Arkada-Engineering Ltd.
Training Center

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Guidance Manual

Technology of Construction of Prefabricated Buildings using Thermoprofile Panels

г. Смоленск
2008г.

This manual has been drafted in accordance with the approved program of the advanced training courses in specialty 14612 “Installer for Installation of Steel and Concrete Structures”.

The manual contains tutorial material on the technology of erection of buildings of thermoprofile panels. The manual includes the following sections: foundation, frame and roof. Each section includes the description of construction materials used in these structures; methods of installation: detailed and panel; quality control of the work performed; occupational health and safety when performing this work.

This manual can be used by instructors and trainees of the advanced training courses as an aid for mastering of the studied material.

Drafter: I. A. Anisimova

Contents

Introduction

This technology is based on the use of thermo-structure panels and light steel structures in the construction of buildings.

Thermo-structure panels are the external wall panels made of thermoprofiles filled with thermal insulator and intended for the construction of residential buildings of different layouts.

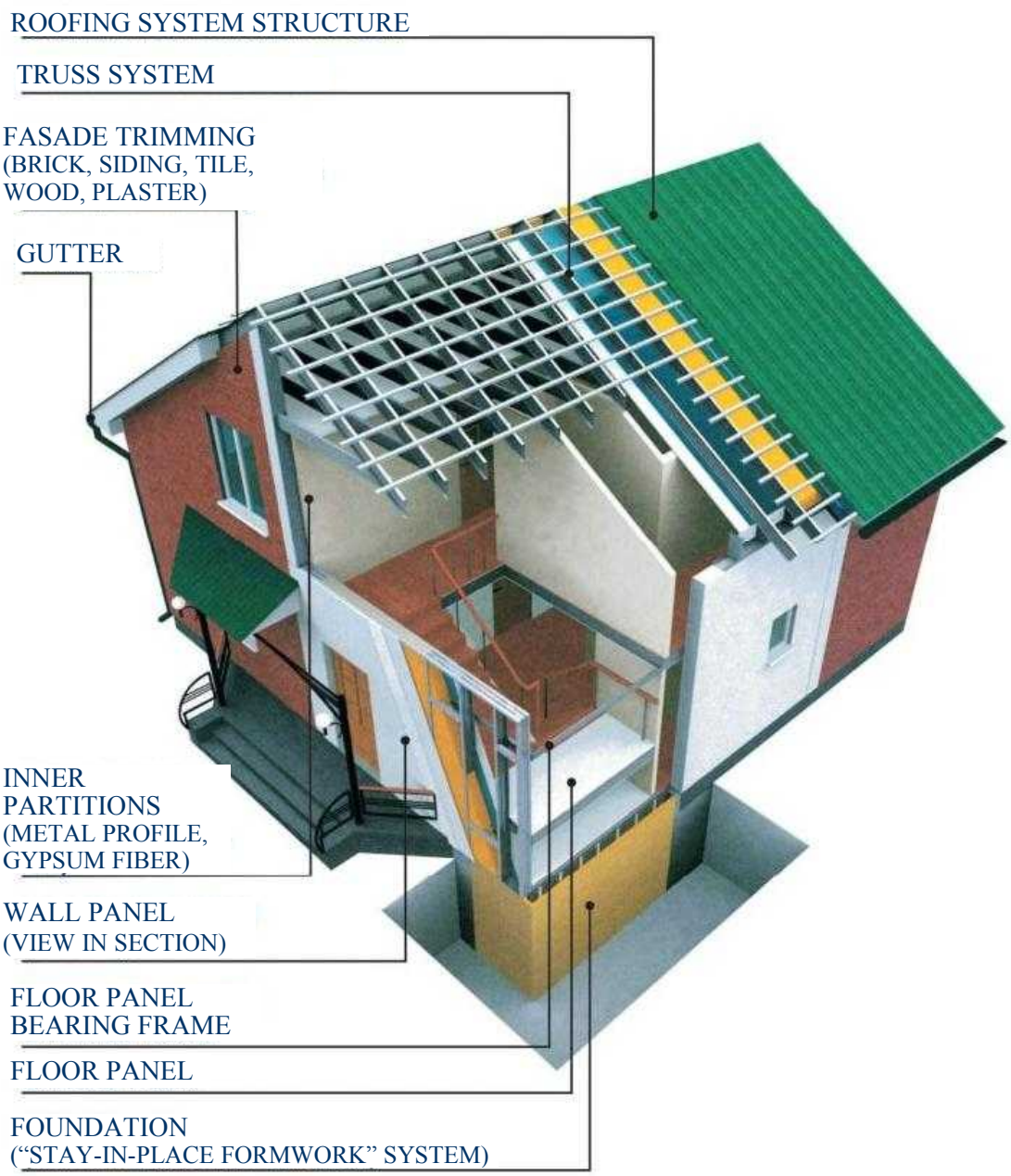
The design features of thermoprofiles make it possible to avoid the so-called "cold joints". Owing to the special perforation, the indices of the thermal conductivity of thermoprofile wall panels become equal to those of wood and exclude any probability of freezing.

Advantages of the technology:

- Delivery in complete sets is a factor of cost cutting and time saving. Thanks to the lightness of each element, the exact size, labeling and thoughtful assembly drawings, the construction is greatly simplified.
- Savings at the building erection stage owing to the absence of necessity for heavy construction machinery.
- Assembly of all the elements of the building only requires an electric drill and an electric screwdriver. All the elements are connected with the self-drilling screws.
- There is no need to dig deep foundations. There is a possibility to use shallow foundations, foundations using Stay-In-Place formwork system, as well as bored piles.
- Light heat-saving walls with the use of thermoprofile panels offer to cut the cost related to construction materials for thermal insulation of a building. Thus, for example, the wall panel 150 mm thick corresponds in terms of thermal conductivity to a brick wall that is 1000 mm thick.
- Possibility of flexible laying-out of interior space.
- Absolute evenness of the inner walls, partitions and ceilings reduces the time and materials for the additional finishing operations.
- Multiple choice of outside finishing of a building. At the request of the customer almost any construction materials can be used for finishing of the building: trim molding, custom-made materials or plaster.
- Possibility to carry out the year-round installation activities, regardless of the season and weather conditions.

The basis of this structural system are Light steel thin-walled structures (LSTS) – the steel zinc-coated profiles of different configurations, 0.7 to 2.0 mm thick, interconnected by means of self-driving screws.

STRUCTURAL SCHEME OF A BUILDING BASED ON THERMOPROFILE PANELS



The system consists of the following subsystems:

- load-bearing walls with thermoprofile framework and effective thermal insulation, inner bearing walls and nonbearing partitions;
- floor and garret framing of thin-wall profiles with the corrugated steel sheet covering;
- load-bearing truss structures (trusses and joists) of light gauge steel zinc-coated profiles.

Subsystems can be used all together – in this case a complex structure of a building will be obtained, or as individual components.

For example, a build-up in the form of an attic floor (mansard) above the existing building, where bearing truss structures are used complete with attic joists.

Thus, this system is a flexible, versatile building system that can be combined with any conventional constructions and technologies, whereas adding its own advantages to these structures (systems).

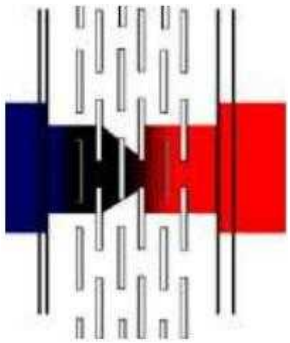
Bearing and self-bearing external walls of buildings consist of:

- perforated (punched) metal zinc-coated profiles, made of a thin sheet steel band 0.7 to 1.5 mm thick, interconnected by the self-drilling screws in the panel plane. Vertical studs, horizontal tracks and connecting elements make up the framework of a building;
- effective thermal insulation (for example, mineral-wool basalt boards), tightly stacked between the studs. The thermal insulation shall be non-flammable, environmentally friendly and shall ensure high thermo-physical parameters of the wall;
- gypsum boards for sheathing from the inner and the outer sides of the walls (use of CBPB, OSB and other materials is possible);
- vapor-insulation and diffusion membranes
- external cladding, made on the principle of "ventilated faэade"; an air gap ensures aeration of the thermal insulation.

Main Characteristics of Thermoprofile Walls

1. Thermo-technical Characteristics

Good thermo-technical indices of thermoprofiles are based on the perforation of the wall part of the profile, which reduces the thermal conductivity of the cross section by 80-90%. Use of the pass-through traditional steel profiles in the cross-section of the outer wall will result in the formation of the so-called “cold joints”. The perforation of the thermoprofiles cuts across the cold joint; the path of heat flow through the cross section will become longer and more complicated. Eventually, the thermo-technical indices of the thermoprofile and the wooden cross-section of the same height are approximately at the equal level.



Heat flow in the cross section of the thermoprofile

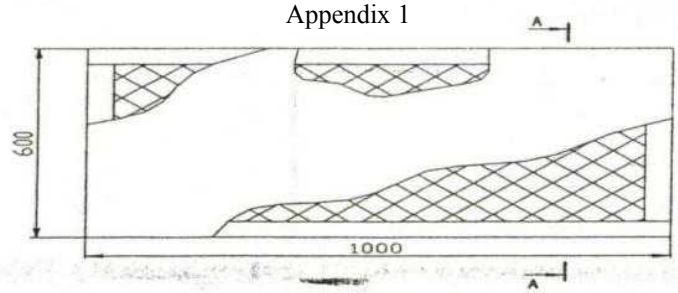
According to the test results, the temperature of the inner surface of the thermoprofile wall even in the locations of the framework elements is high enough to prevent condensation of water vapor on the inner surface of the wall or on the vapor-proof membrane. Similarly to the traditional walls on the timber framework, the water bound in the materials of the thermoprofile wall can cause a slight and temporary condensation of water vapor on the inner surface of the windproof board. This slight condensation poses no danger, since the high vapor permeability of the windproof board contributes to the rapid drying of the wall.

The “Composite-Test” Institute for Research and Testing of Building Materials and Products JSC carried out the tests for investigation of the resistance of the panels to thermal transmission, based on which Protocol № ИКТ-052-2008 was drawn up.

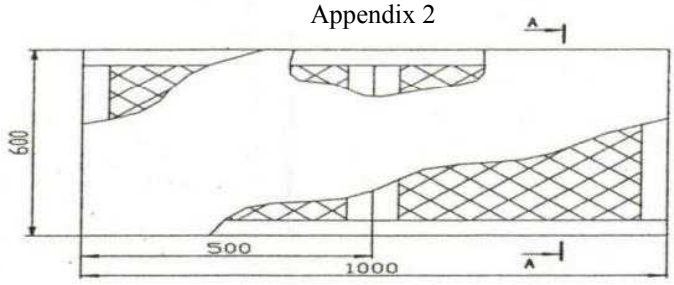
When determining the thermal transmission resistance in a cold chamber, the temperature was maintained at –28°C, in a heating cabinet it was maintained at +20°C. The accuracy of temperature control was 1°C.

