

## REINFORCED CONCRETE **WALL ELEMENTS**

### **GENERAL**

SIA TMB Elements manufactures wall elements according to the requirements of standards LVS EN 14992 "Precast concrete products – Wall elements" and LVS EN 13369 "Common rules for precast concrete products".

In our factory commonly are produced the following types of wall elements:

- 1) three-layer thermo-insulated exterior wall elements, i.e. sandwich-wall elements (SW-wall elements), where facing panel is fixed to base panel with stainless steel anchors;
- 2) solid wall elements (SP-wall elements).

Wall elements can be classified as follows:

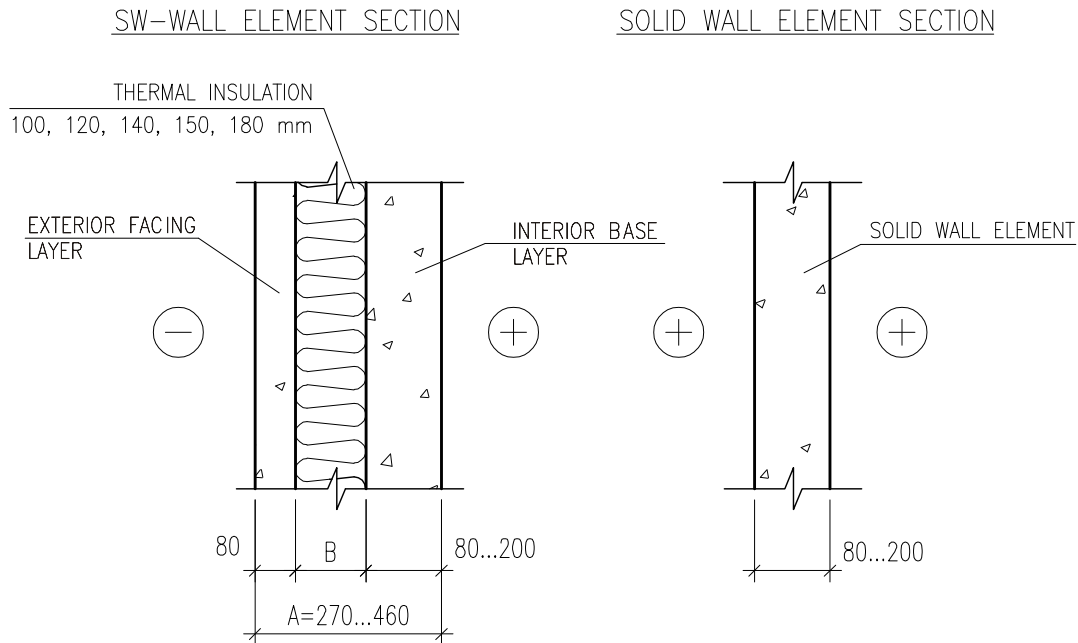
- 1) load-bearing (structural) elements;
- 2) non-bearing elements;
- 3) elements reinforcing the load-bearing structures of a building, i.e. diaphragms of structure.

The approximate thicknesses of wall elements are 80–460 mm (Figure 1).

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

**Figure 1.**

Cross-sections of wall elements



The maximum overall dimensions of wall elements are 4,000 x 11,000 mm and the maximum weight is 20 tons. The minimum thickness of the exterior layer is 70 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.

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.

## U S A G E

Wall elements mainly are used in the construction of dwelling houses and nonresidential buildings as well.

There is several advantages if precast wall elements are used in construction:

- factory controlled conditions. Quality can be controlled and monitored much more easily;
- at production are used only certified raw materials;
- influence of weather at production is eliminated;
- accelerated curing reduce the time between casting of element and putting it into service;
- precast elements can be installed immediately. It results faster construction time;
- it is possible to obtain smoother surfaces and different types of surface finishes as well.

**FIRE RESISTANCE,  
SOUND AND THERMAL INSULATION**

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

Fire resistance classes have been determined according to standard LVS-EN 1992-1-2 "Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design"; the acoustic properties are determined according to standard LVS-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 LVS-EN ISO 6946:2004 "Building components and building elements – Thermal resistance and thermal transmittance. Calculation method" and LVS-EN ISO 10456 "Building materials and products - Hygrothermal properties - Tabulated design values and design thermal values".

The results are indicated in Tables 1 and 2.

**Table 1.**

Fire resistance and acoustic properties 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 2.**

Thermal insulation properties 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 Interior layer 140 <sup>1</sup>	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				
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		

<sup>1</sup> 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%.

