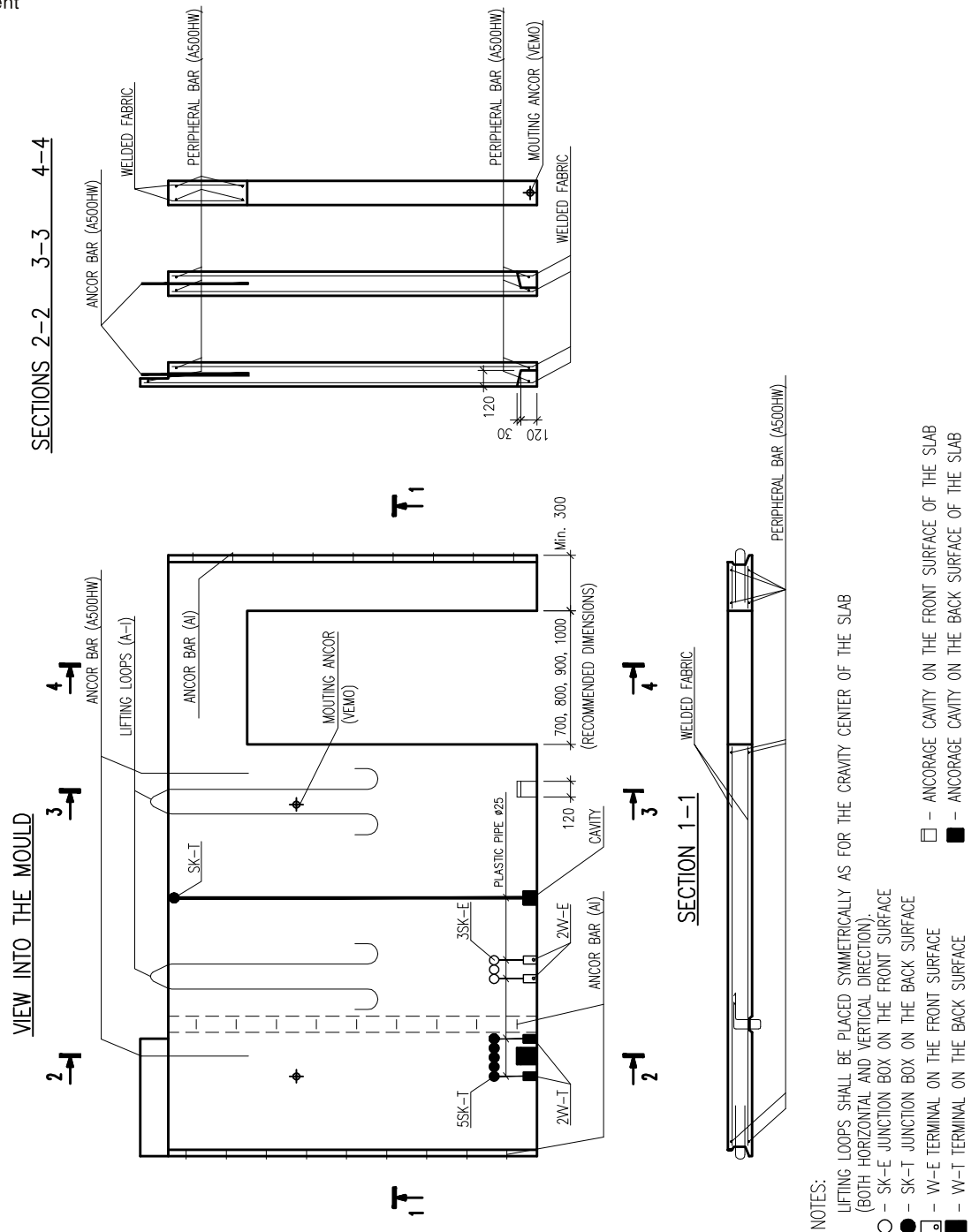


Figure 13.

Reinforcement scheme of
a solid wall slab

