Erasmus+ Project ID: 2023-1-ES01-KA220-HED-000156652

Data of building to Study

1. Data of Spanish Case Study – Single-family house

2. Data of Lithuanian Case Study – Dormitory building

3. Data of Romanian Case Study – School building

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Data of the Spanish Case Study

1. Case Study Approach

Spanish case study consists of analysing the energy demand and consumption, as well as proposing alternatives that improve its efficiency, of an existing single-family house, type terraced house, located in the municipality of Ceutí, Spain.

2. Description of the single-family house

2.1. Introduction

The terraced single-family house consists of a basement, first floor and second floor. The roof of the house is a flat roof. This building was built in 2023.

The basement has a space of 60 m^2 for vehicle parking and a storage room of 12 m^2.

The first floor has an interior usable area of 56 m^2, not including stairs. The spaces on the first floor are a bedroom, a living room, the kitchen and a bathroom. On the outside of the first floor, the house has a terrace of 13 m2 where the main door of the house is.

On the second floor it has an interior usable area of 54.6 m^2, not including the staircase. This floor consists of 3 bedrooms, and a bathroom. On the outside of this floor, one of the bedrooms has a balcony of 3 m^2 useful.

The width of the façade of this terraced house is 7.71 m and the depth is 11.64 m. On the main façade of the house has a fenced plot of 36 m2 where the ramp is located to go down to the basement with the vehicle.

Figure 1: Terraced houses in Spain

2.2. House Plans

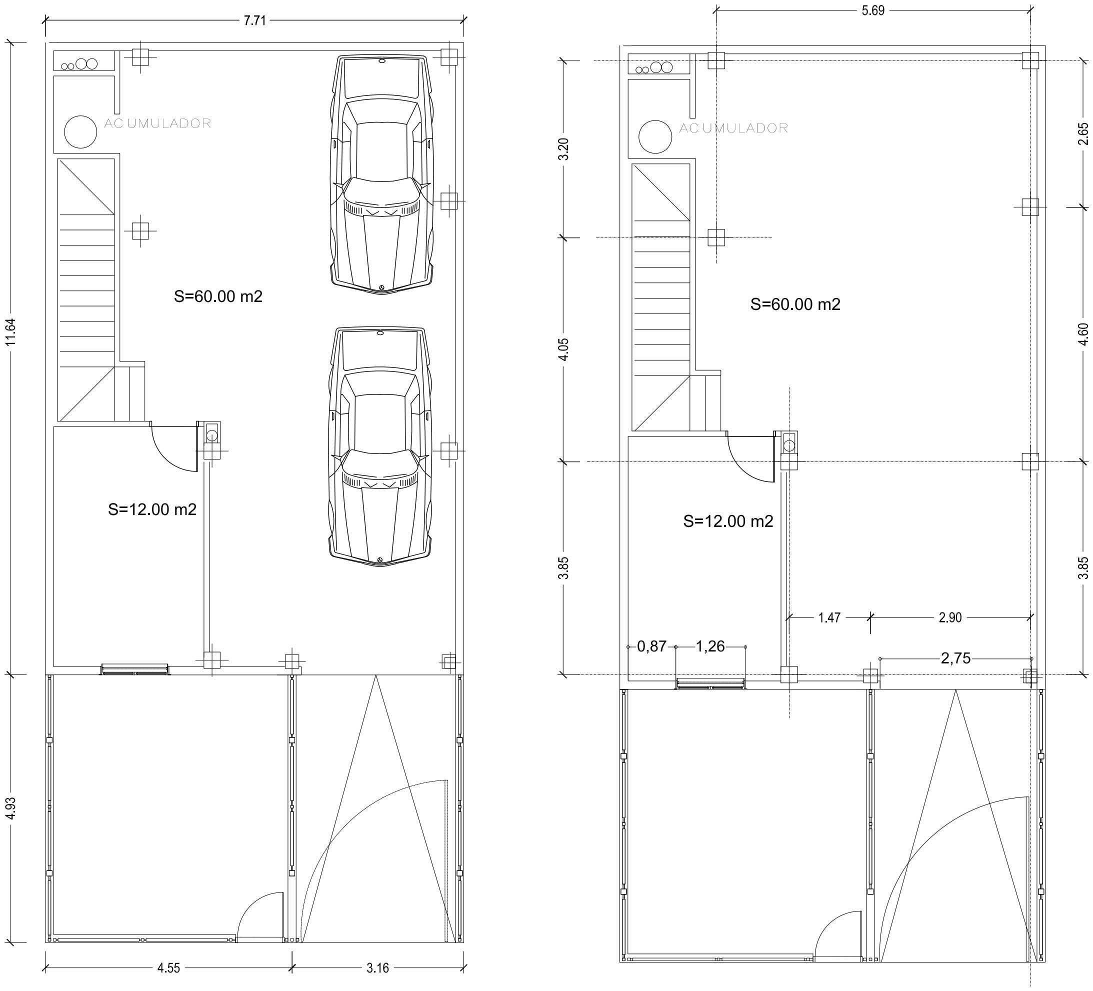


Figure 2: Basement Floor Plans

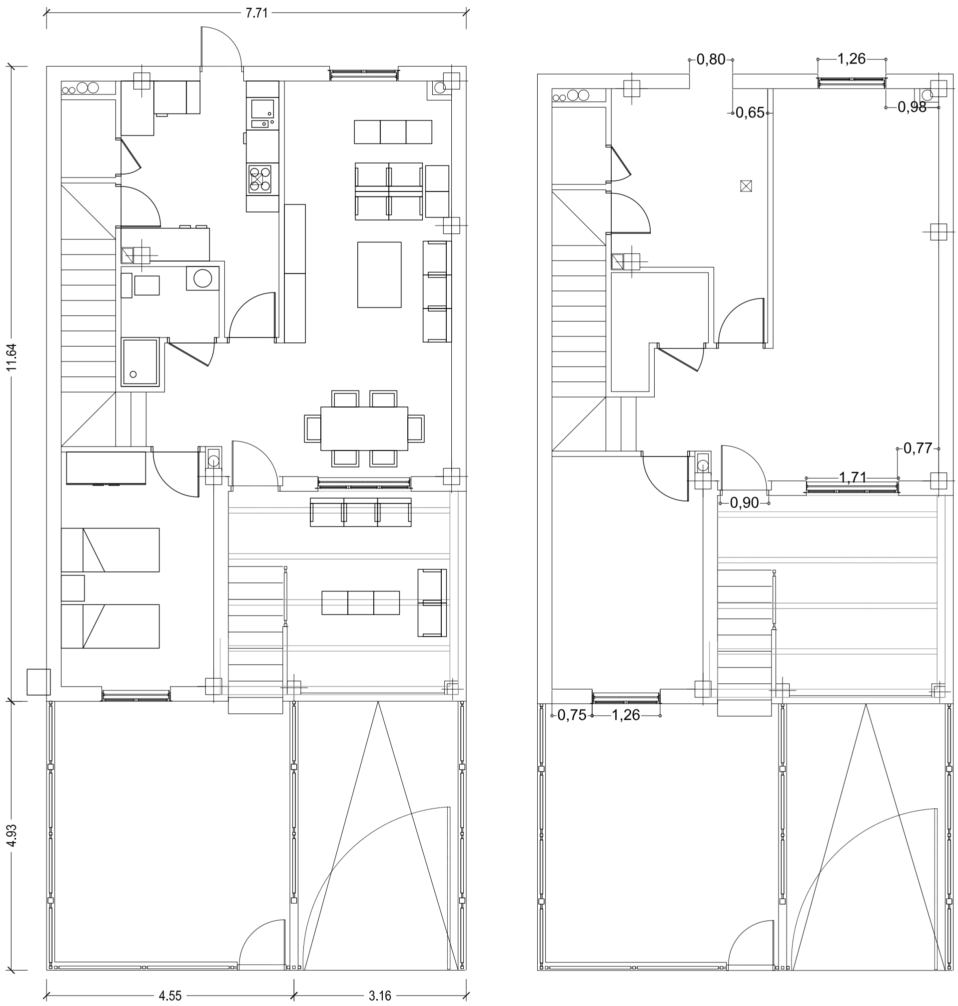


Figure 3: Fist Floor Plans

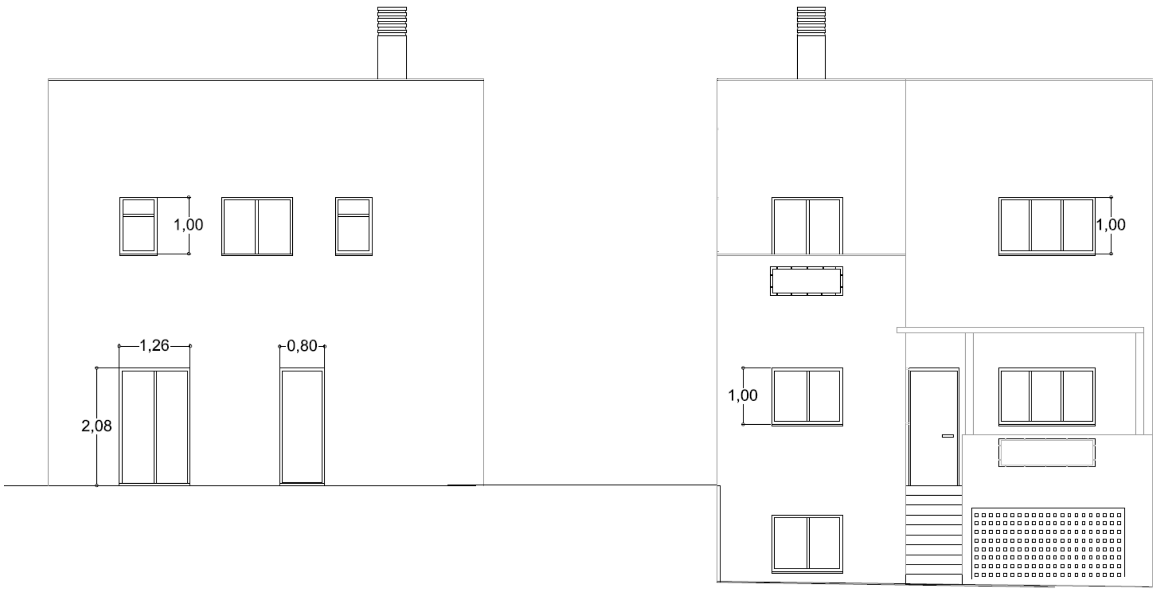


Figure 5: Rear and front elevations.