**M A T E R I A L S**

**Concrete** for wall elements complies to the requirements of standards LVS EN 206-1 “Concrete - Specification, performance, production and conformity” and LVS 156-1 “Concrete - National annex of Latvian standard to European standard EN 206-1 - Part 1: Requirements for classification and attestation of conformity”.

For SP-wall elements and base layer of SW-wall elements are used **normal-weight concrete** with:

- strength class of at least C25/30 according to LVS EN 206-1.

For facing layer of SW-wall elements are used **normal-weight concrete** with:

- strength class of at least C30/37 according to LVS EN 206-1;
- freezing and thawing resistance class up to F200 according to LVS 156-1 Annex C;
- water vapor permeability coefficient  $5/15$  according to tabulated values of LVS EN 13369 Annex L;
- water absorption up to 6% according to LVS EN 13369 Annex G;
- water impermeability class up to W10 according to LVS 156-1 Annex B.

**Reinforcing steel.** Reinforcement shall conform to standard LVS-EN 10080 “Steel for the reinforcement of concrete – Weldable reinforcing steel – General”.

**Thermal Insulation.** For thermal insulation layer of SW-wall elements are used:

- mineral wool sheets manufactured from molten rock or glass which conform to standard LVS EN 13162 “Thermal insulation products for buildings - Factory made mineral wool (MW) products – Specification”, which are supplied with ventilation grooves in order to avoid the condensation of moisture from rooms in the infilling.
- polystyrene foam sheets which conforms to standard LVS EN 13163 “Thermal insulation products for buildings - Factory made products of expanded polystyrene (EPS) – Specification”.

## PRODUCTION

Wall elements are produced on heated inclinable steel stands (moulds) by moulding with formwork. Wooden structures and veneer are used as formworks which are fixed to steel stands with magnetic locking devices.

Wall elements are commonly reinforced as follows:

- 1) load bearing base layer of SW wall elements with welded fabric in two layers;
- 2) non-bearing face 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, should 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.

When placed concrete is compacted with high-frequency vibration. Surface finishing is discussed more detailed in next section. Concrete curing is secured by cover with plastic sheets to slow down water loss. If there is no specified other curing is provided until concrete strength reaches at least 15 MPa.

## SURFACE FINISH

The facing of SW-wall elements is usually formed against a smooth steel mould, the interior surface is finished manually by troweling.

Finishing of the facing (facade) layer can be perform as follows:

- 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.

## QUALITY

Because precast concrete elements are produced in a controlled environment, they exhibit high quality and uniformity.

The quality of wall elements is based on Factory production control (FPC) including frequent inspection of the testing and measuring equipment, storage and production equipment, raw materials, production processes and finished product.

Our FPC system is certified.

## PRODUCTION TOLERANCES

The values of the production tolerances indicated in figure 2 and presented in Tables 3a, b and c, are based on the requirements of standard LVS-EN 14992 "Precast concrete products - Wall elements".

**Table 3a.**

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 technical specification.

**Table 3b.**

Tolerances of dimensions (L, l), height (H, h), thickness (B) and rectangularity (d<sub>2</sub>-d<sub>1</sub>)

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 <sup>a</sup>	+/- 5 <sup>a</sup>	+/- 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 3c.**

Tolerances of surface undulation (f) and side warp (a, a<sub>1</sub>)