Determination of Thermal Transmission Resistance of Panels

Appendix 1



Appendix 2



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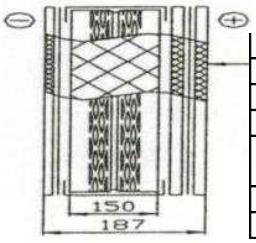


Gyproc GN 13 Gypsum Board	12.5 mm
Isospan B Vapour Insulation	1 mm
Gyproc GN 13 Gypsum Board	12.5 mm
Frame (zinc-coated steel 08 semikilled)	150 mm
ISOVER Thermally Insulating Boards (framework filling)	150 mm
Isospan A Windproof membrane	1 mm
Gyproc GTS 9 Gypsum Board	9.5 mm

Specimen No.	Specimen Dimensions	Type of Specimen	Thermal Transmission Resistance $\frac{m^2 ЧK}{W}$
1	600Ч1000Ч187	Full optional panel of notched thermoprofiles (Appendix 1)	3.52
2	600Ч1000Ч187	Full optional panel of waffle-type thermoprofiles (Appendix 2)	3.57
3	600Ч1000Ч187	Joint of full optional panels of notched thermoprofiles (Appendix 1)	3.04 – in the zone of joint 3.53 – corrected to the whole specimen
4	600Ч1000Ч187	Joint of full optional panels of waffle-type thermoprofiles (Appendix 2)	2.85 – in the zone of joint 3.44 – corrected to the whole specimen

Head of Laboratory (Signed) A.V. Davydova

The following table sets out the thermal conductivities of a thermoprofile wall (U-values) at the different heights of the cross-section of the framework elements, and the wall thicknesses emanated from the heights. The outer surface of the framework is coated with a 9 mm windproof gypsum board with the sealed joints,

and the inner surface is coated with a 13 mm gypsum board. The space between the framework elements is completely filled with mineral wool.

Thermal conductivity of insulation, W/mK	Profile height, mm	U-value of thermoprofile wall at different thicknesses of profile material, W/m^2K			
		1.0 mm	1.2 mm	1.5 mm	2.0 mm
0.037	150	0.279	0.287	0.297	0.313
0.037	175	0.249	0.257	0.268	0.284
0.037	200	0.227	0.234	0.245	0.261
0.037	225	0.209	0.216	0.227	0.243
0.041	175	0.270	0.278	0.288	0.305
0.041	200	0.245	0.254	0.264	0.280

The wall panel of thermoprofiles 150 mm thick can substitute in thermal conductivity a brick wall 1000 mm thick.

The use of high-quality thermal insulation in walls and ceiling structures allows obtaining kind of "thermos" formed by the enclosing structures, which in its closed state can conserve heat for up to 2 to 3 days, without requiring any additional heating; thus, significantly reducing the power consumption costs.

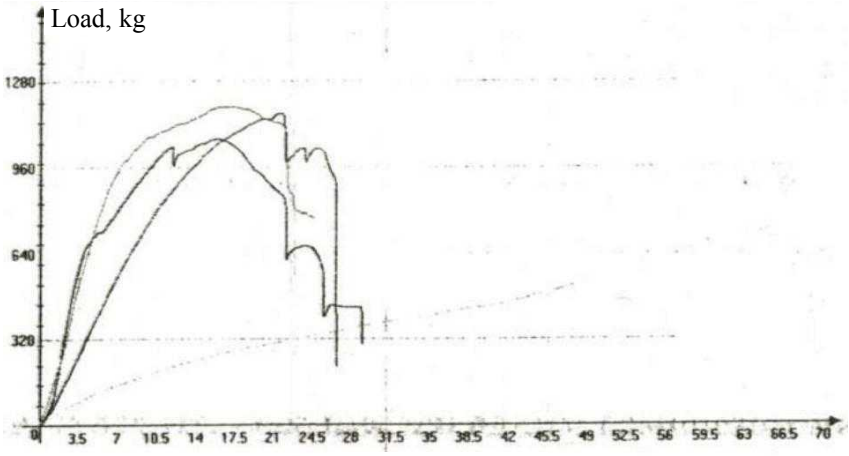
2. Sound Insulation

The sound insulation characteristics of the thermoprofile wall (framing studs have the cross section height of 175 mm and the interval of 600 mm; the space between the framing elements is filled with mineral wool; the frame is faced with the 9 mm windproof gypsum board from the outside and with the 13 mm gypsum board from the inside) are as follows:

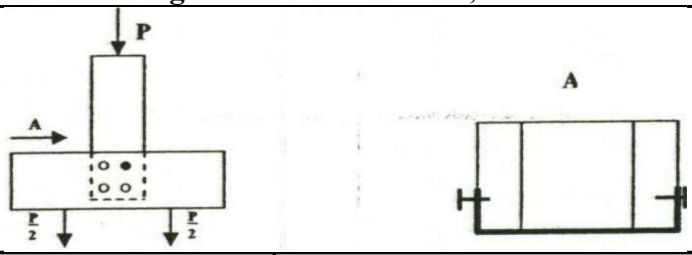
- measured muffling of street traffic noise 43 dB;
- measured muffling of other outside noise 51 dB.

3. Fire Resistance

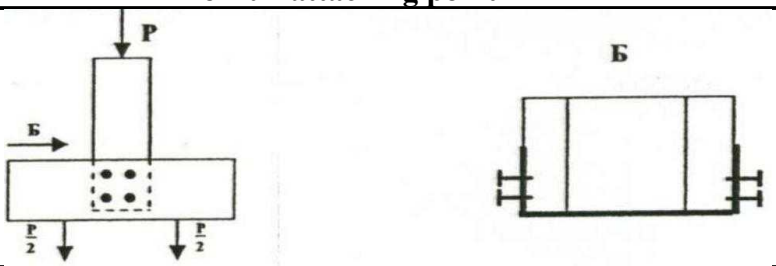
As a rule, the thermoprofile wall is assembled of non-combustible materials. If necessary, the fire resistance of the wall is checked according to the instructions of the manufacturer of the framework sheathing boards.



Screwed connections of metal frame with punched screwed connections using one self-drilling screw DIN 7982C-H, Ш4.8Ч20

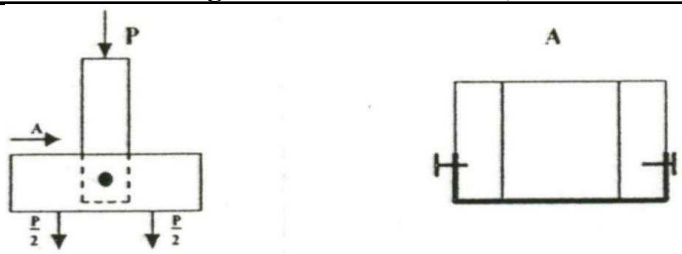
Specimen No.		
	Destructive Load, kg	**Mode of Fracture**
1	1158.60	Tear-out of self-drilling screw, initial tear of perforation
2	1217.60	Tear-out of self-drilling screw
3	1039.00	Tear-out of self-drilling screw, rupture of perforation
4	1162.40	Tear-out of self-drilling screw
5	1201.30	Tear-out of self-drilling screw, initial tear of perforation

Screwed connections of metal frame with punched screwed connections of full attaching point

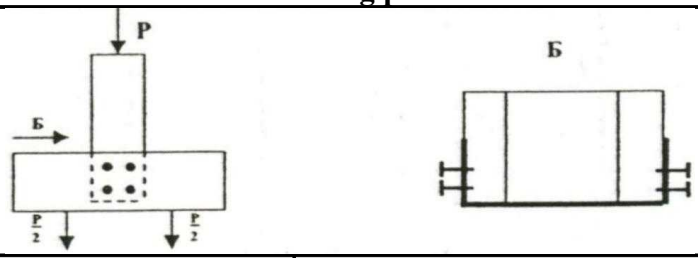
Specimen No.		
	Destructive Load, kg	**Mode of Fracture**
1	1089.80	Rupture along the perforation
2	941.44	Rupture along the perforation
3	1184.60	Rupture along the perforation
4	1120.30	Rupture along the perforation
5	1079.00	Rupture along the perforation

Mesh Channel Thermoprofiles		
1	АИ ТСс 250-45-1.5	604.0
2	АИ ТСс 250-45-1.5	610.0
3	АИ ТСс 250-45-1.5	612.0
4	АИ ТСс 250-45-2.0	830.0
5	АИ ТСс 250-45-2.0	855.0
6	АИ ТСс 250-45-2.0	835.0

Screwed connections of metal frame without any punched screwed connections using one self-drilling screw DIN 7982C-H, Ø4.8×20

Specimen No.		
	Destructive Load, kg	**Mode of Fracture**
1	726.13	Bending along the perforation, shear of self-drilling screw
2	993.69	Bending along the perforation, shear of self-drilling screw
3	1052.00	Bending along the perforation, shear of self-drilling screw
4	824.36	Bending along the perforation, shear of self-drilling screw
5	902.48	Bending along the perforation, shear of self-drilling screw

Screwed connections of metal frame without any punched screwed connections of full attaching point

Specimen No.		
	Destructive Load, kg	**Mode of Fracture**
1	1063.80	Rupture along the perforation
2	1362.60	Rupture along the perforation
3	1440.60	Rupture along the perforation
4	1288.10	Rupture along the perforation
5	1391.20	Rupture along the perforation

4. Environmental Friendliness

Inorganic and chemically inactive materials, of which the buildings are constructed, are 100% recyclable and are not susceptible to termites, fungi and mould. They do not absorb or emit any harmful substances. The Asthma Society of Canada recognized these buildings as the most suitable for asthmatics and people suffering from allergies.

The opportunity of unlimited metalwork recycling is also a significant advantage.

Additional Thermal Insulation of Thermoprofile Wall

In order to achieve very low heat losses, the thickness of the wall insulation materials is increased. Most often, additional insulation is placed evenly on the outer surface of the ordinary thermoprofile wall. For this purpose special windproof boards of mineral wool are used, whose joints are sealed with the elastic mastic compound.

The influence of additional insulation on the thermal conductivity of the thermoprofile wall structure based on 175/1.2 profiles. The windproof boards of mineral wool featuring thermal conductivity λ=0.037 W/mK are used as additional insulation.

Windproof board of mineral wool, λ=0.037 W/mK			
Thickness of additional insulation, mm	U-value of the basic wall, W/m^2K	Effect of additional insulation on U-value of the wall, W/m^2K	Total U-value, W/m^2K
30	0.257	0.044	0.213
45	0.257	0.061	0.196
50	0.257	0.066	0.191

I. Foundation

The choice of the structure of foundations depends on the type of soils, serving as a base, on the structure of the underground part of the building and on the customer's wishes.