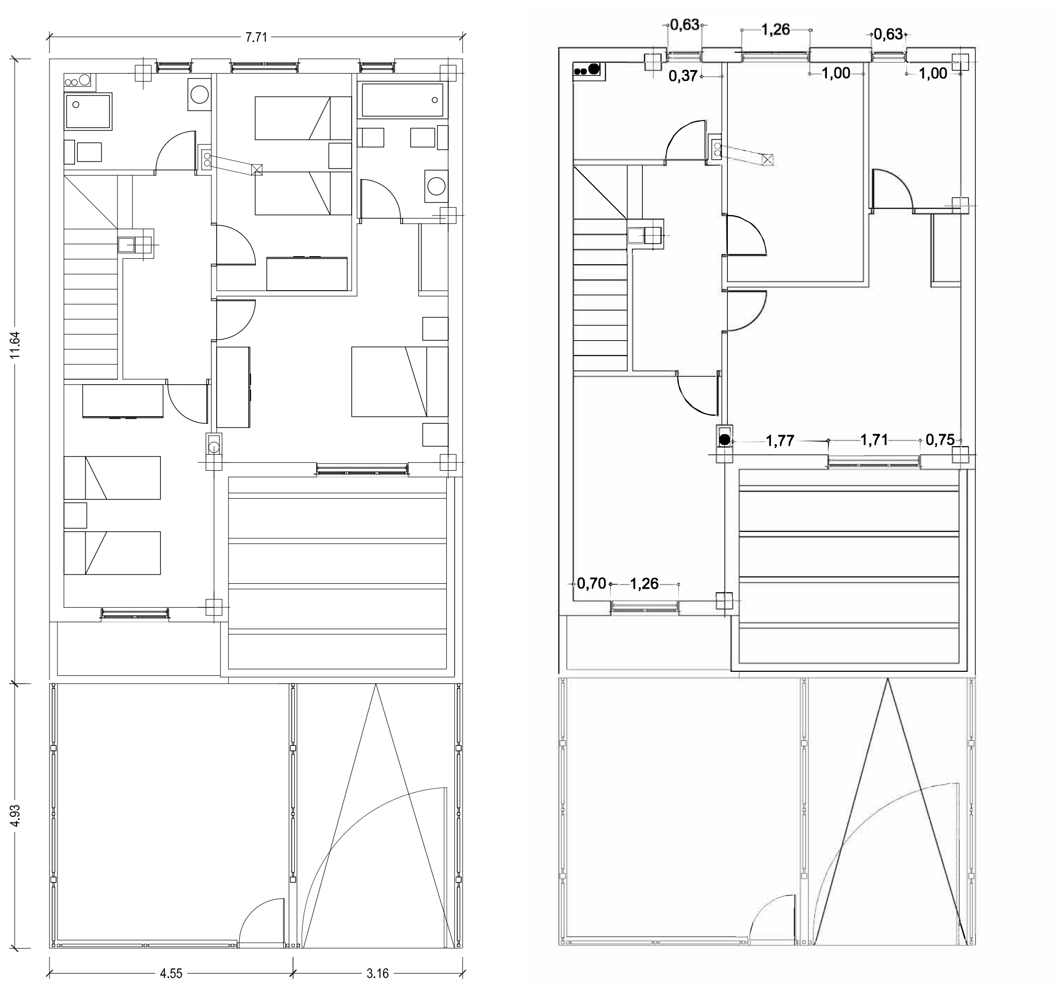


Figure 4: Second Floor Plans

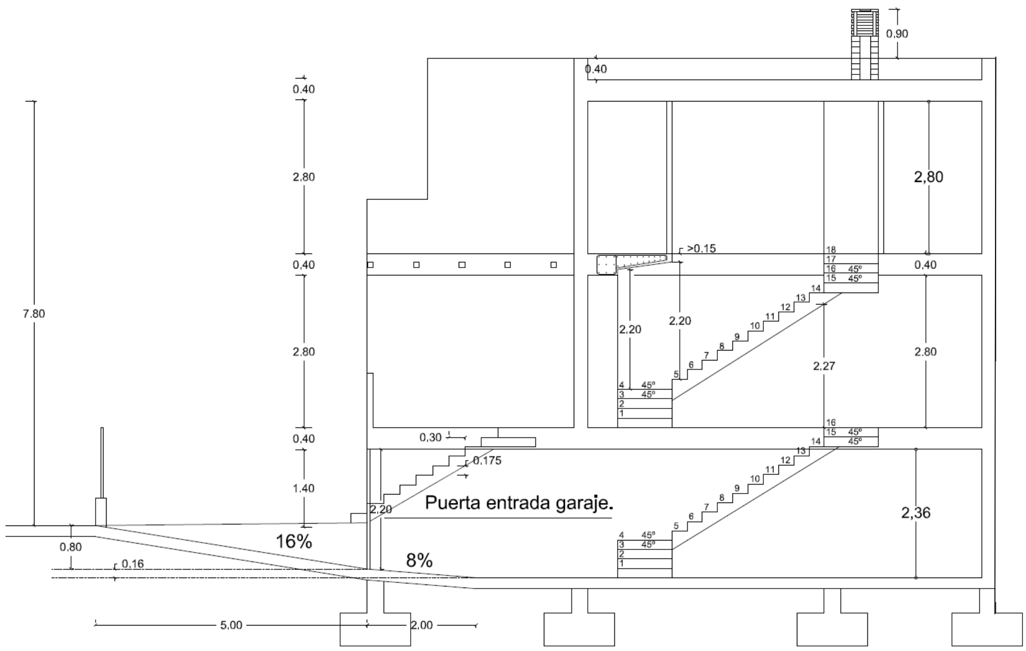


Figure 5: Building section.

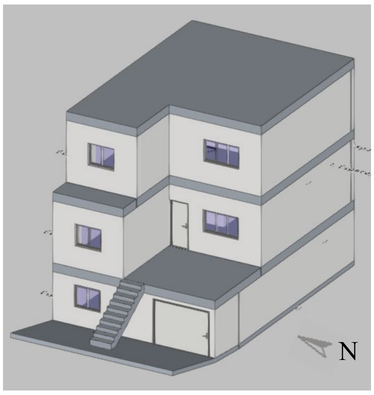
2.3. Location

This detached house is located in the municipality of Ceutí, province of Murcia (Spain)

The location data of this building are the following:

Location data		
City	Ceutí	
Altitude	94.000	m
Latitude	38.1	degrees
Longitude	-1.3	degrees
Time zone	0.0	
SCOP climatic conditions	Warm climate	

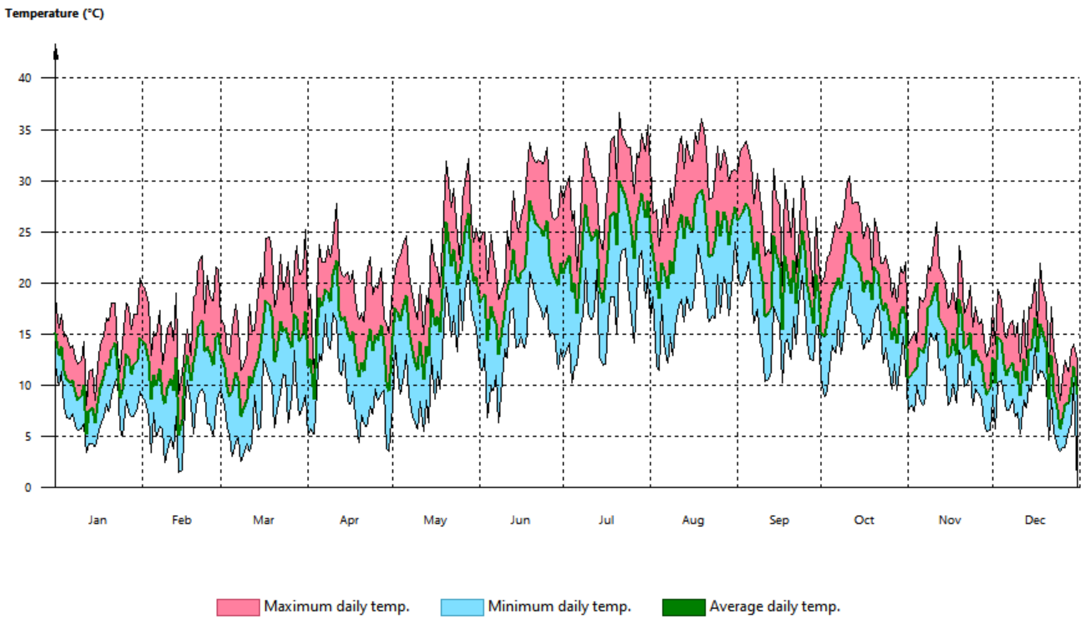
The main façade of the house faces west.



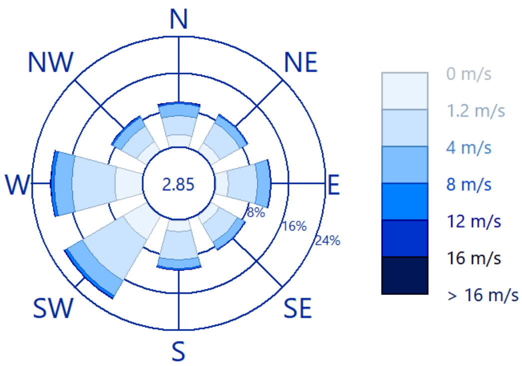
2.4. Climatic zone

The climatic zone in which the house is located is B3 according to the Spanish standard of energy efficiency in the building.