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

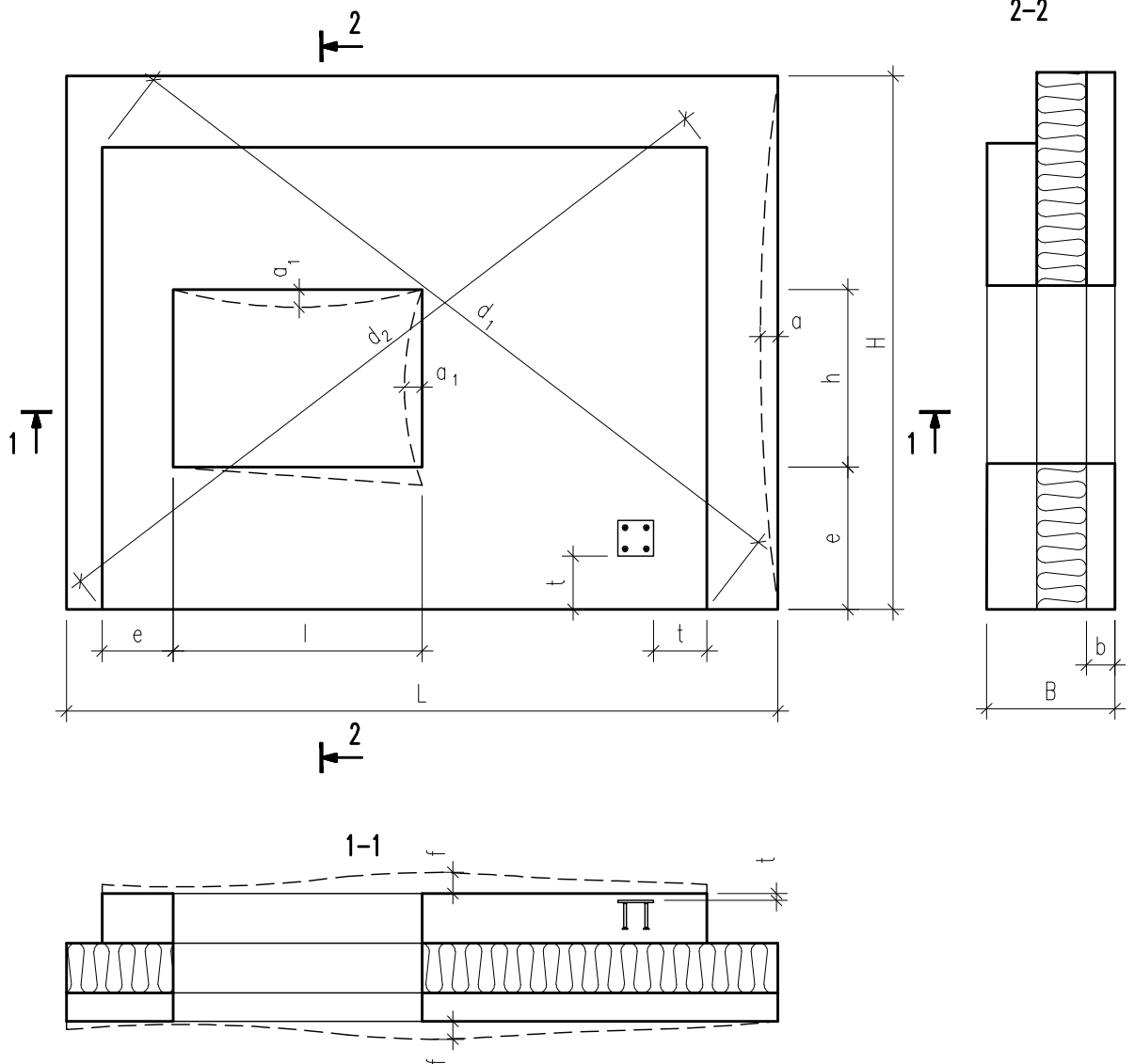
Class A - mould surfaces

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

More detailed explanation of surface characteristics can be found in Appendix 2.

**Figure 2.**

Symbols in tolerance tables



**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 at hoisting eyes. A special so-called slab-comb or storage trestle is used for storage. SW-wall elements must not be supported on a non load bearing facing layer.