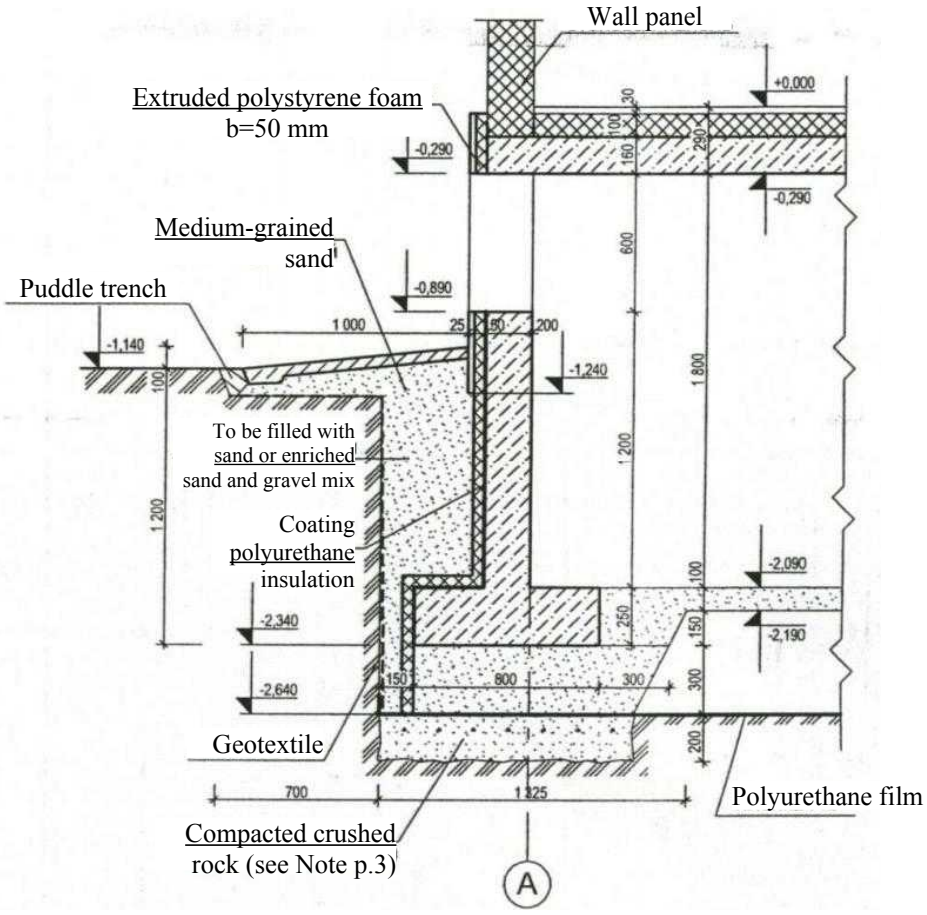
As the load of the buildings, built based on the system of thermoprofile panels, transmitted to the foundation is insignificant, it is permissible to use the following types of foundations:

- strip monolithic or prefabricated foundations;
- shallow foundations;
- drilled pier foundation.

Monolithic strip foundations can be of the following types:

- monolithic concrete foundations;
- monolithic reinforced concrete foundations;
- monolithic foundations using the Stay-In-Place formwork system.

Monolithic reinforced concrete foundations.

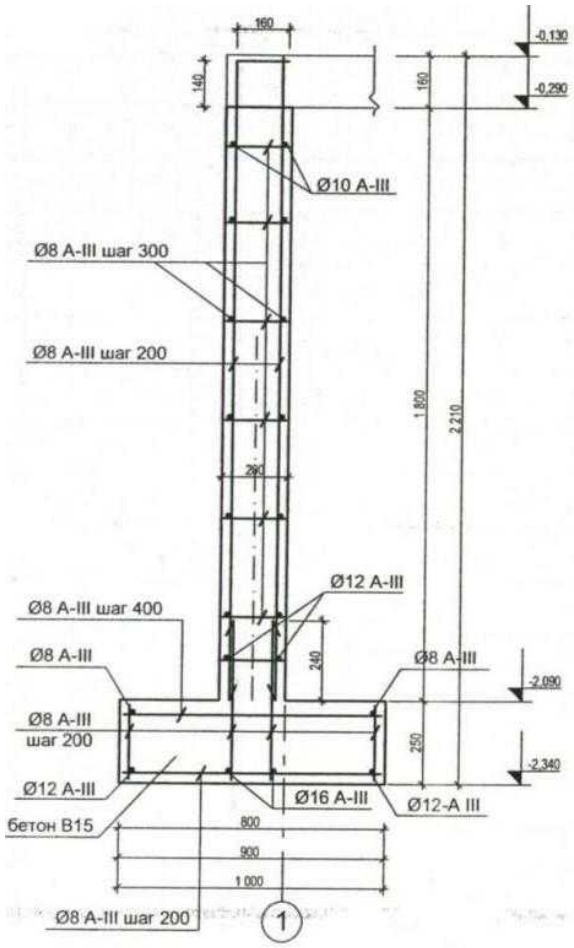


Fully compacted 150 mm thick sand mattress serves as a base for foundations.

Construction of monolithic foundations begins with the installation of formwork. The type of the formwork and its dimensions shall follow with the designed project.

In case of the reinforced concrete foundations, after installing the formwork, the reinforcement shall be installed. The reinforcement dimensions shall follow with the design values. Project location of reinforcing bars and meshes shall be achieved by means of proper installation of supporting devices: templates, spacers, chairs, pads. Do not use pads from scrap rebar, wood blocks and break stone as support for reinforcement.

Reinforcement of Foundation



interval	interval
concrete B15	concrete B15

For reliable bond of fresh concrete mixture with the re-bar, the latter must be cleaned of dirt, flaky rust and debris of grout using sandblaster or wire brushes.

The concreting section shall be cleaned, washed with water and blown with compressed air immediately prior to concrete placement.

For monolithic foundations concrete of Class B-5 – B-30 shall be used. The choice of the concrete class depends on the loads accepted by the foundation and on the type of soils. The concrete class shall be determined by the calculation and downloaded into the Project.

Laying and compaction of concrete mix shall be performed in such a way as to ensure the solidity of concrete masonry, the design physical and mechanical indices and homogeneity of the concrete, its proper bond with the reinforcement and the inserts and the complete (without any voids) infill with the concrete of the formworked space of the structure being built.

The concrete mixture shall be laid in tiers, whose height shall comply with the type of the applicable vibrator. The internal vibrator must get immersed into the previously laid layer not less than 5 to 8 cm. The distance between the points of the vibrator immersion into the concrete mix shall not exceed 1.5 R. R is the radius of action of the internal vibrator.

The key indicators of the sufficient vibrating are the cessation of slump and formation of cement wash on its surface.

Removal of formwork shall be carried out after the concrete reached its design strength.

During the maturing of concrete mix, care must be taken as follows. If the concrete work is done in summer, care must be taken to prevent excessive moisture loss in the concrete mixture. Freshly laid concrete keep wet by means of periodic watering. At air temperatures above 15°C watering shall be made every 3 hours during the day and 1 time at night time. Preventing moisture loss is possible by covering the concrete with moisture-proof materials (burlaps, mats, sawdust).

Monolithic concrete foundations

Construction of this kind of foundations differs from the construction of monolithic reinforced concrete foundations merely by the absence of reinforcement. All of the rest processes are similar.

Shallow foundations

The footing depth is the distance from the founding level to the land leveling datum mark.

In heaving soils the footing depth is primarily dependent on the depth of seasonal earth freezing.

Foundations will work properly in the event that the loads acting on the building from the top (the load from the upstream structures) and from the bottom (earth pressure) are balanced.

When erecting low-rise light buildings, the earth pressure upon the foundation is much higher than the loads acting from the building structures. Earth pressure can be decreased by reducing the depth of foundation.

This solution also makes it possible to save materials when constructing foundations.

Soil heaving is bloating of aqueous soil when freezing.

When building shallow foundations, sand blanket shall be installed beneath the foundation. The thickness of sand blanket depends on the type of foundation. It may be 300 to 500 mm. By this means, the insufficient embedding of foundations will be compensated. Sand is not considered as heaving soil.

One of the options for solving the soil heaving problem is the winterizing of the basement body and soils using foam-polystyrene plates, such as Penoplex plates.

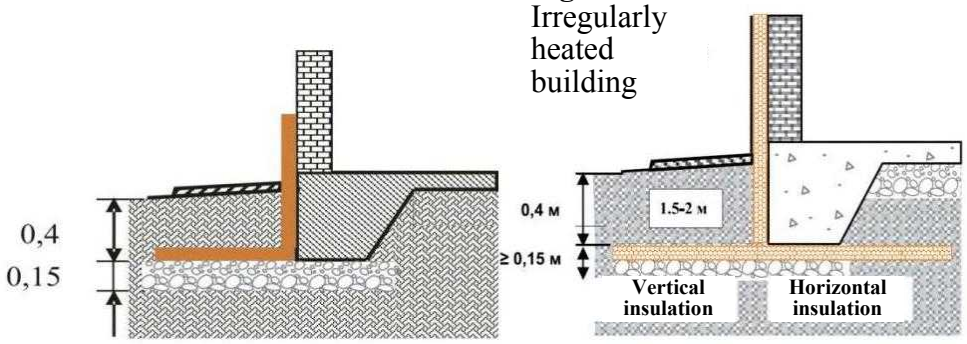


Fig. 3
Irregularly heated building

м = m

Foundations using the “Stay-In-Place Formwork” system

This system allows saving labor costs related to the processes of installation and removal of formwork.

The design of such a foundation is as follows. The Stay-In-Place structural formwork represents an expanded mesh 0.45 mm thick. The mesh is supplied in rolls 600 mm high. The mesh shall be brought to service position by extension from top to bottom up to 1200 mm.

The mesh shall be fastened to the studs using the fastening elements included into the formwork supply. The studs are made of 1.5 mm thick profiles. The height and the size of the profile cross section depend on the design of foundation and shall be defined by calculation and specified in the working drawings.

Concrete class shall be defined by calculation. Supply, laying, vibrating of concrete mixture as well concrete curing are similar to those for the monolithic reinforced concrete foundations.

After setting of the concrete mixture, the heat insulation of the outer surface of the foundation around the perimeter of the building shall be carried out. Type of insulant and method of its attachment to the foundation shall be indicated in the Project.

Advantages of Stay-In-Place Formwork

- Low labor intensity
- High speed of assembly
- Simplification of finishing operations
- Increased seismic safety

Quality Control of the Work Performed

Quality control of the work performed shall be carried out at each stage.

When installing the formwork, special attention shall be paid to the uprightness and levelness of elements, rigidity and stability of all structures in general and correctness of connections of the formwork elements in accordance with the working drawings.

Quality control of the concrete work involves registration of the strength of the concrete laid. Concrete strength shall be determined in two ways: destructive and nondestructive.

Ready-made structures are subject to measuring. Vertical deviation of the planes and their intersection lines to the entire height for foundations must not exceed 20 mm.

Horizontal deviation of horizontal planes to the entire plane must not exceed 20 mm.

Deviations in the size of the cross-sectional elements of no more than 8 mm.

Occupational Safety and Health

When mixing, conveying, placing and curing the concrete, cutting, bending and installing the reinforcement, as well as installing and dismantling the formwork, provisions shall be made to prevent exposure of workers to hazardous and harmful occupational factors related to the work nature:

location of working places close to the height differences of 1.3 m or more;

moving vehicles and the objects repositioned by them;

collapse of structural elements;

noise and vibration;

overvoltage in the electric line whose short circuit may pass through the human body.

Cement shall be stored in silos, bunkers, bins and other closed containers, taking measures against spray during loading and unloading. Charging holes must be closed with protective grates, and hatches in protective grids shall be locked.

Walking on the laid down reinforcement shall be permitted only by special flooring having the width of at least 0.6 m, laid down onto the reinforcement cage.

When using concrete mixtures with chemical additives, protective gloves and goggles must be worn.

The workers engaged in laying the concrete mixture on the surface with a slope exceeding 20 degrees, must use safety harnesses.

The scaffold for delivery of concrete mixture by self-dumping trucks must be equipped with baffle bars. Between the baffle bars and the guardrails the walkways must be provided with the width of at least 0.6 m. The cross baffle bars must be installed on the dead-ended scaffolds.