The data of the **outside temperature** considered in this case study in this climatic zone are as follows:

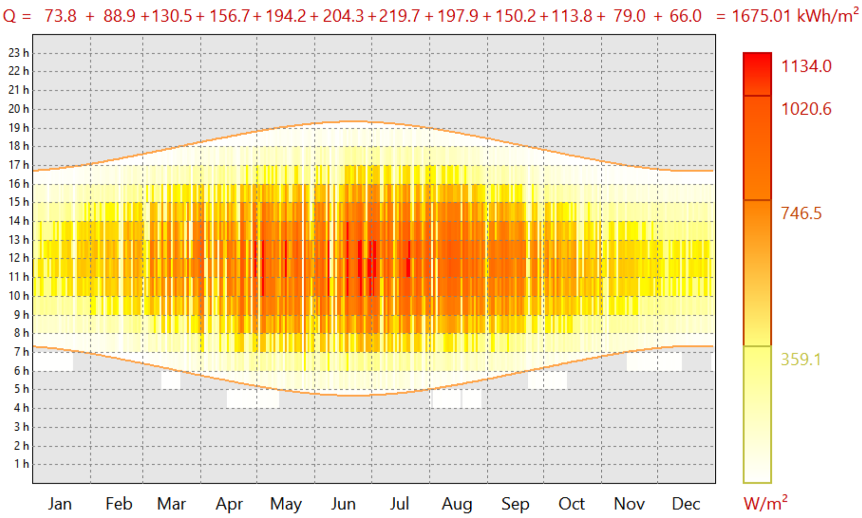


Wind distribution:



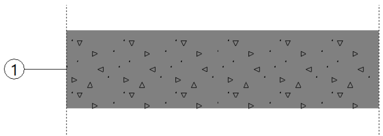
Solar irradiation on the site of the house:

The graph below shows the global irradiance on a horizontal surface



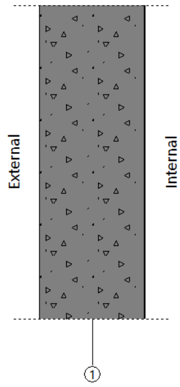
2.5. Thermal Envelope Materials

Floors in contact with the ground (screed)



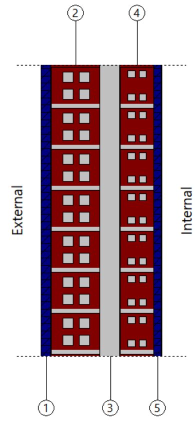
Layers
1 - Concrete. Medium density (density 1800): 15.00 cm Total thickness: 15.00 cm
Thermal description
Thermal resistance: 0.13 (m²·K)/W

Walls in contact with soil



Layers
1 - Concrete. Medium density (density 2200): 20.00 cm
Total thickness: 20.00 cm
Thermal description
Thermal resistance: 0.12 (m²·K)/W

Façades



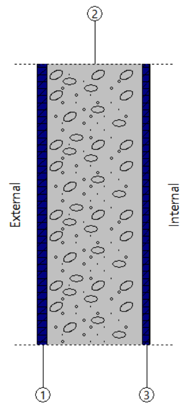
Layers
1 - Cement, sand: 2.00 cm
2 - M01 - 100 mm brick: 10.16 cm
3 - F04 - Wall air space resistance: 4.00 cm
4 - M007 - 70 mm brick: 7.00 cm
5 - Gypsum (density 600): 1.60 cm
Total thickness: 24.76 cm
Thermal description
Heat transfer coefficient (U): 1.61 W/(m²·K)
Thermal capacity: 53714.62 J/m²·K

Façade openings

Windows with aluminum frame and monolithic glass

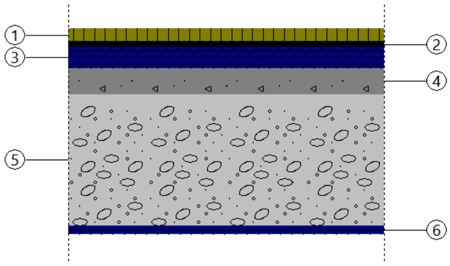
Heat transfer coefficient (U)	5.70	W/(m²·K)
Solar heat gain coefficient	0.70	

Party walls



Layers
1 - Cement, sand: 2.00 cm
2 - M03 - 200 mm LW concrete block: 20.32 cm
3 - Gypsum (density 600): 1.50 cm
Total thickness: 23.82 cm
Thermal description
Heat transfer coefficient (U): 1.29 W/(m²·K)
Thermal capacity: 37649.65 J/m²·K

Roofs

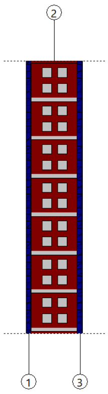


Layers
1 - F18 - Terrazzo: 2.54 cm
2 - Asphalt: 1.00 cm
3 - Cement, sand: 4.00 cm
4 - Concrete. Reinforced (with 2% of steel): 5.00 cm
5 - M04 - 300 mm LW concrete block: 25.00 cm
6 - Gypsum (density 600): 1.50 cm
Total thickness: 39.04 cm

Thermal description
Heat transfer coefficient (cooling): 1.36 W/(m²·K)
Heat transfer coefficient (heating): 1.51 W/(m²·K)
Thermal capacity: 145567.19 J/m²·K

2.6. Interior partitions and Intermediate slabs.

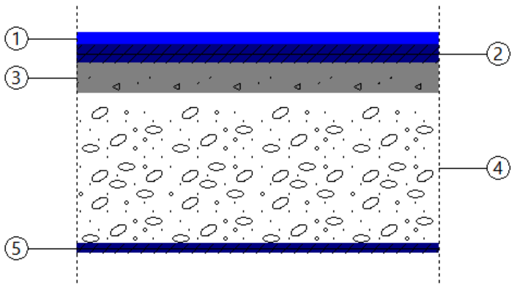
Interior partitions



Layers
1 - Gypsum (density 600): 1.00 cm
2 - M01 - 100 mm brick: 10.16 cm
3 - Gypsum (density 600): 1.00 cm
Total thickness: 12.16 cm

Thermal description
Heat transfer coefficient (U): 2.06 W/(m²·K)
Thermal capacity: 53129.19 J/m²·K

Intermediate slabs



Layers
1 - Ceramic/porcelain: 2.00 cm
2 - Cement, sand: 3.00 cm
3 - Concrete. Medium density (density 2200): 5.00 cm
4 - M03 - 200 mm LW concrete block: 25.00 cm
5 - Gypsum (density 600): 1.50 cm
Total thickness: 36.50 cm
Thermal description
Ceiling slab
Heat transfer coefficient (cooling): 1.00 W/(m²·K)
Heat transfer coefficient (heating): 1.16 W/(m²·K)
Floor slab
Heat transfer coefficient (cooling): 1.16 W/(m²·K)
Heat transfer coefficient (heating): 1.00 W/(m²·K)
Floor slab exposed to open air
Heat transfer coefficient (cooling): 1.25 W/(m²·K)
Heat transfer coefficient (heating): 1.15 W/(m²·K)
Thermal capacity: 141371.08 J/m²·K

2.7. Heating and air conditioning systems

The heating and air conditioning system is a multi-split direct expansion system with the properties shown in the following Figure.

TOSHIBA

Outdoor unit

Equipment: RAS-4M27U2AVG-E

Maximum number of internal units: 4
Gross rated total cooling capacity: 8000 W
Gross rated cooling COP: 3.5
Gross rated heating capacity: 9000 W
Gross rated heating COP: 4.67

Control of the operating mode: Load priority

Total pipe length: 30.000 m

The system includes 4 indoor units as the following:

Indoor unit

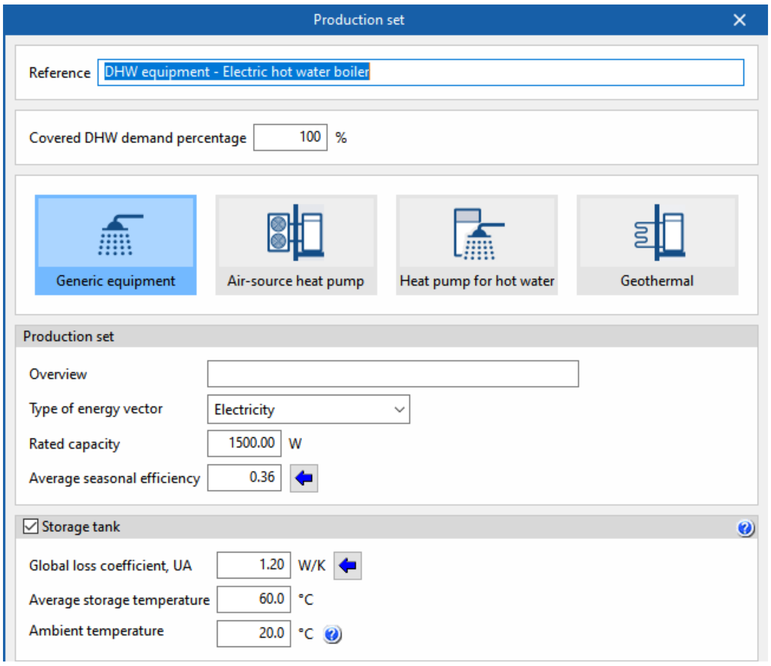
Cassette: RAS-M10U2MUVG-E

Gross rated total cooling capacity: 2500 W
Nominal cooling power: 2000 W
Gross rated heating capacity: 3200 W

Operational conditions: Minimum temperature inside the house is 20 degrees and maximum 25 degrees.

2.8. Domestic hot water system

The domestic hot water system consists of an Electric hot water boiler.



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Technical characteristics of the building
DORMITORY

1. Location of the building

Dormitory building is located in Staneviciaus g. 108, Vilnius, Lithuania (see Fig. 1).