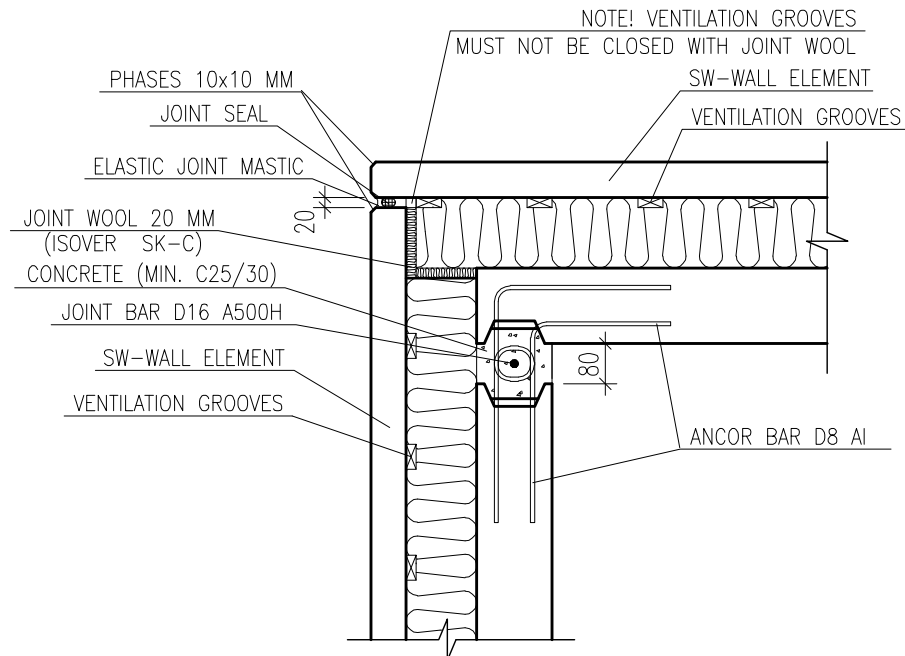
**A S S E M B L I E S**

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.**

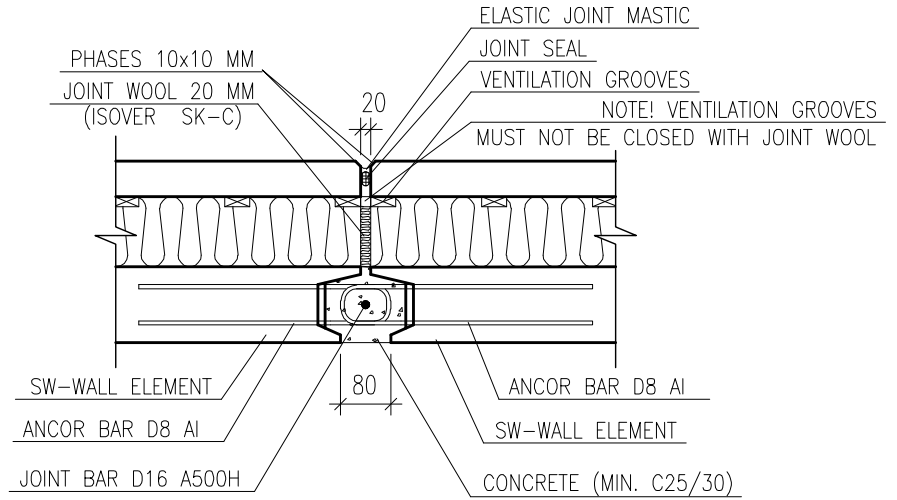
Corner assembly of SW-wall elements





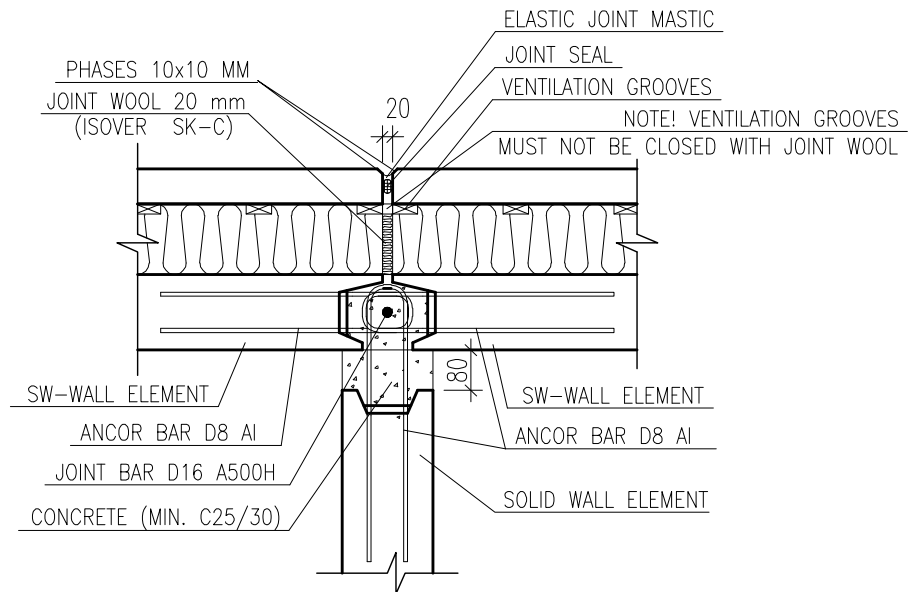