When cleaning the dumping body from the remnants of concrete mixture, the workers are prohibited to be in the self-dumping truck.

Preparation and pre-assembly of the reinforcement must be carried out in the especially dedicated areas.

Every day, before placing the concrete in the formwork, the condition of containers, formwork and scaffolding must be checked. The disorders detected should be immediately removed.

Prior to placement of concrete mixture using vibrotrunk, check the serviceability and reliability of attachment of the pieces connection to each other and to the lifeline.

When delivering the concrete with the help of concrete pump it is necessary to:

remove all workers to a distance of not less than 10 m from the concrete conveying pipe for the time of purging in run;

lay the concrete conveying pipe down on the pads to reduce the effect of dynamic load on the reinforcement cage and formwork when concrete running.

When installing the formwork elements in several tiers, each subsequent tier should be installed after the anchorage of the lower tier.

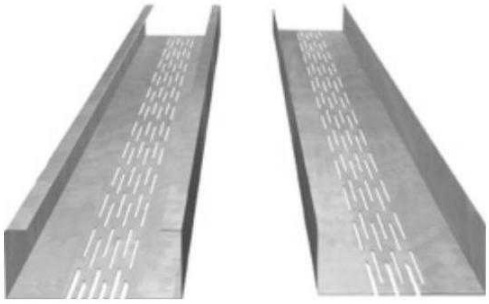
When compacting the concrete mixture using electric vibrators, do not move the vibrator beyond the current-conducting cables, and during interruptions of work and when moving from one place to another, turn off electric vibrators.

II. Frame

Materials used

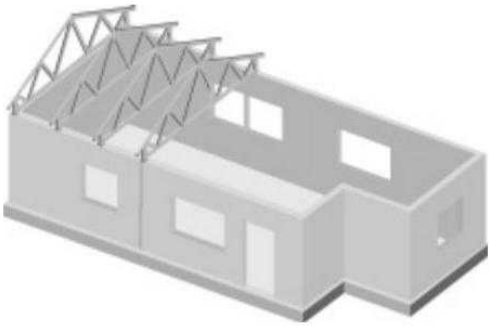
Thermoprofile

Thermoprofile is a bent hot dip zinc-coated light-gage steel profile, whose thermal conductivity is 80-90% lower than that of traditional steel profiles. Good thermo-technical characteristics of thermoprofiles are achieved by perforating the walls of the profiles. Thermoprofiles are lightweight, have precise dimensions, hold their shape and are enduring in the environmental conditions.

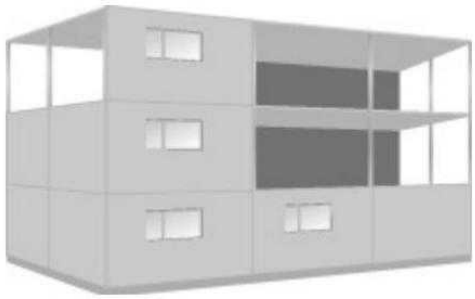


Scope of Application of Thermoprofiles:

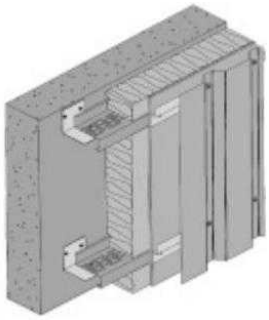
1. load-bearing frame elements of low-rise buildings, private and ordinary houses and additional floors



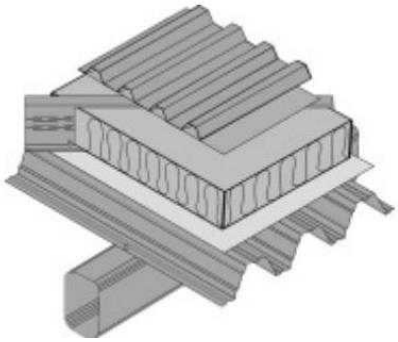
2. frames of external walls of multistoried buildings with bearing reinforced concrete or steel frame



3. additional insulation of existing walls



4. intermediate elements in the open roofs of load-bearing profiled sheet

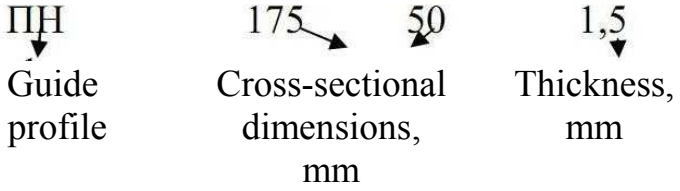


Thermoprofiles are made of hot zinc-coated thin sheet steel with specified minimum yield strength of 350 N/mm^2 and tensile strength of 420 N/mm. The thickness of the zinc layer that coats the steel sheet from both sides is about 20 μm.

Types and Marking of the Profiles Used

Guide profiles for building structures:

АИ ПН 100-50-1,5
АИ ПН 100-50-2,0
АИ ПН 150-50-1,5
АИ ПН 150-50-2,0
АИ ПН 175-50-1,5
АИ ПН 175-50-2,0
АИ ПН 200-50-1,5
АИ ПН 200-50-2,0
АИ ПН 250-50-1,5
АИ ПН 250-50-2,0



Guide thermoprofiles for building structures:

АИ ТН 150-50-1,5
АИ ТН 150-50-2,0
АИ ТН 175-50-1,5
АИ ТН 175-50-2,0
АИ ТН 200-50-1,5
АИ ТН 200-50-2,0
АИ ТН 250-50-1,5
АИ ТН 250-50-2,0

Guide thermoprofile | Cross-sectional dimensions, mm | Thickness, mm

Guide profiles – the lintels for window and door apertures:

with no thermo-notching	with thermo-notching
АИ ПНп 100-50-2,0	АИ ТНп 150-50-2,0
АИ ПНп 100-50-2,0	АИ ТНп 175-50-2,0
АИ ПНп 100-50-2,0	АИ ТНп 200-50-2,0
АИ ПНп 100-50-2,0	АИ ТНп 250-50-2,0
АИ ПНп 100-50-2,0	

Stud thermoprofiles with equal flanges for building structures

АИ ТС 150-45-1,5
АИ ТС 150-45-2,0
АИ ТС 175-45-1,5
АИ ТС 175-45-2,0
АИ ТС 200-45-1,5
АИ ТС 200-45-2,0
АИ ТС 250-45-1,5
АИ ТС 250-45-2,0

Stud thermoprofile | Cross-sectional dimensions, mm | Thickness, mm

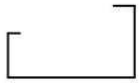
Stud profiles with equal flanges for building structures

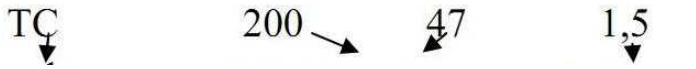
АИ ПС 100-45-1,5
АИ ПС 100-45-2,0
АИ ПС 150-45-1,5
АИ ПС 150-45-2,0
АИ ПС 175-45-1,5
АИ ПС 175-45-2,0
АИ ПС 200-45-1,5
АИ ПС 200-45-2,0
АИ ПС 250-45-1,5
АИ ПС 250-45-2,0

Stud profile | Cross-sectional dimensions, mm | Thickness, mm

Stud thermoprofiles with unequal flanges for building structures

АИ ТС 150-47-1,5
АИ ТС 150-47-2,0
АИ ТС 175-47-1,5
АИ ТС 175-47-2,0
АИ ТС 200-47-1,5
АИ ТС 200-47-2,0
АИ ТС 250-47-1,5
АИ ТС 250-47-2,0





Stud thermoprofile with unequal flanges	Cross-sectional dimensions, mm	Thickness, mm

Stud profiles with unequal flanges for building structures

АИ ПС 150-47-1,5
АИ ПС 150-47-2,0
АИ ПС 175-47-1,5
АИ ПС 175-47-2,0
АИ ПС 200-47-1,5
АИ ПС 200-47-2,0
АИ ПС 250-47-1,5
АИ ПС 250-47-2,0

The size of the bigger flange is 47 mm
The size of the smaller flange is 41 mm

Stud profile with unequal flanges	Cross-sectional dimensions, mm	Thickness, mm

Joist profile	АИ ПП 84,5-44-0,8
Angle	
АИ У 50-1,5 АИ У 50-2,0	Equal flange angle 50×50 mm
АИ У 50-100-2,0 АИ У 90-1,5 АИ У 90-2,0	Unequal flange angle 50×100 mm
Tape	АИ Л 100-0,8
Perforated tape	АИ Лп 25-0,8

Thermal Insulation Materials

Different types of mineral wool boards are used as thermal insulation material.

ISOVER Series Mineral Wool Boards

- Non-flammable material
- Density, 20 kg/m^3
- Thermal conductivity in normal conditions, λ=0.037 W/mK

PAROC Series Mineral Wool Boards

- Non-flammable material
- Density, 35 kg/m^3
- Thermal conductivity in normal conditions, λ=0.037 W/mK

Cladding Materials

Gypsum plasterboard 12 mm thick, with thinned edges, is used for internal cladding.

Other boards can be used at request:

- 12 mm gypsum board of increased strength;
- 10 or 12 mm of wood-gypsum board;
- 10, 11 or 12 mm chipboard;
- 9 or 12 mm plywood;
- 9 mm semihard fiberboard.

In wet rooms, special materials can be used, which are referred to in specific projects.

The outer cladding that serves as a windproof panel is usually made of weather-resistant gypsum board with thickness of 10 mm.

Other boards can be used as well:

- 12 or 25 mm windproof porous fiberboard;
- 6.5 or 9 mm plywood;
- 12 mm bitulith board.

Gypsum plasterboard (GPB)

Gypsum plasterboard is produced in accordance with State Standard ГОСТ 6266-89 or Technical Specifications ТУ 5742-005-04001508-95. Production of GPB is carried out by conveyor method.

Gypsum plasterboard is a gypsum core, all planes of which except the end edges are lined with cardboard.

The core is made of G-4 plaster compliant with State Standard ГОСТ 125-79, which as a building material possesses outstanding physical and technical properties. Gypsum-based materials have the ability to “breathe”, i.e. to absorb the excess moisture and release it into the environment in case of its deficiency. Gypsum is a nonflammable, fire-resistant material. It does not contain toxic components, and its acidity is similar to the acidity of human skin. Its production and use has no adverse impact on the environment. To achieve the required criteria of gypsum core, characterizing its strength and density, special components are added that enhance its performance.

Another important component of the GPB is linerboard compliant with Technical Specifications ТУ 544-018-04766356-94, whose bond with the core is ensured at the expense of use of adhesive agents. The linerboard serves both as a reinforcing frame and excellent basis for the application of any finishing material (plaster, wallpaper, paint, ceramic tile). In terms of its hygiene and physical properties the linerboard is ideal for residential premises.

Main nominal dimensions of GPB:

<table>
<tr><th>Thickness,
mm</th><th>Length,
mm</th><th>Width,
mm</th></tr>
<tr><td>8
10
12.5
14</td><td>2500, 2600, 2700, 2900, 3000</td><td rowspan="2">1200</td></tr>
<tr><td>16
18
20</td><td rowspan="2">2500, 2600, 2700, 2900, 3000, 3300, 3600, 3900, 4200, 4500, 4800</td></tr>
<tr><td>24</td><td>600</td></tr>
</table>

The following types of GPBs are produced: УК – with thinned edges, ПУК – with thinned rounded edges, ПК - with straight edges.