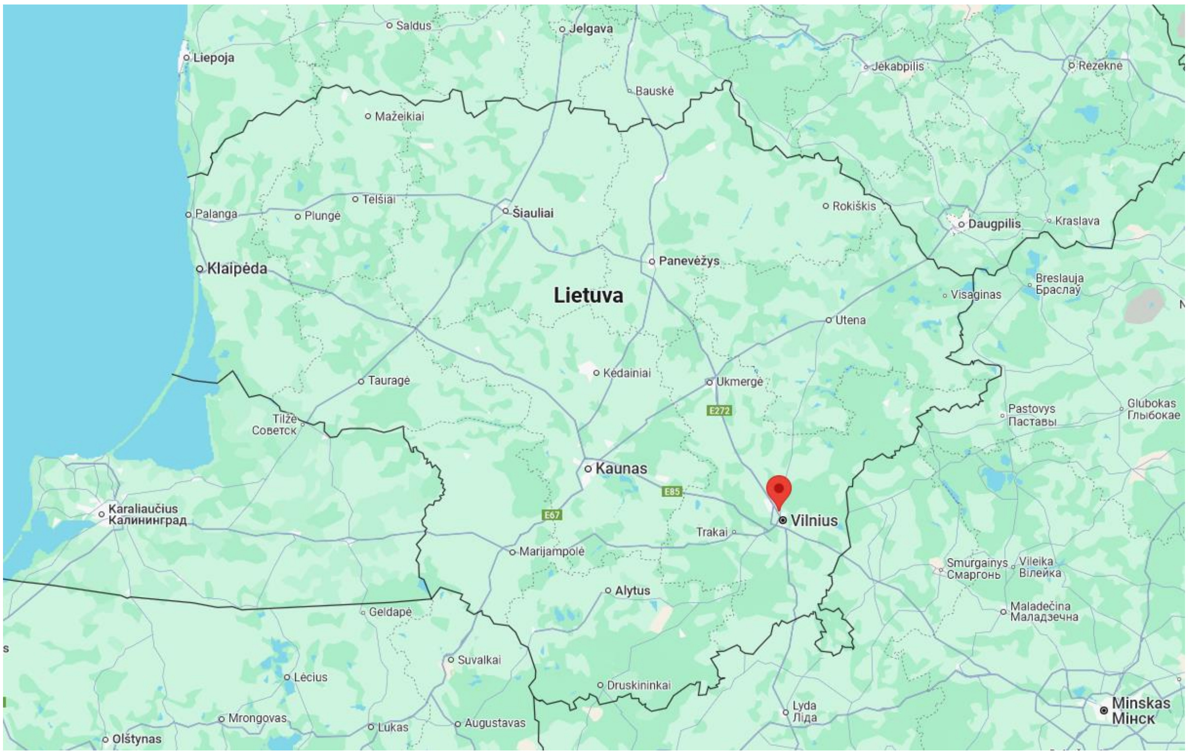


Figure 1 Location of the building.

The geographical coordinates of this building are:

Latitude: 54°43'52.7"N

Longitude: 25°15'14.8"E

Figure 2 Site location on a map.

Elevation: 176 m

Figure 3 Elevation of the location.

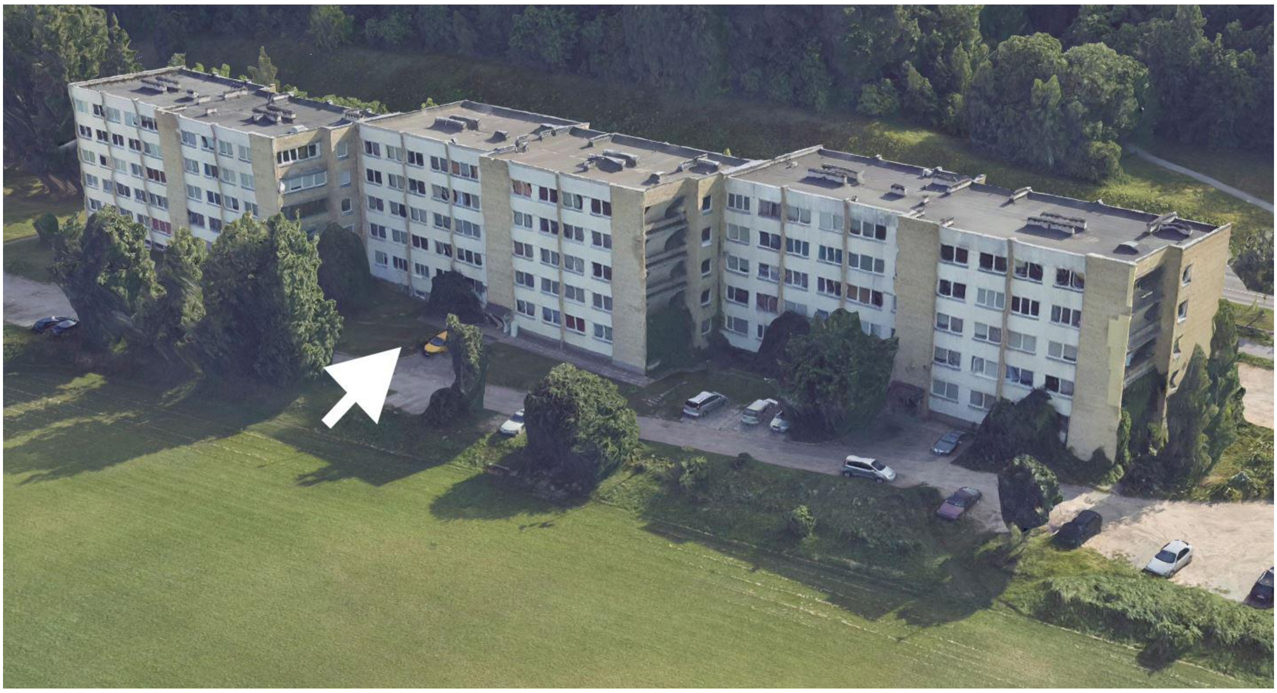
2. Orientation of the building

Picture 1 Orientation of the building. Top view.

Main entrance (front facade) of the dormitory is located on the East side of the building, facing Stanevičiaus Street.

Picture 2 East façade and the main entrance.

Picture 3 East façade.



Picture 4 West façade.

Picture 5 West façade.

Picture 6 West façade.

Picture 7 East façade.

3. Physico-geographical characteristics of the country Lithuania

Geographical centre of Lithuania (close to Dotnuva) is 6 130 km away from Equator, 3 870 km from North Pole and 1 488 km from Greenwich 0° meridian. As determined by the French National Geographic Institute, 26 km to the north from Vilnius, close to Purnuškės village and Bernatoniai mound, there is a **geographical centre of Europe** (54°54′ N 25°19′ E). Sun raises 23 min 20 s earlier in the eastern part than in the western part. Lithuania is in UTC+2h (Coordinated Universal Time) time zone and uses seasonal time. Lithuania belongs to the temperate climate zone. It lies in the western part of East European Plain and includes middle-course and delta regions of Nemunas river basin. This territory belongs to the glaciations zone of the last Scandinavian ice age (Valdai period).

By the climate classification of B. Alisov, Lithuania belongs to the south-western part of the Atlantic continental forestation zone. According to different climate variables it is possible to identify four seasons in Lithuania. Start and end dates of these seasons are not constant and differ from astronomical or calendar seasons.

The average mean annual air temperature in Lithuania is 6.9 °C (varying from 6.1 °C to 8.0 °C in its different parts). Annual precipitation varies from 560 to 910 mm, average wind speed in Lithuania is rather low: 4.6 m/s on the coast and 2.3 m/s in the south-eastern part. On average there are 14–28 days with thunderstorms and 10–15 days with freezing rain.

Vegetation period, when average daily temperature is higher than 5 °C, is quite long (195–215 days), but rather cool. Active vegetation period, when average daily temperature is higher than 10 °C, lasts for 145–160 days. This period is getting shorter when moving from the coastal to the eastern parts of Lithuania. The coldest month in Lithuania is January, although on the coast it is often February. **In most parts of Lithuania, negative maximum air temperature is observed 50–60 days per year.** The warmest month is July, and on the coast it is August. In Lithuania, advection of air masses from the west dominate throughout the year, number-two during the warm season is advection from the north, and during the cold season from the south. Advection from north and north-east usually brings cold air masses, so during these events transformational warming of air mass occurs. In warm season, advection from south-east and east brings warm air masses and leads to temperature raise. In cold season it brings cold air masses and leads to the temperature drop.

From the middle of XX century (since 1970) average annual air temperature is constantly rising. These local changes correspond to global climate warming trend. [1]

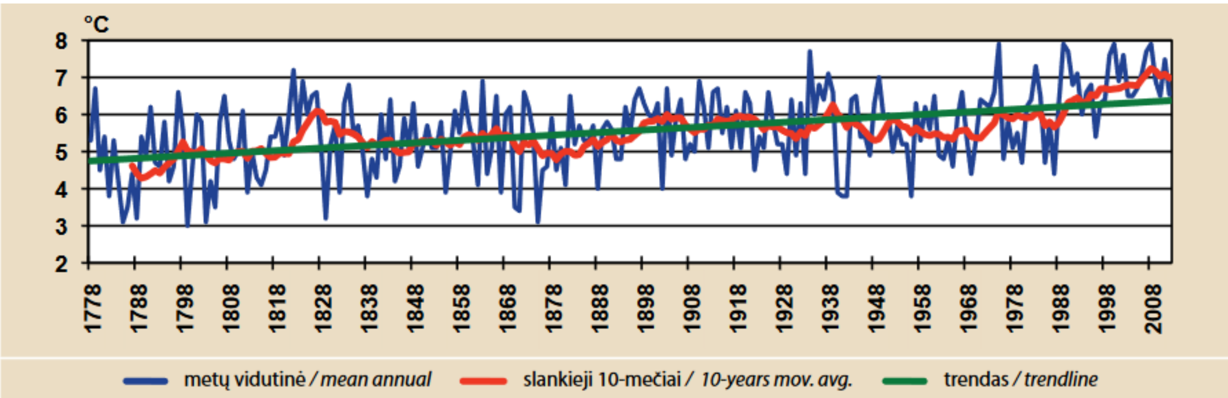


Fig. 4 Average anual temperatura in Vilnius, Lithuania, 1778-2012.