**Figure 4.**

Connection assembly of two SW-wall elements



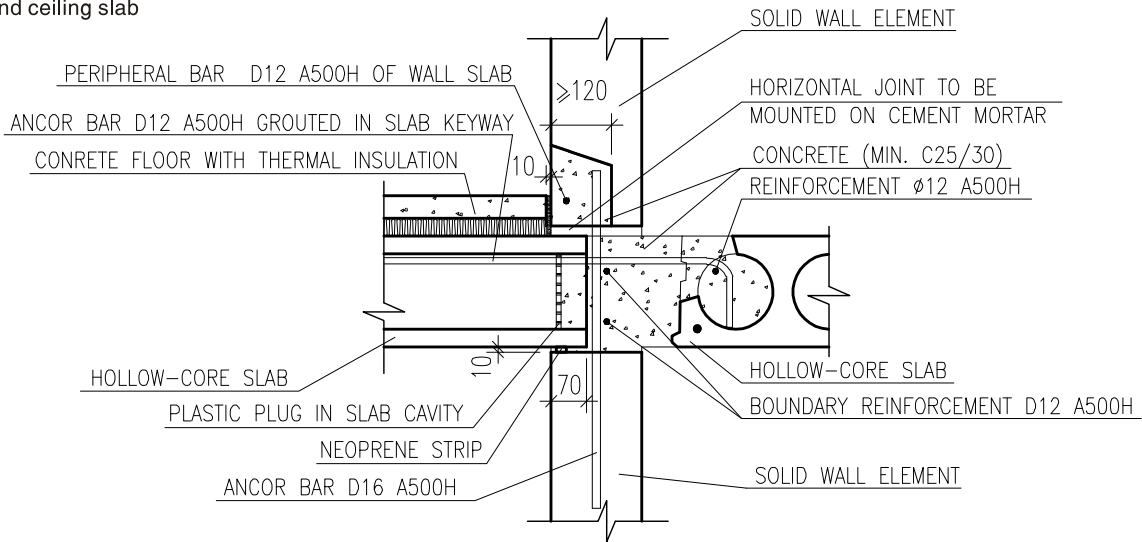
**Figure 5.**

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



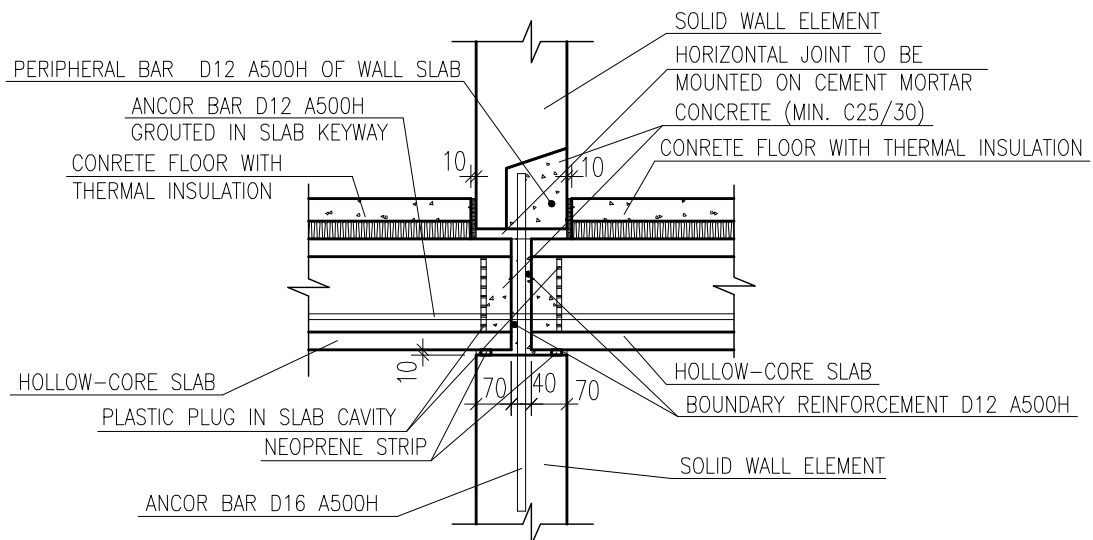
**Figure 6.**

Connection assembly of  
solid wall and ceiling slab