Special types of GPBs: MRGPB – moisture-resistant gypsum plasterboard, FRGPB – fire-resistant gypsum plasterboard.

Gypsum Fiber Board (GFB)

Gypsum fiber board is a homogeneous, environmentally friendly construction material, obtained from a mixture of gypsum binder and fluff cellulose pulp by semidry pressing method in accordance with the requirements of Technical Specifications ТУ 5742-004-035177-97.

Depending on the properties and the scope of application, gypsum fiber boards are divided into the ordinary gypsum fiber boards – GFB, and the moisture-resistant gypsum fiber board – MRGFB.

Properties of GFBs:

- Ability to maintain optimal humidity in the room due to absorption of excess moisture, and in case of its deficiency ability to release it into the environment;

- Low coefficient of heat absorption, which makes them warm to the touch;

- High rates of fire safety.

GFBs represent rectangular elements, polished on the front side, and impregnated with a special compound that acts as a primer. Therefore, applying of the subsequent coating is usually carried out without priming.

The geometrical dimensions of boards:

Board Type	Length, mm	Width, mm	Thickness, mm
Standard	2500	1200	10, 12
Small-format	1500	1000	10, 12

GFB have the same kinds of edges, as GPB.

Sealing materials, vapor- and air-insulation

Joints between the structural elements are sealed, for example, by SK-20 or VK-20 joint sealing tapes made in Finland, as well as by Lignotherm tape.

Joints of the windproof boards are sealed by 3M weatherproof tape, by ISOVER or PAROC adhesive tapes for joints or by appropriate adhesive tapes made by the manufacturers of the boards.

Acceptable is sealing of the joints with the sealing mastic, applied between the edges of the joints in the process of cladding or onto the joints after cladding the frame. Sikaflex A1 sealant can be used as mastic.

Vapor and air-tightness is ensured by solid vapor insulator.

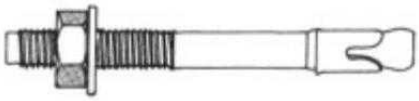
Special film, for example, 0.2 mm thick LPDE (Low-Density Polyethylene) film compliant with the Finnish standard SFS 4225 with protection from ultraviolet radiation, water vapor permeability of $1.83Ч10^{-12}$ kgm is used as vapor insulation.

Fasteners

Thermoprofile frame shall be assembled using zinc-coated self-drilling screws or rivets. Cladding boards shall be fastened using the fastening elements that correspond to the type of the boards. Fixing to the concrete and reinforced concrete structures shall be done by means of various fixing anchors.

The following fasteners are used in the developed technology:

1. HSA-F-M12 stud anchor shall be used to fasten guide profiles to the foundation

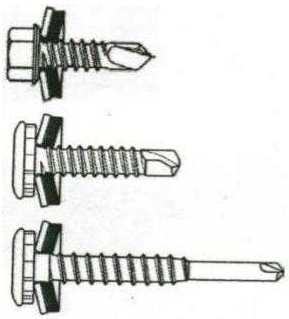


2. SL3-F-/SL4-F- self-drilling screws (depending on the thickness of outer and inner connected profiles) shall be used for fastening thermoprofiles to each other within the framework

3. SD-5 H15-5,5x22 shall be used to connect the panels to each other

SD5-H, SD8-H, SD14-H shall be used depending on the thickness of the connected elements

4. Self-drilling screws with washer pads



SD3-T15-4,8x19

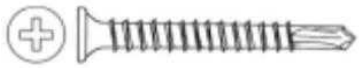
SD3-L15-5,5x45

SD5-T15-5,5x19

SD5-L12-T15-5,5x25

Screw Grades depend on the thickness of the connected elements.

5. Self-drilling screw for gypsum board, 3.5 x 25 zinc-coated, is used for fixing of GFB or GPB boards to the frame



Mounting of a frame by the detailed method

When working by the detailed method, the framework profiles are delivered to the construction site pre-cut to the design dimensions. The detailed method is used in the cases when it is advisable to perform most of operations on site.

1. Preparatory work

Before installation, check completeness of supply and availability of all required fastening elements and sealants on the site. Also check the frame profiles. The elements must be straight, with no significant dents and deformations of torsion. Defective profiles shall be replaced by the new ones.

Installation of the wall frame begins after the basement of the building reaches its designed availability. It is necessary to check accuracy of dimensions of the basement and evenness of its top surface. Permitted deviation of the height of upper surfaces of various parts of the basement shall be not more than 10 mm, the maximum incline shall not exceed 1:1000.

Permissible deviations from the plane of the upper surface:

- on the length up to 200 mm ± 2 mm
- on the length up to 1000 mm ± 3 mm
- on the length up to 2000 mm ± 5 mm

When the deviations exceed the specified values, the defects shall be remedied. For example, it can be done by leveling using cement mortar or by cutting-off with the subsequent grounding with emery.

It is also necessary to check the compliance with the Project of the embedded parts and fasteners built into the basement.

Rectangularity of foundation is checked by measuring of its diagonals.

2. Arrangement of Hydro-insulation

Place the damp-proof tape and joint sealing along the edge of the basement under the lower horizontal chord of the frame. Only use of waterproof socle tape is permitted. The tape is fixed using mechanical fastening devices or adhesive mastic.

3. Assembly of Wall Frame

The frame is assembled in accordance with the assembly drawings. Each element of the frame has its unique identification number; location of each element within the frame is specified in the assembly drawings, as well as the manner of fastening and connection.

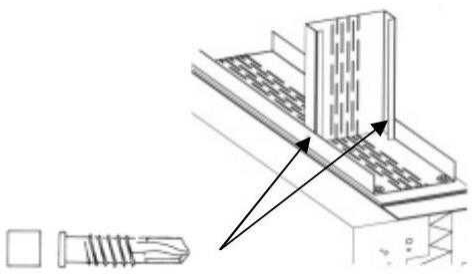
The frame panels are assembled “on the floor”.

The frame elements are put down in the horizontal position in accordance with the assembly drawings. The spacing between the studs has been accepted to be 600 mm, which is necessary for fastening of gypsum boards. АИ ТС Series stud thermoprofiles are used for external walls; АИ ТН Series thermoprofiles are used for horizontal guide profiles. АИ ТС Series stud thermoprofiles are used for internal load-bearing walls. АИ ТН Series thermoprofiles are used for horizontal guide profiles. АИ ПС Series stud thermoprofiles are used for internal load non-bearing walls. АИ ПН Series thermoprofiles are used for horizontal guide profiles. The dimensions of profiles are accepted by calculation and are specified in the working drawings.

After the assembly of the frame, the finished elements are lifted up and installed onto the pre-marked location. Verticality is adjusted with the help of adjusting wedges installed beneath the studs of the framework.

Start the installation of panel framing from the corners of the building. Stiffen the corners by reciprocal fastening of angle units. Perform the installation of the remaining elements in a sequential order along the contour of the building. At the same time, install the connecting pieces of stiffening walls. Raise the elements onto the basement in such a way as not to displace the socle tape laid beneath the panel. Fasten the elements being mounted to the basement using wedge or impact anchors.

Fasten the frame studs to the chords by the low-head self-drilling screws.



It is recommended that the temporary anchorage is set to the studs, located next to the window or door openings, where they would not interfere with assembling of the remaining wall.

The number of temporary anchorage is determined based on the particular situation. Usually, one-story buildings require one temporary anchorage every 3.0 to 3.6 m.

In the course of construction, the frame can be stiffened with the sheet steel diagonals, located in the plane of the walls and fastened to the frame studs by self-drilling screws. In case of use of the low-head screws, the diagonals can be later left under the panel lining.

After completing the installation of the frame, the gaps between its elements shall be filled with insulating materials, vapor-proof membrane installed and lining boards secured. It is recommended that windproof boards are installed in the first turn, followed by installation of thermal insulation, vapor-proof membrane and inner lining. Prior to laying the thermal insulation, the accumulated rainwater shall be removed from the bottom chord.

When attaching the GFB or GPB sheathing, it is necessary to follow the process of fastening of gypsum-fiber boards or plasterboards to the profiles.

The temporary anchorage of the frame can be removed only after the assembly of the elements conferring the ultimate stiffness to the building (stiffening walls).

4. Sealing of the Joints

The joint between the wall and the basement is sealed with the Lignotherm socle tape inserted beneath the lower horizontal chord. If necessary, the lower edge of the wall is sealed with mastic after fixing the lining boards of framing.

Seams of the outside windproof boards that cover the frame from outside are sealed with the adhesive tape or filled with the mastic compound.

Gaps between the window- and door frames, and the frame studs are sealed with the packing wool and sealants being part of the door frame construction.

5. Vapor-Proof Membrane

Vapor-proof membrane is placed between the wall frame and the inner lining boards. During the installation, the film is fixed to the frame using the double-sided adhesive tape, the final fixation is done using lining boards of the frame. On all edges of the vapor-proof membrane shall extend at least 200 mm beyond the

wall. With the help of its extending part, the vapor-proof membrane of the wall conjoins with the vapor-proof membranes of the floor, ceiling and the adjacent walls. Most often the seams and joints of vapor-proof membranes are spliced by the adhesive tape. In more complex areas, the tightness of vapor-proof membrane is ensured by additional films on the adhesive tape or by elastic paste.

Frame Installation by Panel Method.

When installing the frame by the panel method, the thermopanels of which the walls of the building are assembled are delivered to the site with a desired degree of readiness. The panels are lightweight and do not require any heavy-duty lifting equipment.

1. Preparatory Work

Prior to the installation, check the delivery for completeness and quality of the panels. Installation of the thermopanels begins after the load-bearing structures (a basement, in a multistoried building – a load-bearing framework) reach their designed availability.

It is necessary to check the accuracy of dimensions of the basement and evenness of its top surface. Permitted deviation of the height of upper surfaces of various parts of the basement shall be not more than 10 mm, the maximum incline shall not exceed 1:1000.

Permissible deviations from the plane of the upper surface:

- on the length up to 200 mm ± 2 mm
- on the length up to 1000 mm ± 3 mm
- on the length up to 2000 mm ± 5 mm

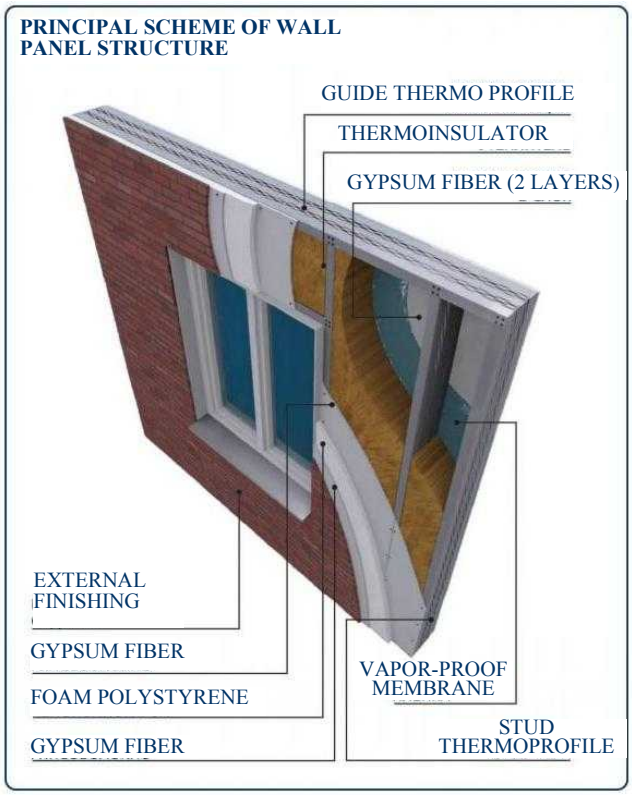
When the deviations exceed the specified values, the defects shall be remedied. For example, it can be done by leveling using cement mortar or by cutting-off with the subsequent grounding with emery.