3.1. General information on solar radiation indices in Vilnius city

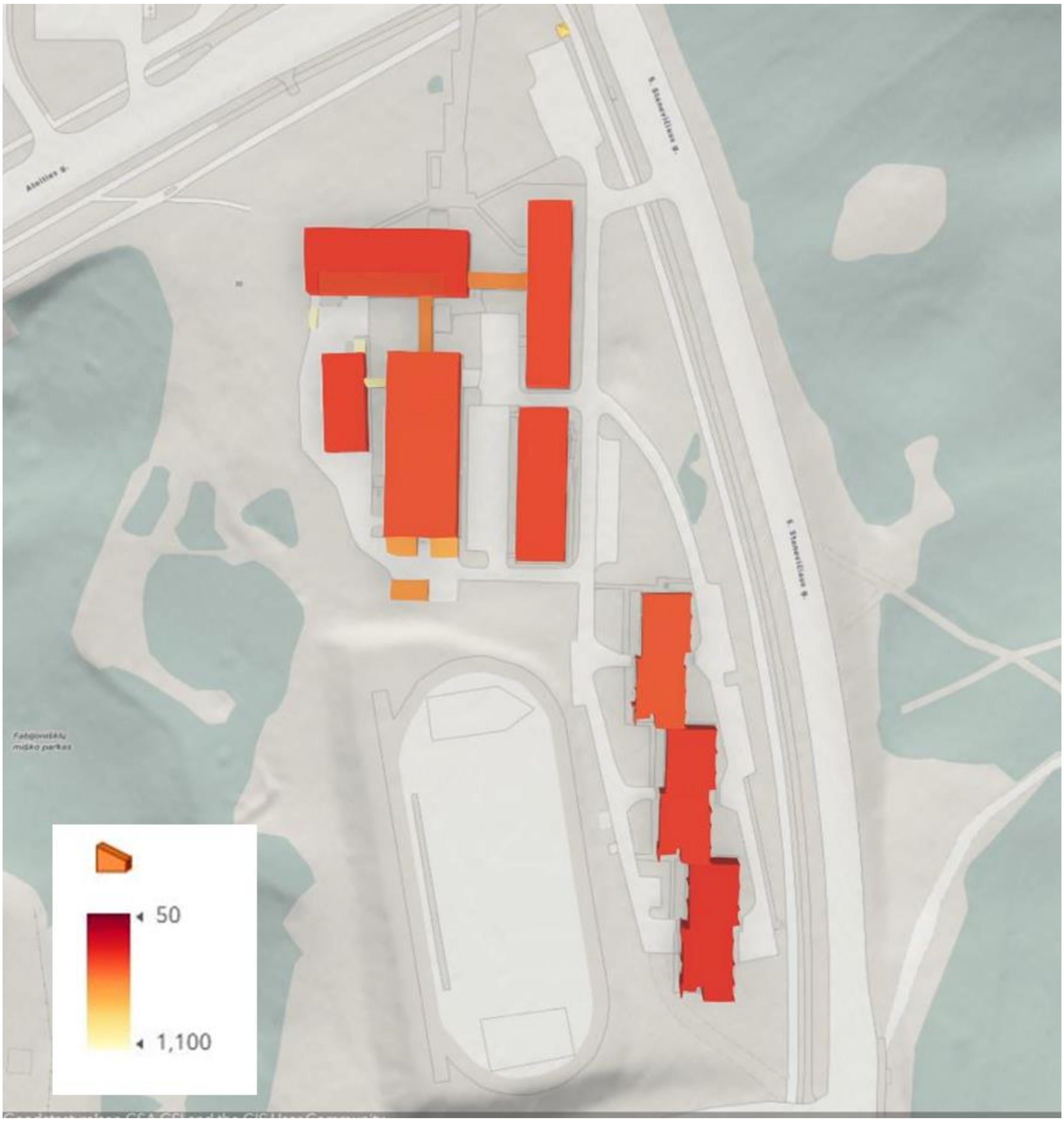
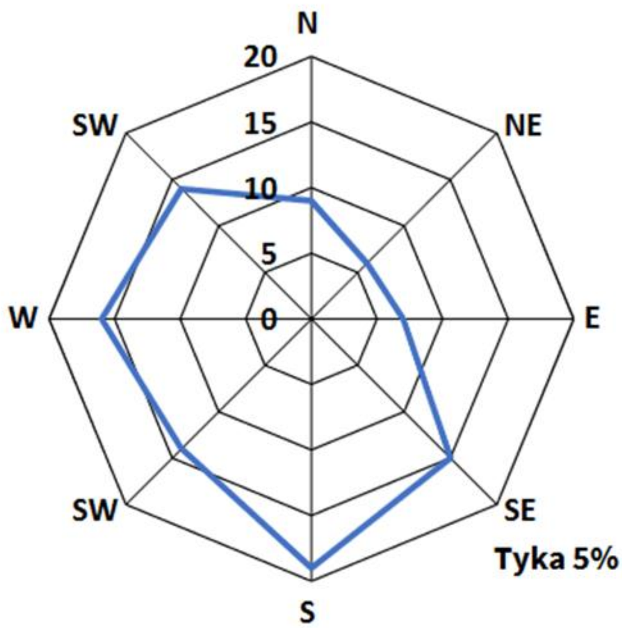


Figure 25 Buildings, by average solar potential.

Figure 26 Solar energy potential details.

3.2 Vilnius wind rose

Direction	N	NE	E	SE	S	SW	W	SW	Tyka
%	9	6	7	15	19	14	16	14	5
m/s	2,5	2,3	2,5	3,2	3,6	3,4	3,6	3,2	



4. Original Project plans

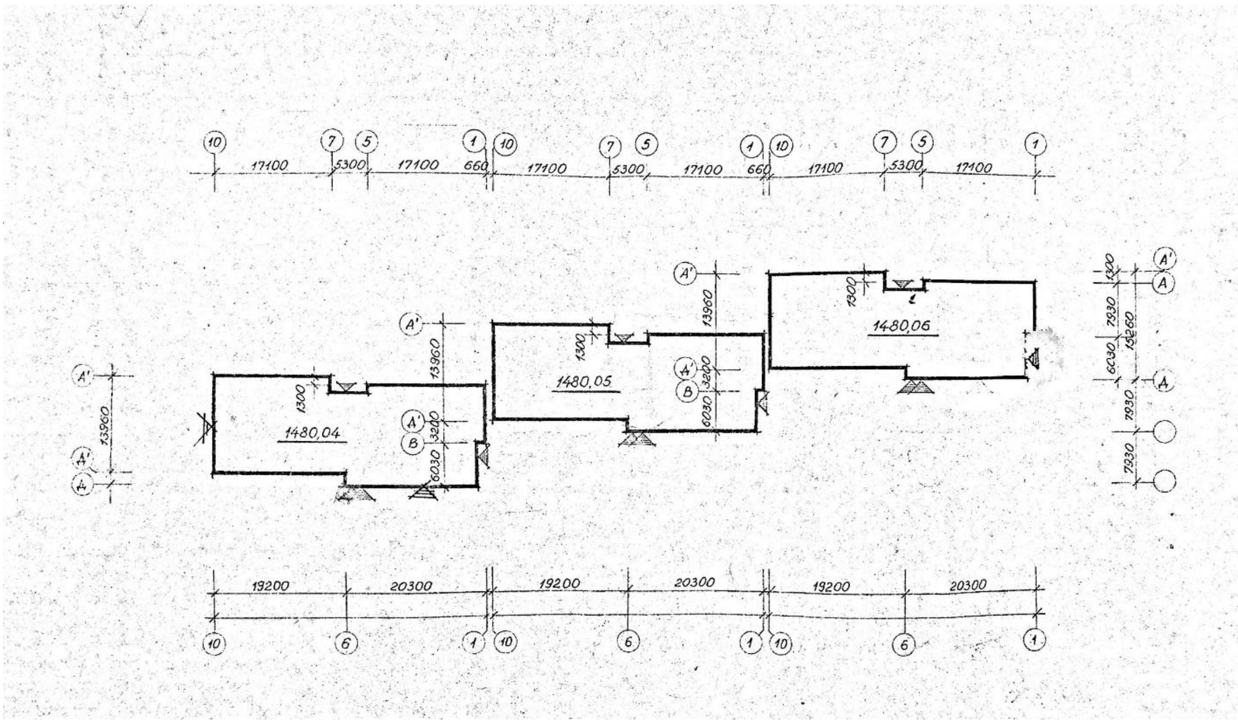


Figure 8 Dormitory blocking scheme.