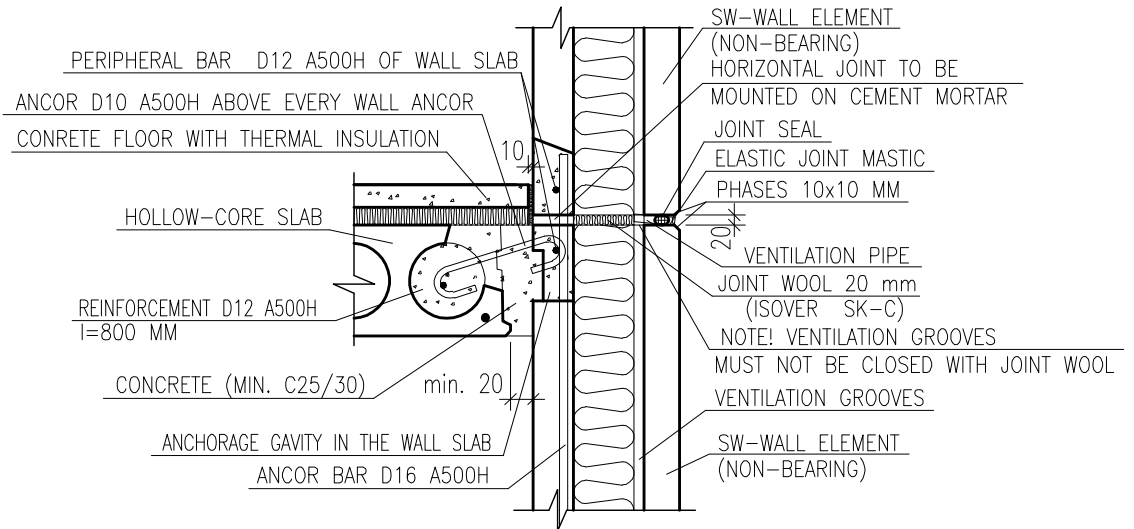
**Figure 7.**

Connection assembly of  
solid elements and ceiling  
slabs



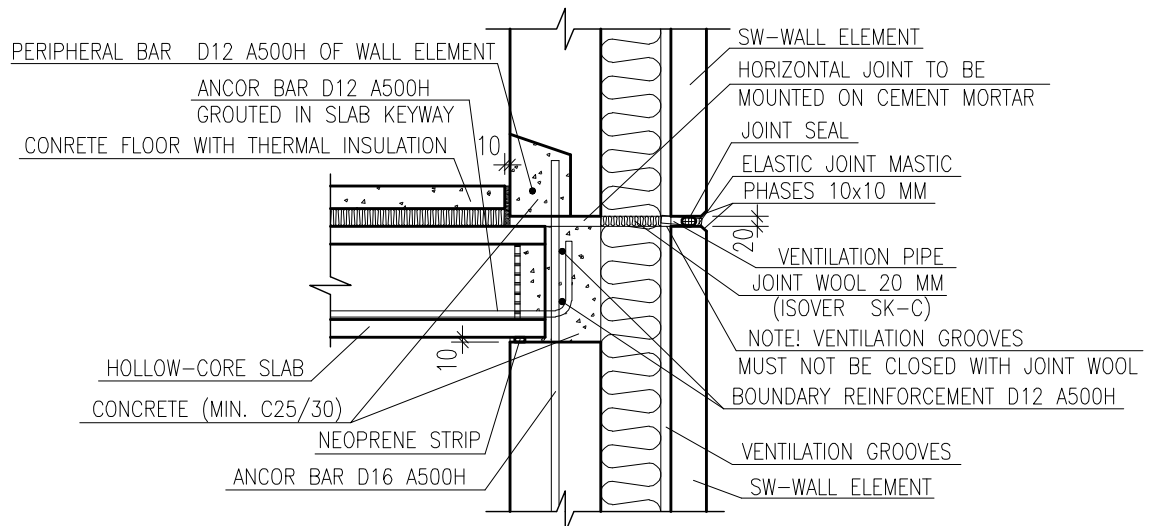
**Figure 8.**

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