It is also necessary to check the compliance with the Project of the embedded parts and fasteners built into the basement.

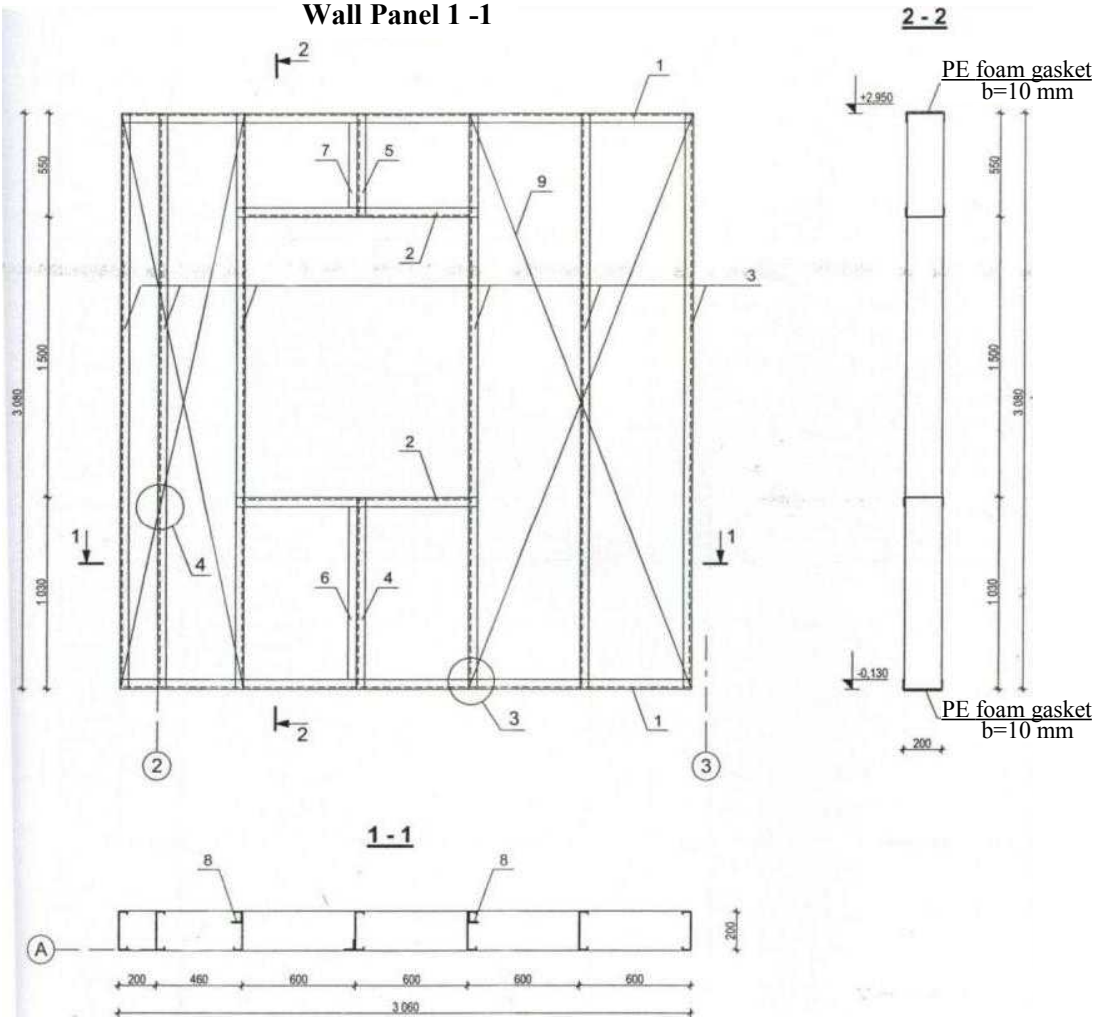
Rectangularity of foundation is checked by measuring of its diagonals.

Positions of thermopanels shall be marked with the lines on the surface of the bearing structure. The socle tape serving as joint sealant is secured onto the bearing surface beneath the panel.

2. Structure of Thermopanel



Thermopanels offer a new alternative in the construction of the external walls of a modern building. The panels are light-weight (the weight of a base element of 175 mm profiles is about 40 to 45 kg/m^2), thin and allow the use of various materials for the external and interior finishing.



Variant of Wall Panel Frame Structure

1. АИ ТН 200-50-1,5
2. АИ ТНп 200-50-1,5
3. АИ ТС 200-45-1,5
4. АИ ТС 200-45-1,5
5. АИ ТС 200-45-1,5
6. АИ У 50-50-0,8
7. АИ У 50-50-0,8
8. АИ У 50-50-1,5
9. АИ Ли 25-0,8
10. PE Foam b=200 h=10

Provision is made for the supporting elements of the 0.7 to 0.8 mm sheet steel in the thermoprofile frame, which are fixed to the frame under the board lining to fasten the built-in stationary furniture. The elements are fastened with the self-drilling screws or rivets through to two or more frame studs.

3. Handling of Thermopanels

When installing the thermopanels, comply with the requirements of the assembly drawings, in which the identification number specifies the location of each element and method of its fastening in the wall.

4. Unpacking of Thermopanels

Cut the packing tapes and remove the protective bars from the sides of the package. The protective film is removed from the lower edge of the panel, keeping it intact for protection of the items during the sustained interruptions in operation. When stacking the panels without any protective film, they should be protected against weather impact.

5. Lifting of Panels

Each panel has lifting eyes (usually two). The pivoted lifting clevis with 19 mm diameter shall be used for lifting.

During the lifting the ropes must be vertical, which preconditions the use of an adjustable lifting traverse. During lifting, the element shall not be suspended inclined. It is recommended that the panels shall be taken in turns on both sides of the package. Please also pay attention to the stability of the package when lifting the elements.

6. Installation of Panels

Fix the ropes to the lower edge of a panel and use them to control the movement of the cargo in the course of construction work. Lift the element to the pre-marked position. Align the panel in the vertical and horizontal directions prior to its disengagement from the pick-up frame. The verticality is adjusted by the mounting wedges being installed beneath the vertical studs of the frame panel. Having aligned the lower edge, align also the upper edge and secure the connecting pieces on it. First fix the panel at its ends; in the last turn install the intermediate fastening devices if any. In single-story buildings, steel squares for mounting the panels are mainly used, in multi-storey buildings special fasteners are used.

In single-story buildings, installation of panels is started from the corners of the building. The corners are stiffened by reciprocal fastening of L-shaped panels and their fixation with temporary backstays. Installation of the remaining wall panels is carried out in a sequential order along the contour of the building. At the same time, the connecting pieces of the stiffening walls are installed. During installation, the panels are supported by the temporary backstays (2 – 3 pieces per panel), which rest upon the wedges hammered into the ground. Raise the panels on the basement in such a way as not to displace the socle tape laid beneath the panel. Having temporarily fastened the element, its lower edge is secured on the foundation by the designed method. Usually wedge or impact anchors are used for this purpose. The panel is only released of the hoisting appliance tongs after it has been fixed.

The panels already mounted must be protected against the adverse effects of atmospheric conditions and the potential damage during construction. Usually they are protected with the film. As a minimum protection measure, the upper edge of the panel is covered with the film band having the width of about one meter. The edges of the band are affixed with the adhesive tape to the panel facing boards. The band of the film is removed after the completion of roofing work.

Temporary fasteners of the panels can be only removed after the elements ensuring spatial stiffness of the building (stiffening panels) have been installed.

7. Sealing of Joints between the Panels

The joint between the wall and the basement is sealed with the socle tape laid beneath the lower horizontal chord of the element. If necessary, the lower edge of the wall is sealed with mastic from outside.

To seal interpanel vertical and horizontal joints, the tubular rubber gaskets (as well as mineral wool) which are fixed to the elements are used most often at the construction site. During the installation, precautionary measures shall be taken so as not to displace the gaskets from their seats. The horizontal joints between the panels and the corner joints shall be additionally packed with the strips of mineral wool, 20 to 40 mm wider than the width of the joint, and shall be closed with windproof board of suitable width. The joints of the windproof boards are sealed with the adhesive tape or filled with the mastic compound.

8. Vapor Insulator

Vapor-proof membrane is placed into the thermopanels as early as at the manufacturing factory. The membrane extends at least 200 mm beyond the panel at its lower and upper edges and allows connecting the vapor insulators of walls, floors and ceilings (in most cases, adhesive tape). Resistance of interpanel vertical joints to vapor penetration is ensured with the help of rubber tubular gaskets. If necessary, joints can be additionally sealed from the inside with mastic.

9. Communications

When using the panel method, it is recommended that communications (electric wiring) shall be mounted on the inner surfaces of walls, or underneath plinths, or in the appropriate conduits.

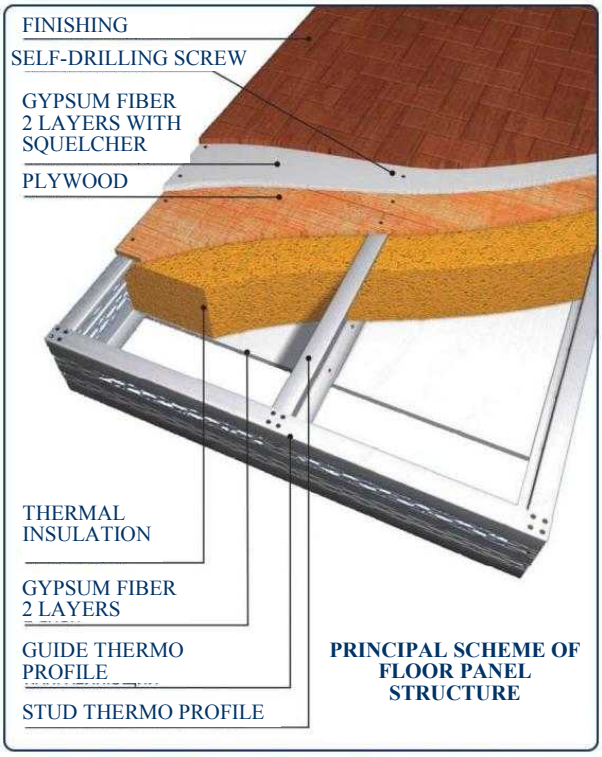
Installation of Flooring

There are several options of installation of flooring.