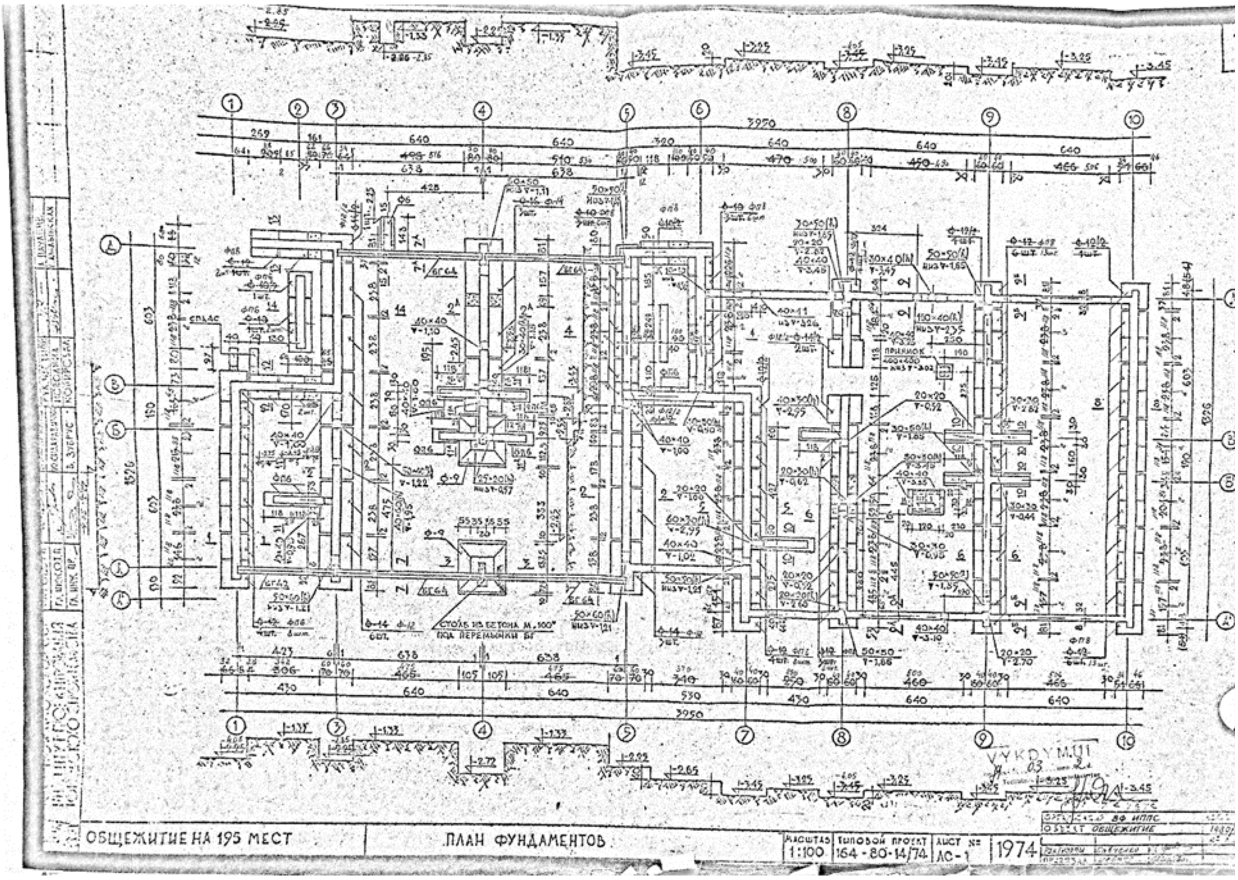
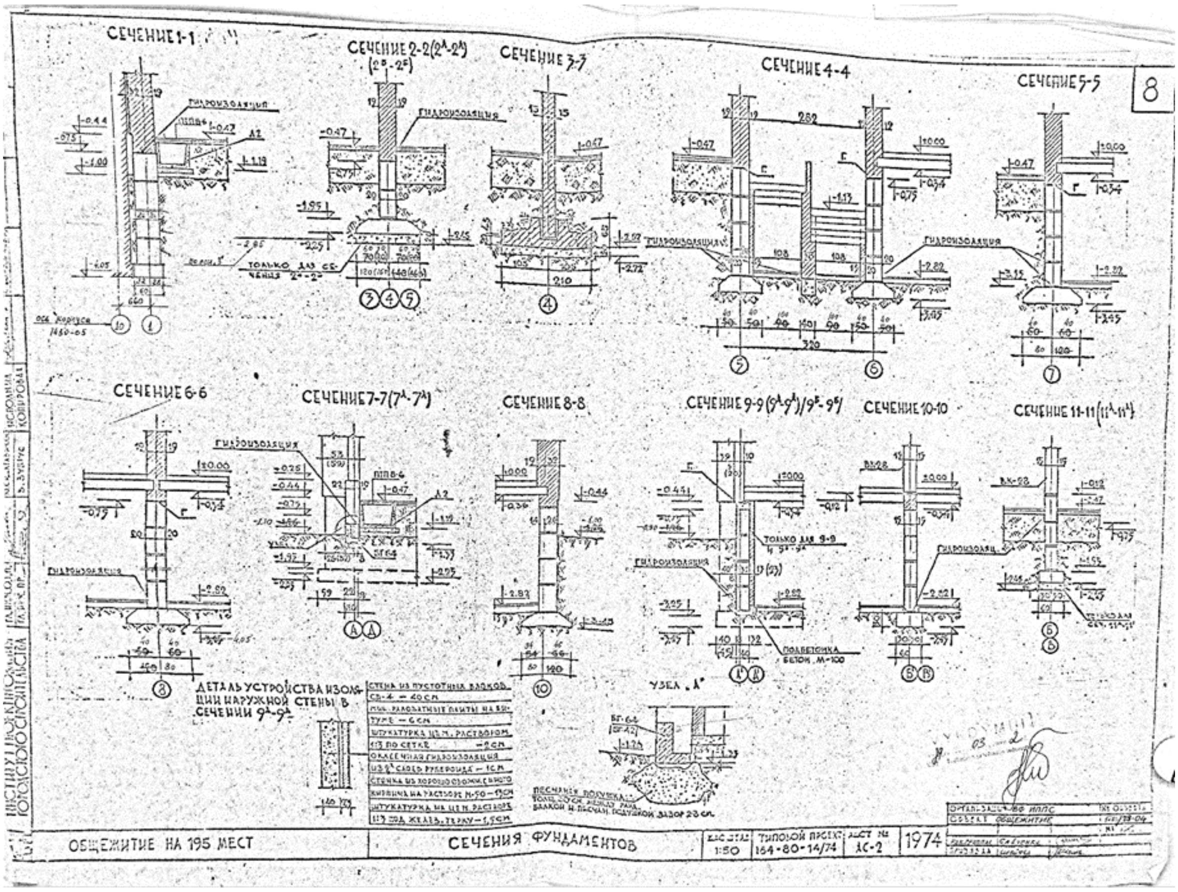


Figure 9 Foundation plan.



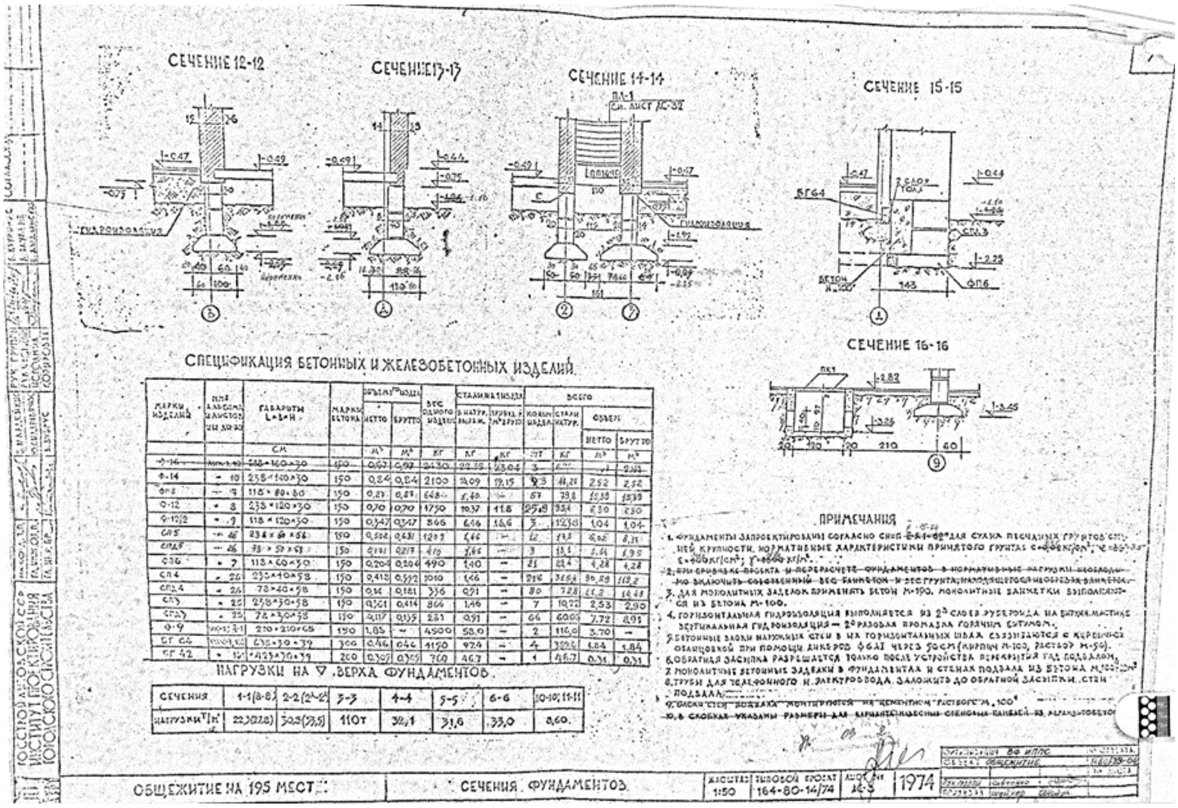


Figure 10 Foundation joints details.

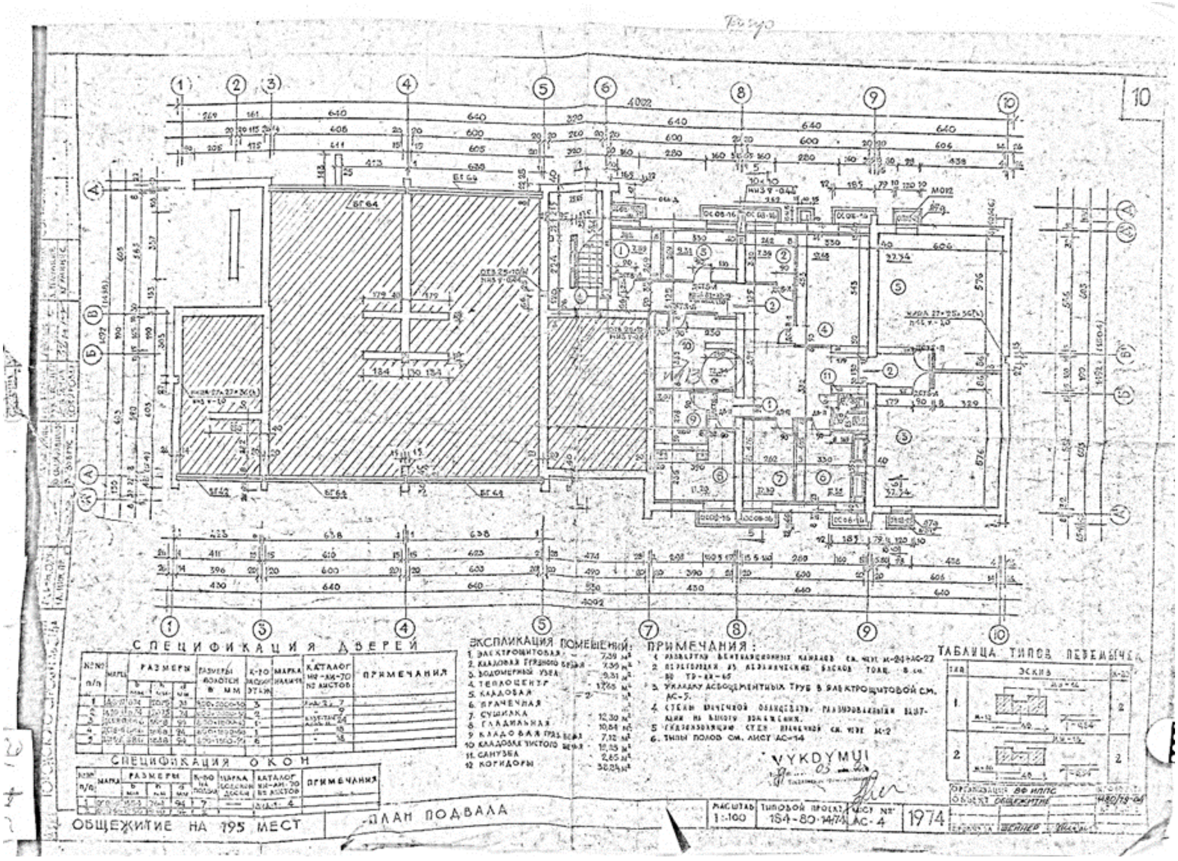


Figure 11 Basement plan.