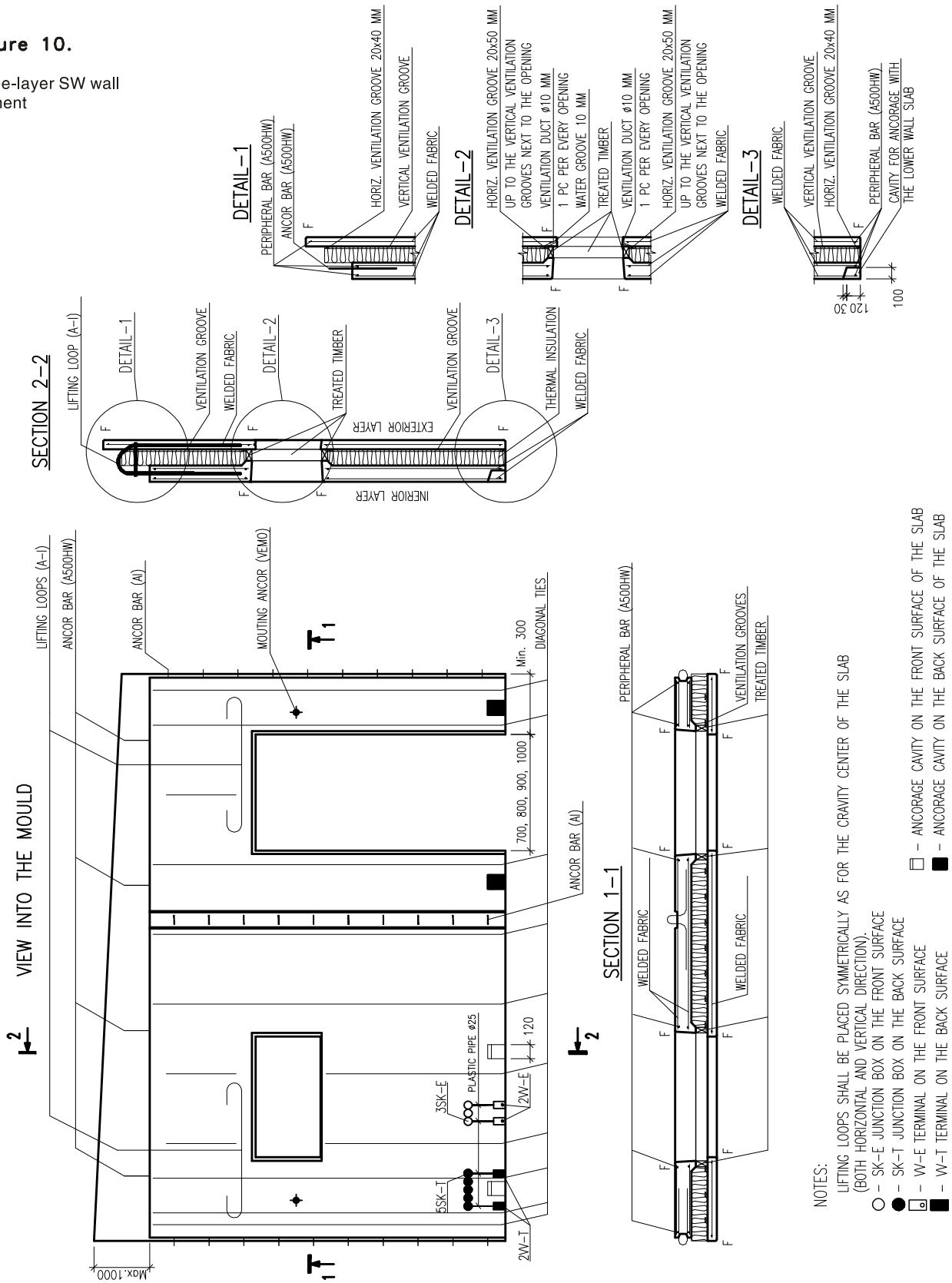
**Figure 9.**

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



**Figure 10.**

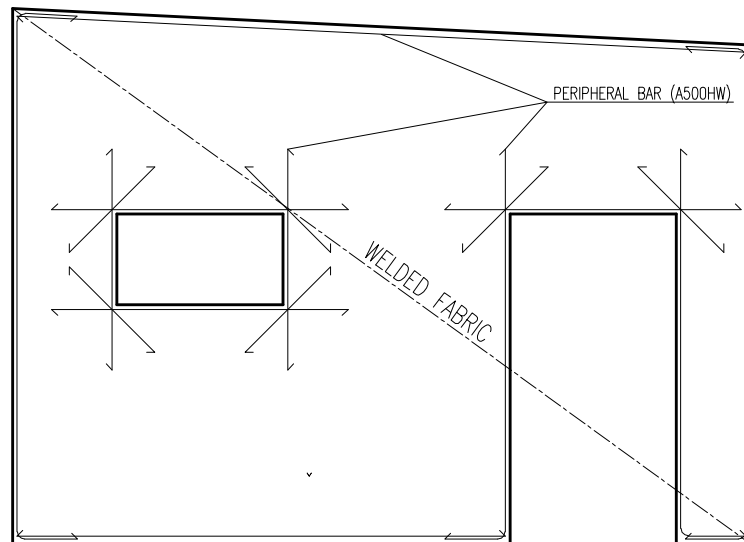
Three-layer SW wall element



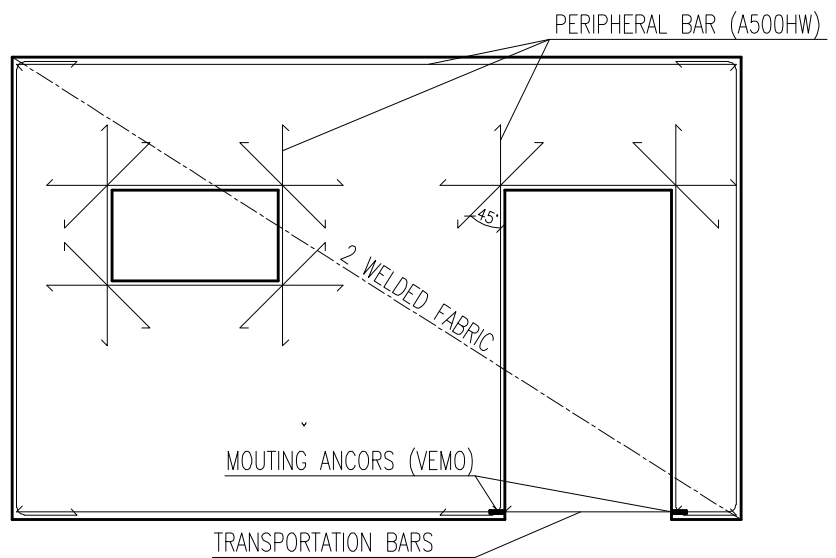
**Figure 11.**

Reinforcement scheme of  