1. Assembly of the flooring panels on the floor

Assemble the frame of the floor panel, which consists of the guide and the stud thermoprofiles, according to the assembly drawings. Lay the thermal insulation between the elements of the frame. The bottom skin of the panel consists of two layers of gypsum fiber. In the upper part of the panel, the plywood is

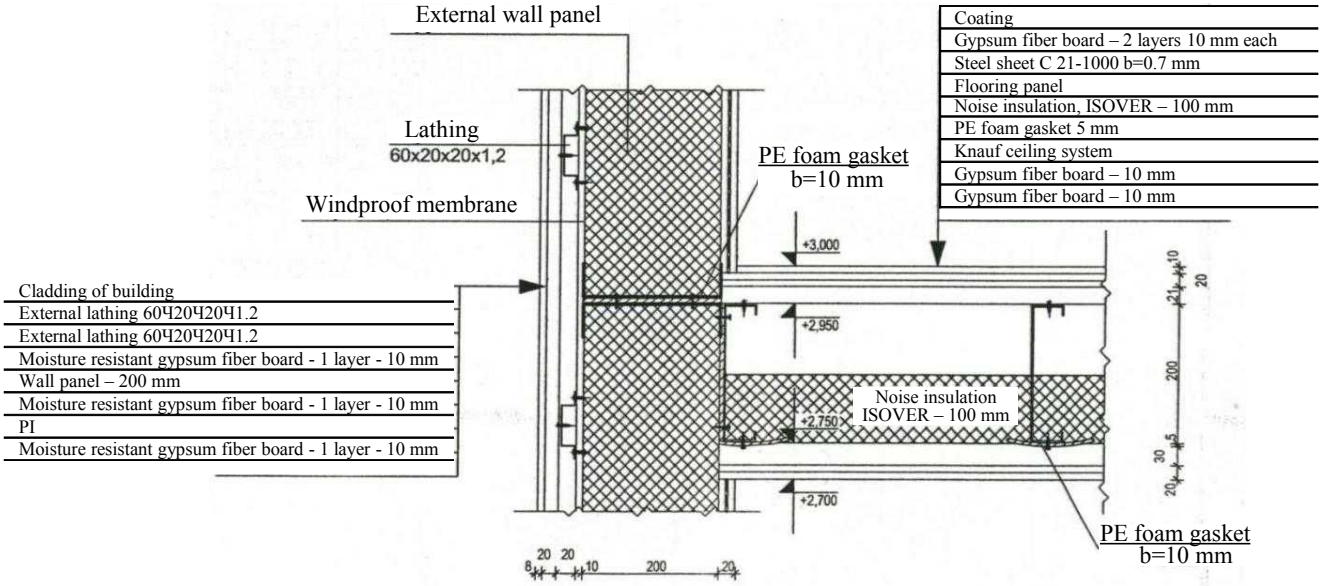
attached to the frame and serves as a substrate for the gypsum fiber. This structure ensures even distribution of the load over the area.



Mount the finished panels onto the supporting contour of the storey according to the drawings (floor-framing plan of the first or the second floor).

2. The variant of element-by-element installation of the flooring on the mounted and reinforced frame is possible.

The bearing flooring frame is constructed of АИ ПС Series girders and АИ ПН edge girders. The thickness of profiles is 1.5 to 2 mm, the height is 150 to 300 mm, depending on the loads taken up. The flooring with the girders of 200 mm in height spans up to 4.2 m. The increased cross-section girders can span up to 6 m. The service penetrations shall be made in load-bearing profiles prior to assembling of the structures.



Connect the flanges of flooring girders to the flanges of guide girders using SL Series self-drilling screws – one self-drilling screw per each flange from the top. Fasten the flooring girders with self-drilling screws to the board girders via the angle.

Lay on the top of the girders the formed steel sheet, which unties the upper flange of girders out of their plane, and serves as underflooring. Fasten the steel sheet to the edge girders and to the floor girders with self-tapping screws. Mount the gypsum fiber board floors in accordance with Construction Rules SP 55-102-2001 “Structures with the Use of Gypsum Fiber Boards”, and the boarded ceilings in accordance with Construction Rules SP 55-101-2000 “Enclosing Structures with the Use of Gypsum Boards”.

The flooring underlay is formed of 2 layers of moisture-resistant gypsum fiber boards (MRGFB). The boards are fastened with screws. Isolon Polyethylene Foam elastic lining is required in case of parquet laminate floors.

The floors shall be preferably made of a roll or large-sized products such as linoleum, parquet laminate, etc.

Suspended ceiling comprises a metal grating of a furring channel, fixed to the lower flange girder with the acoustic cleats, a lining of two layers of gypsum plasterboards and a layer of sound insulator of mineral wool boards.

Garret Floor

Garret floor includes a steel frame, diagonal braces, a boarded ceiling of GPB or GFB, and a thermo-insulating layer of mineral wool boards.

The frame includes the thermoprofile edge girders, fastened to the walls, the thermoprofile joists running with the interval of 600 to 1200 mm, and the lathing along the bottom chords of the furring profile joists, lathing interval is 400 mm. The garret floor is always located below the bearing structures: trusses or floor girders.

Occupational Safety and Health

1. Work Place Arrangement

The premises, areas of work and work places must be prepared with a view to ensuring safe working practices.

Preparatory activities shall be completed prior to the commencement of work.

Production equipment, appliances and tools used for work place arrangement shall comply with the labor safety requirements.

The premises, work areas and work places shall be provided with the necessary means of collective or personal protective equipment, emergency firefighting equipment, as well as means of communication, signaling and other technical means for ensuring occupational safety in accordance with requirements of acting regulatory documents and terms of agreements.

Places of temporary or permanent locations of workers (amenities, leisure areas and passages for people) when arranging and maintaining the premises, areas of work and work places shall be located outside the hazardous areas.

Machinery, transportation vehicles, industrial equipment and other means of mechanization shall be used as intended and shall be applied under the conditions specified by the manufacturer.

Lifting hooks of weight-handling fixtures (straps, cross dikes) shall be equipped with safety locking devices, preventing spontaneous falling out of the cargo.

When operating the hand-held machines, fulfill the following requirements:

Check the completeness and security of fastening of parts, serviceability of protective enclosure, cable before the start of each shift;

Before starting work, check the running order of the switch and the machine at idle;

During breaks at work, after work, as well as when carrying out lubrication, cleaning, changing the working tool, turn off the hand-held machines from the mains;

When operating the machines at heights, use stable scaffolds.

2. Loading and Unloading Operations

Transportation vehicles and equipment used for loading and unloading operations must correspond to the nature of the handled cargo.

The platforms for loading and unloading operations shall be planned and have a slope not more than 1:10.

Mechanized method of loading-unloading operations is compulsory for cargo weighing over 50 kg, and when lifting the cargos to the height of more than 2 m.

3. Installation Works

At the site where installation works are carried out, performance of other works and presence of unauthorized persons is not permitted.

When constructing the buildings and structures, presence of people is prohibited on the site over which the elements of building units are transferred, installed and temporary secured.

In the process of erecting the structures, the installers must be positioned on the previously installed and securely fastened structures or scaffolding.

Staying of people on the structural elements during their lifting and moving is forbidden.

To move from one construction to another, the installers shall use ladders, catwalks and stairways with guard-railing.

Passage of the installers along the installed structures and their elements (trusses, joints), where there is no possibility to install the catwalks with guard-railing, is only allowed with the use of special safety builder's fittings.

Staying of people under the element being installed is forbidden until it is installed into its design position.

Braces for a temporary fixation of the elements being installed must be securely anchored. The number of braces, materials and cross sections thereof, pull-up methods and fixing points must correspond to the designed ones.

The elements of the installed structures shall be restrained from swinging and rotating during their transfer by flexible back-stay cables.

Slinging of structures shall be performed using the means meeting the requirements of Construction Norms & Regulations СНиП 12.03 and ensuring the possibility of remote removal of slings from the working horizon in the cases when the height to the lock of the slinging equipment exceeds 2 m.

Slinging of the elements being installed shall be performed at the locations specified in the working drawings. The elements shall be lifted and delivered to the installation site in the position close to the project position.

Hoisting of the elements of building constructions that do not have lifting eyes, holes or marks and labels ensuring their proper slinging and installation is forbidden.

Cleaning of the structural elements subject to installation of dirt and ice shall be performed prior to their lifting.

Mounted items shall be lifted smoothly, without jerks, swinging and rotation.

III. Roof

Roof framing consists of trussed rafters or joists made of thin-walled zinc-coated steel. The use of light formed sections of thin sheet metal in the rafter systems having the span of 6 to 15 m allows reducing consumption of steel to a minimum. The following systems of lightweight truss constructions are used:

- Dual- or single-pitch trusses with a lattice of slanted struts or slanted struts and studs
- Three-hinged lattice trusses with collars;
- Suspension rafters with a collar, and usually there is one suspension rod, more rarely – two or more;
- Simple rafters with collars. Cross sections of rods of steel trusses and joists are made of light steel thin-walled structures.

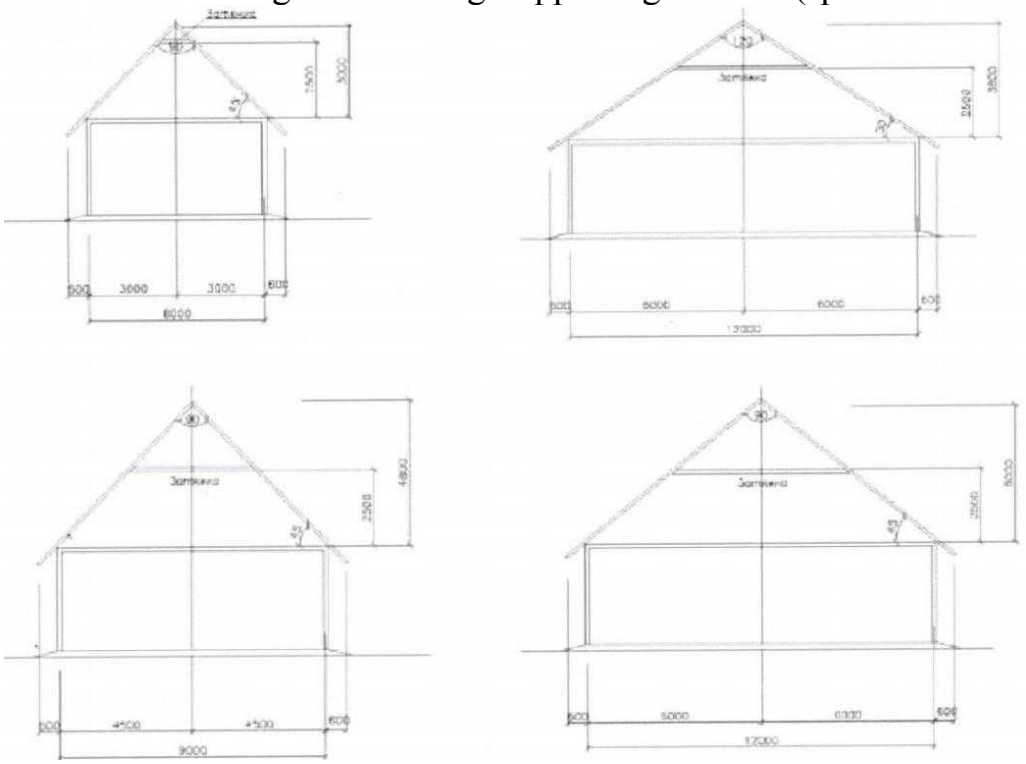
Corresponding to the project positions of roof trusses are marked on the top chord of the frame. Trusses shall be positioned exactly over the uprights of the frame (permissible deviation is ± 10 mm).

Roof trusses shall be lifted into their position and secured to the top chord using the steel L-bars. Vertical position of trusses is supported by the inter-truss braces.