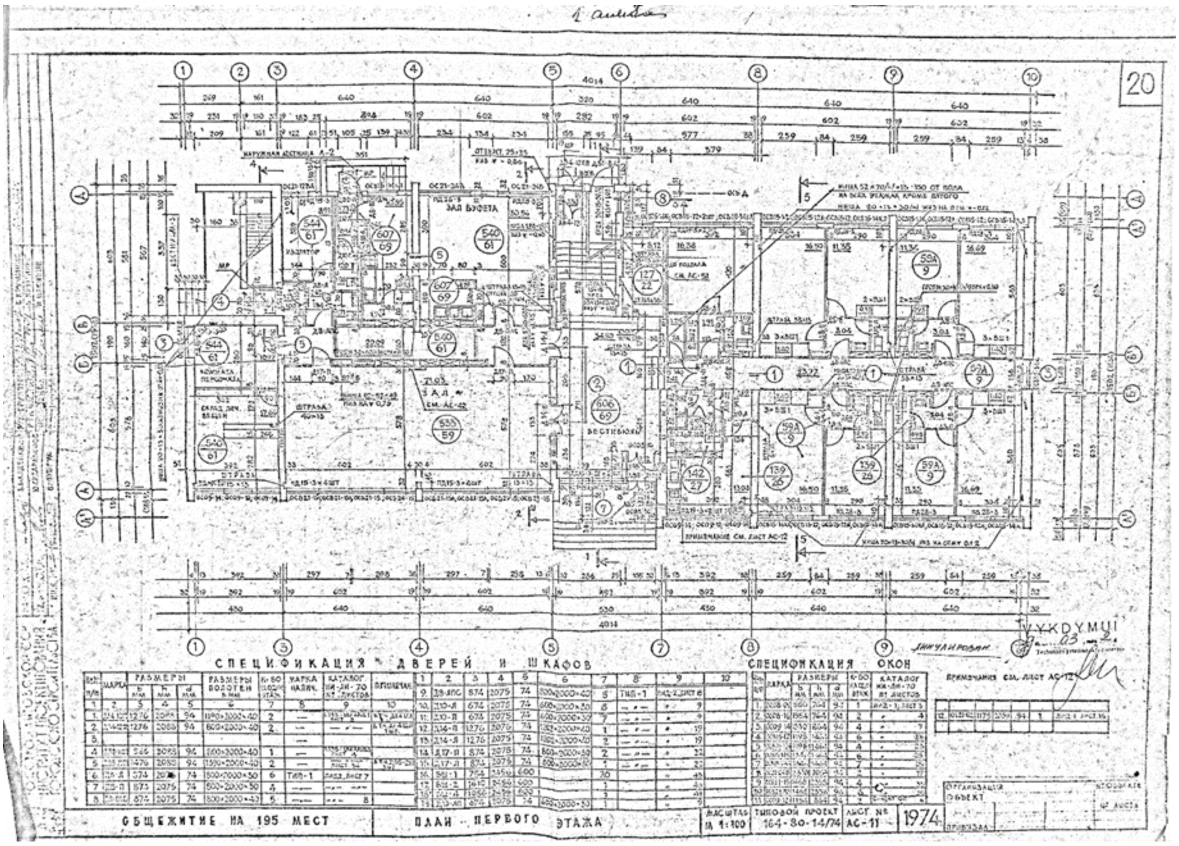


Figure 12 First floor plan.

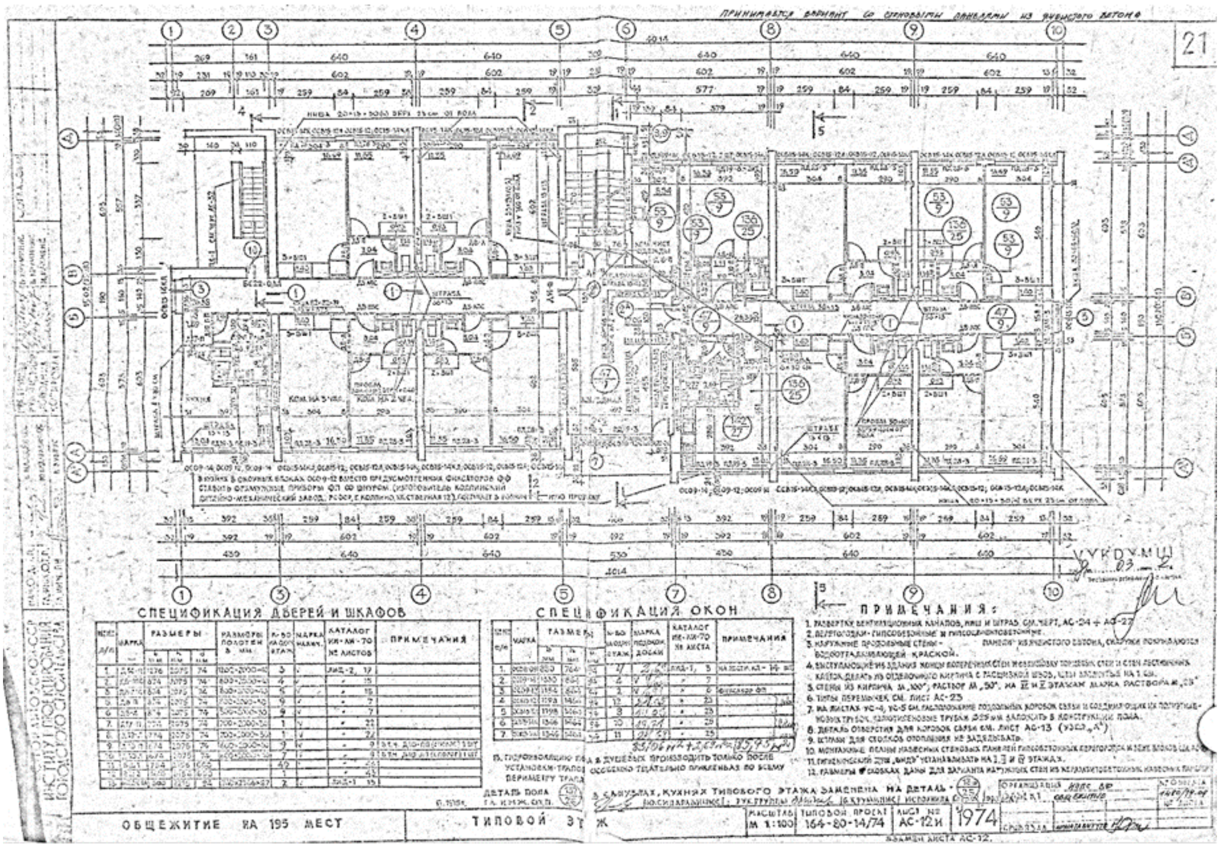


Figure 13 Typical floor plan.

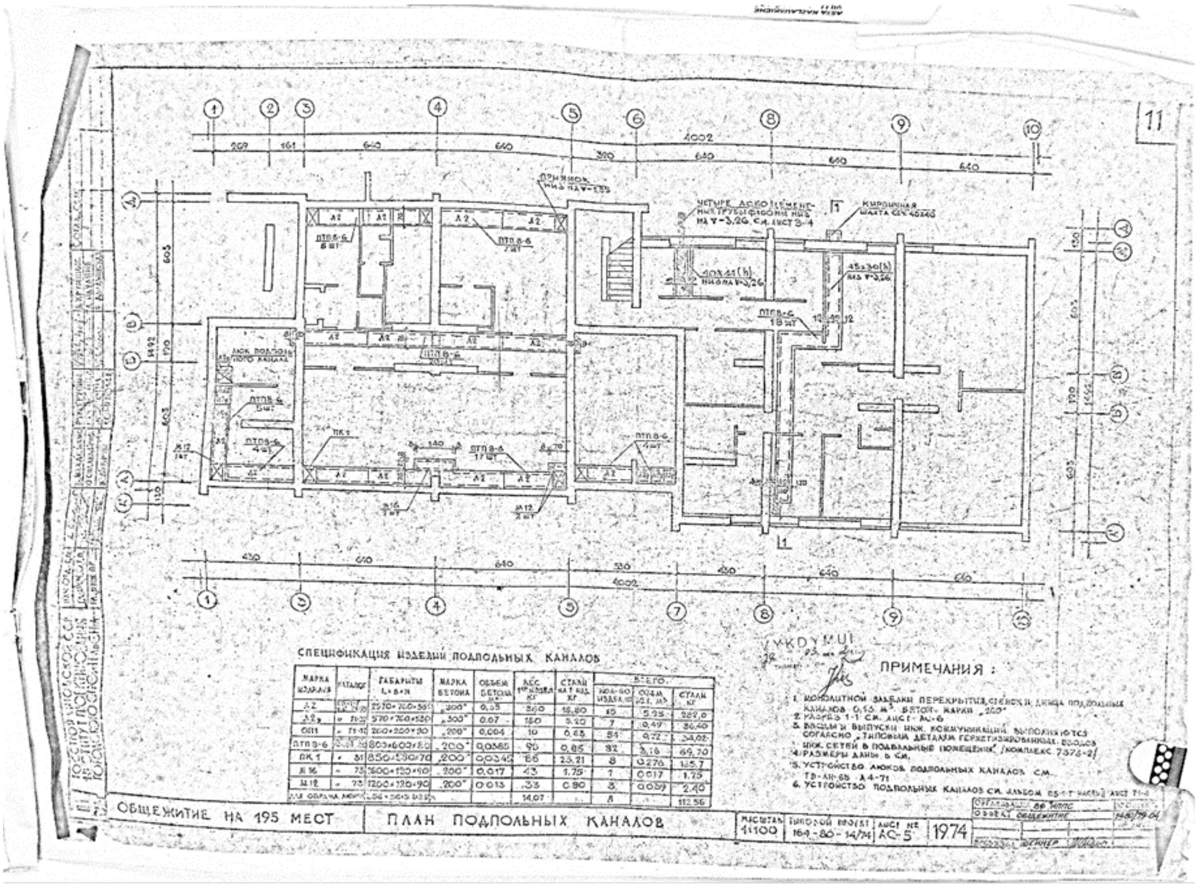


Figure 14 Underfloor channel plan.