a three-layer SW-wall  
element

REINFORCEMENT OF THE EXTERIOR LAYER

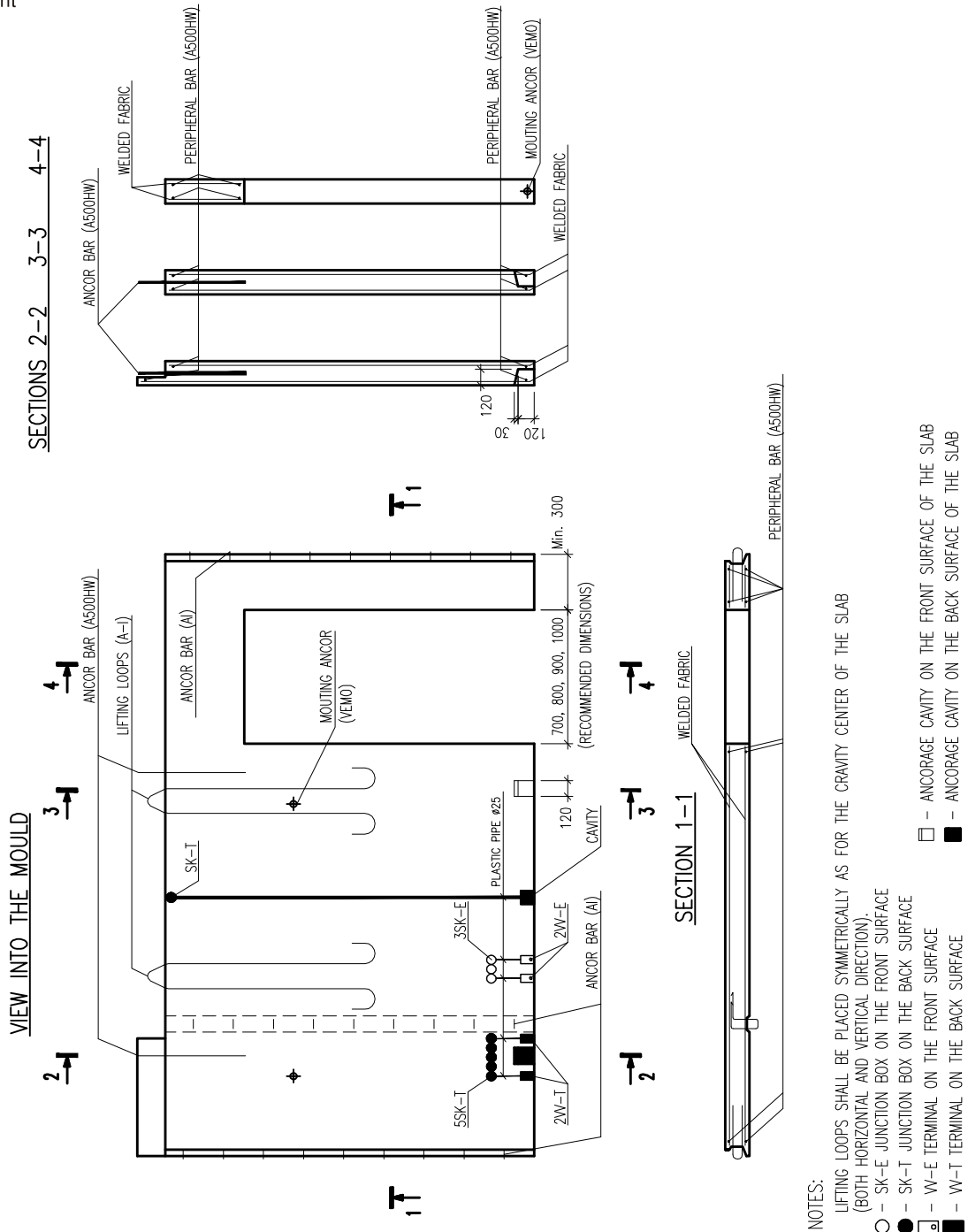


REINFORCEMENT OF THE INTERIOR LAYER



**Figure 12.**

Solid wall element



**Figure 13.**

Reinforcement scheme of  
a solid wall slab