Design of the roof of joists is used in case of spans of 6 to 12 m

Bearing rafter joists of roofing are located in the roofing cold zone above the thermal-insulated garret floor. The solution of connection joints of the load bearing structures and the garret floor eliminates appearance of “cold joints”.

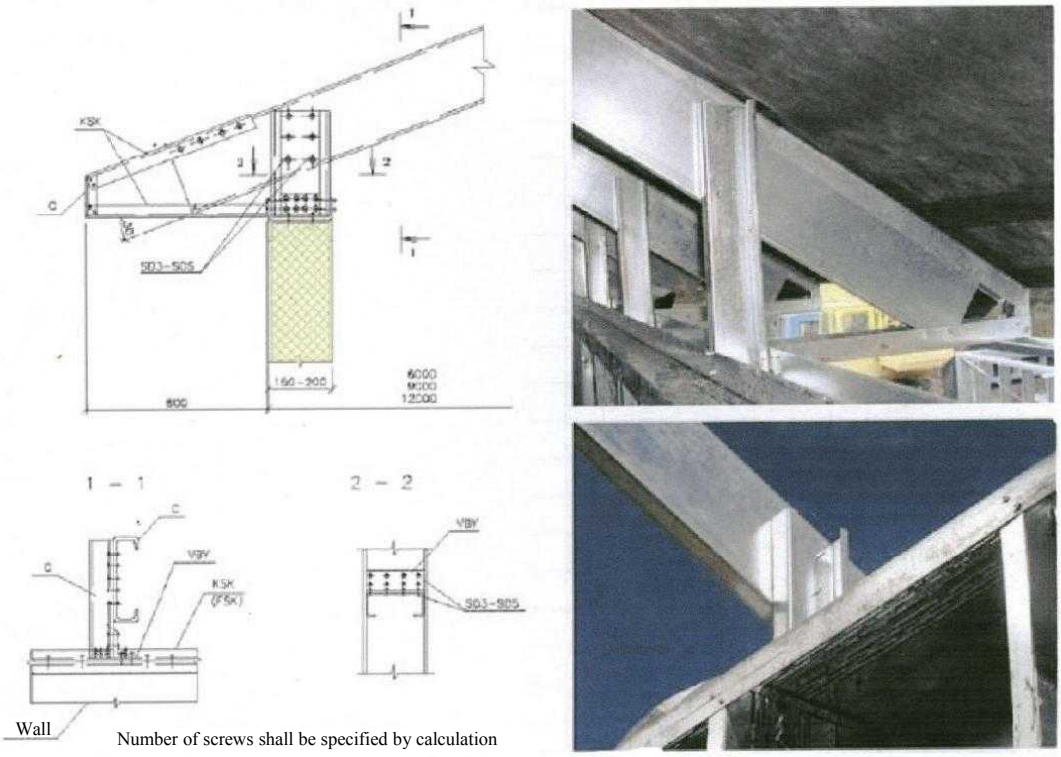
Schemes of Roofing with Ceiling Supporting Trusses (spans 6 – 12 m)



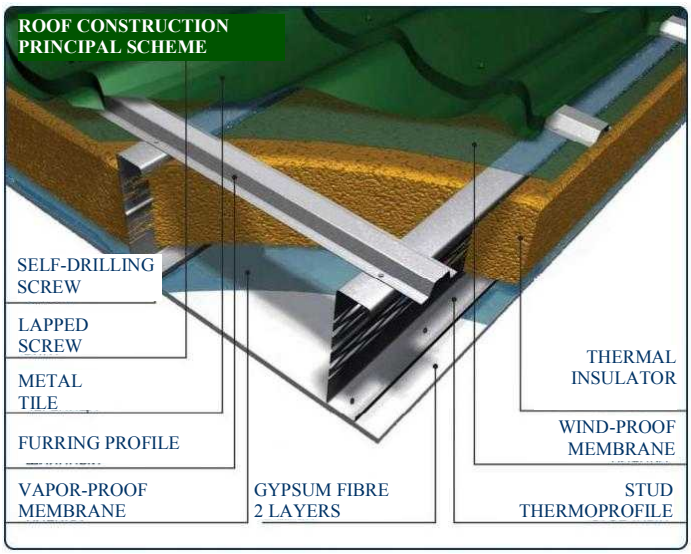
The joists shall be laid with the interval of 1200 mm, in such a way that the joists rest on the bearing uprights of the frame. If the joists rest on the walls in the area of lintel block, the lintel blocks shall be strengthened.

To ensure the spatial rigidity of the roofing along the top chords of the joists, the horizontal braces shall be arranged. Positions of installation of braces shall be specified in the installation drawings. The joists are made of a conventional profile whose height is determined by calculation. To the bottom flanges of the joists thermoprofile shall be fastened with the interval of 600 mm.

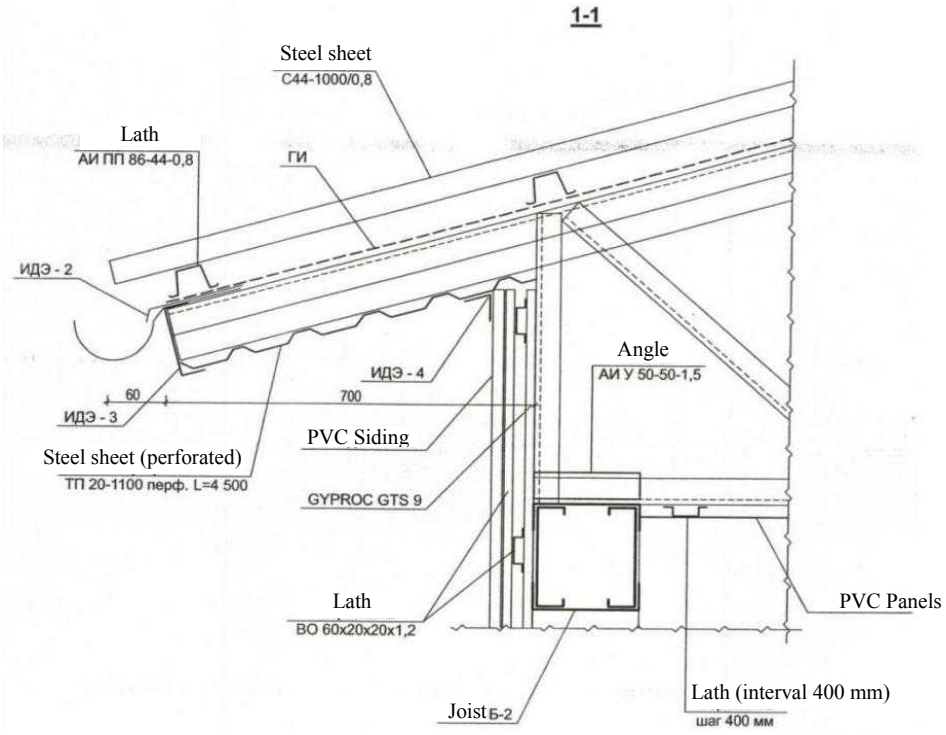
Resting of the ceiling supporting trusses on the wall panels

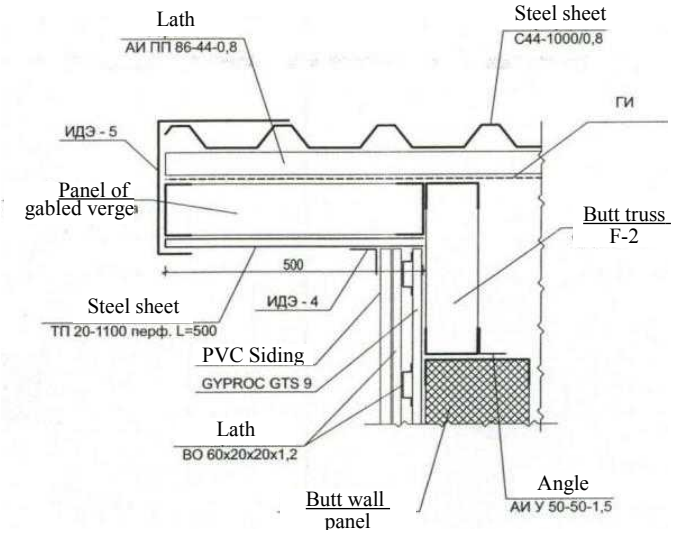


After construction of roof framing, the construction of roof is carried out.



Lay the vapor-proof membrane and two layers of GFB or GPB along the bottom chord of the bearing structures. Place the thermal insulator between the bearing elements. Windproof membrane is included into the roof design. Furring profile is used as roofing lath. Furring profile interval depends on the type of roofing material: metal roofing tiles or corrugated steel sheet. For metal tile roof, 400 mm interval of roofing lath is adopted, for the corrugated steel sheet – 600 mm interval. Fastening of the sheets to the lath is performed at the bottom of the corrugation with the self-drilling screws through the corrugation.





Quality of the Work Performed

Monitoring of roofing work quality shall be carried out during the performance of work, as due to the peculiarities of construction, the part of work appears hidden and difficult to check in future. Conformity of the roof structural elements and materials with the design requirements and work performance specifications shall be checked during the intermediate inspection.

The deviation of the roof elements from the actual slope ratio from the designed is only permitted in the certain places, and shall not exceed 5% for the pitched roofs and 2 - 3% for the terrace roofs.

The corrugations of the laid sheets must match against each other and have no cracks, profile distortions, and through holes.

Occupational Safety and Health

When performing the roofing work on construction of metal roofing, the listed below measures shall be provided for to prevent exposure of workers to the following hazardous and harmful factors related to the nature of work:

location of working place close to the height difference of 1.3 m or more; increased gas content in the air of the working area;

elevated or lowered temperature of the surfaces of equipment, materials and the working zone air;

elevated or lowered temperature of the surfaces of equipment, materials and the working zone air;

sharp edges, burrs and roughness on the surfaces of equipment and materials;

overvoltage in the electric line whose short circuit may pass through the human body.

Climb the roof and descend from the roof only using the stair flights, equipped with the stairs for climbing the roof.

The workers who perform the work on the roof with a slope of 20 degrees, as well as on the roof coverings not designed to hold the load of workers' weight shall use the ladders with the width of at least 0.3 m and with the cross bars for feet support for the passage. The ladders shall be fixed at the time of work.

When working on the roof with a slope of 20 degrees, the workers must use safety harnesses in accordance with the requirements of Constructions Norms and Regulations СНиП 12-03.

Performance of roofing work during the ice crust, the fog, excluding the visibility within the working area, thunderstorm, and wind speed of 15 m/s or more is not permitted.

Elements and parts of roofs, including expansion pieces in the joints, protective aprons, joints of storm-down pipes, gutters, cantilevers, etc. shall be delivered to the work places preassembled.

Assembly of these elements and parts directly on the roof is not permitted.

Conclusion

The market of house-building industry with use of thermoprofile is growing rapidly. The technology has opened new opportunities to improve the construction quality, reduce costs and shorten the time-lines. In most European countries, as well as in the USA, Canada, and Australia the low-rise houses of this design make up to 80% of the housing sector.

This technology is used to build:

- Resident houses up to three stories;
- Multi-storey buildings with use of different types of panels;
- Building and construction in Siberia and the Far North;
- Building and construction in areas of natural disasters and military operations;
- Attic construction, reconstruction of the roofs of buildings;
- Building and construction in seismic areas.

Moreover, the technology allows the reconstruction of buildings, erecting attics, additions to the structures and build-ups.

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