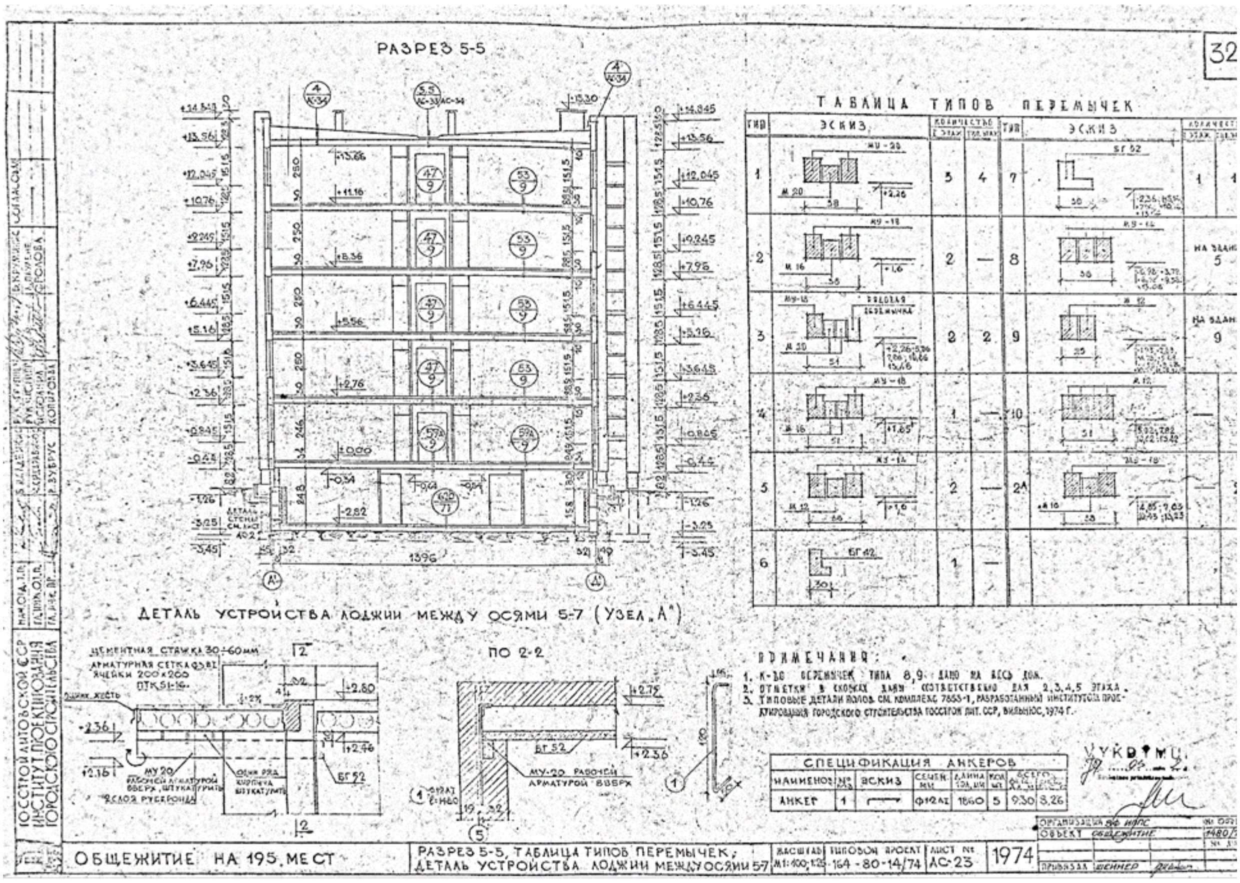


Figure 15 Section.

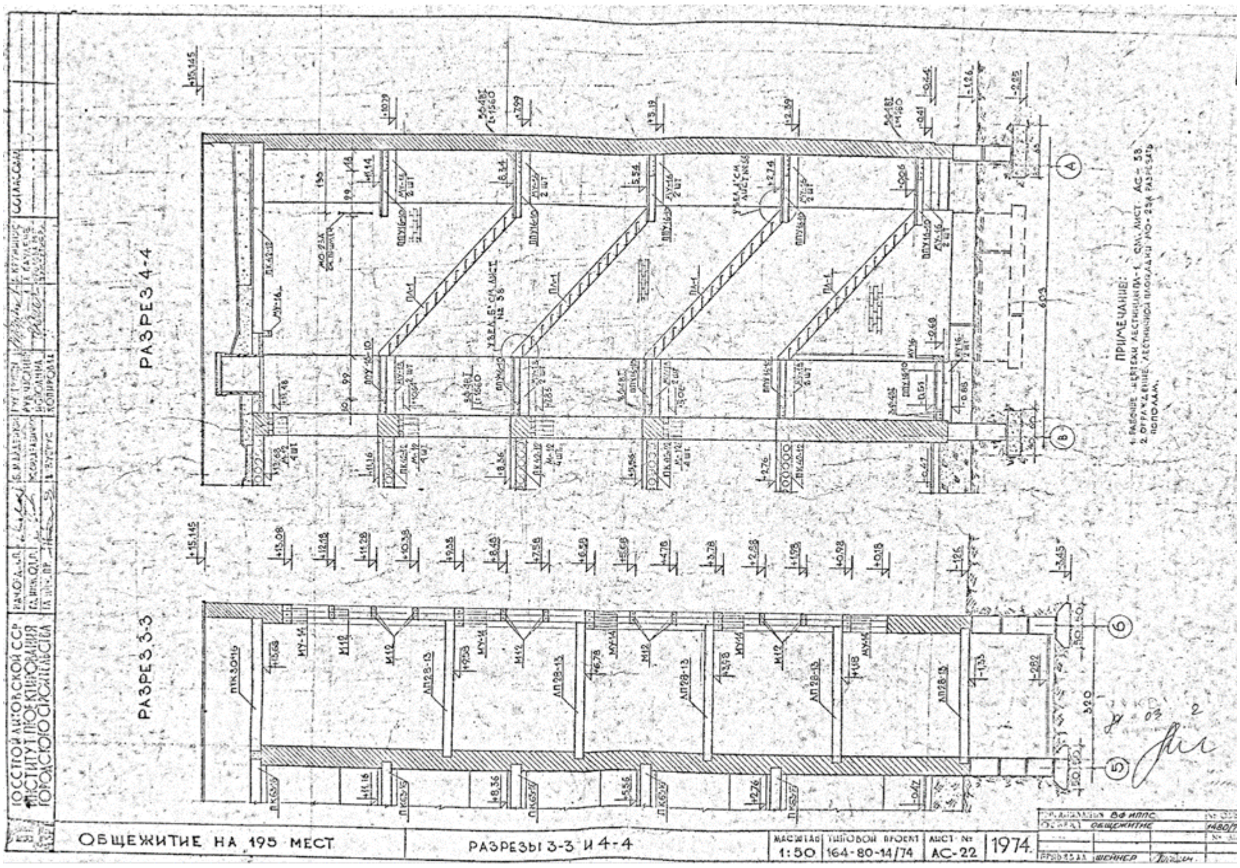


Figure 16 Staircase section.

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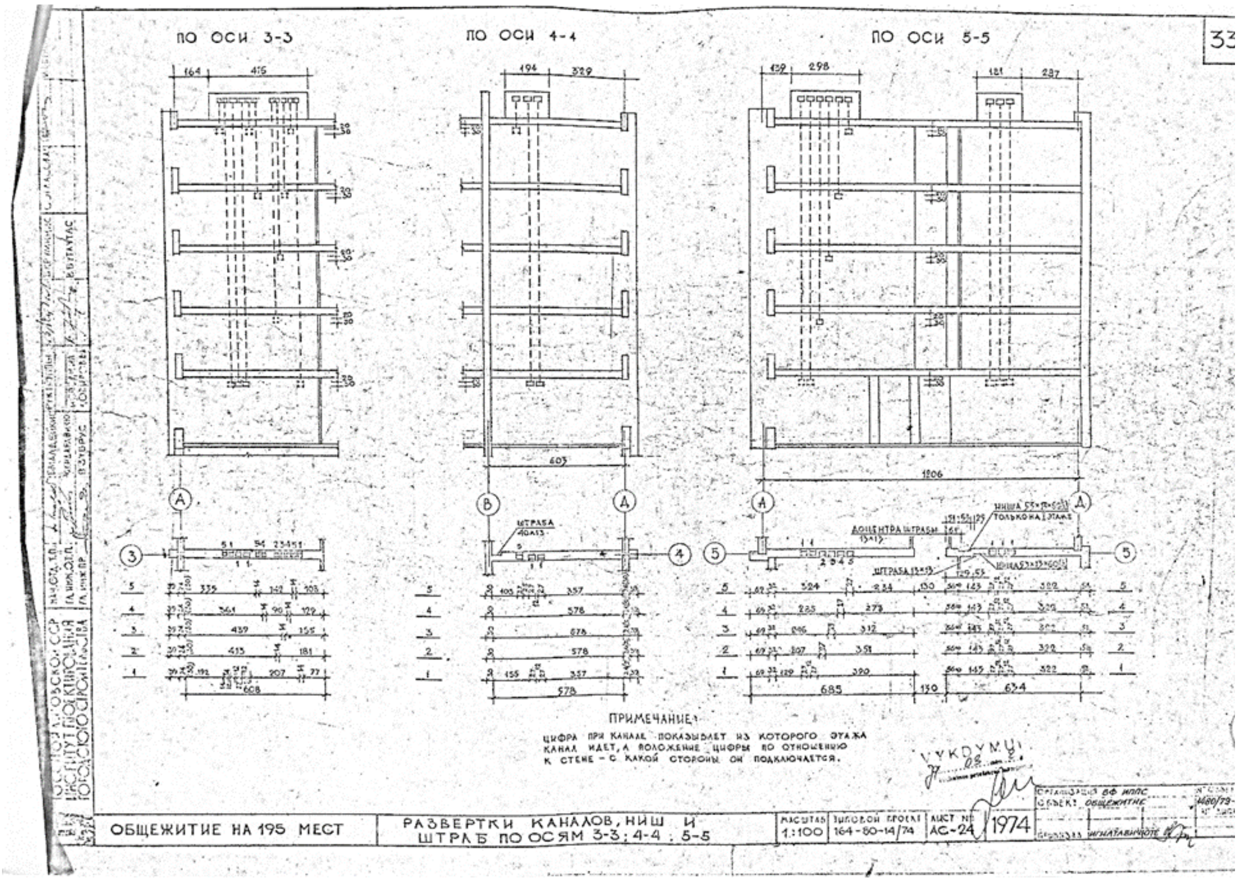

Figure 17 Ventilation section.

5. Cadastral plans

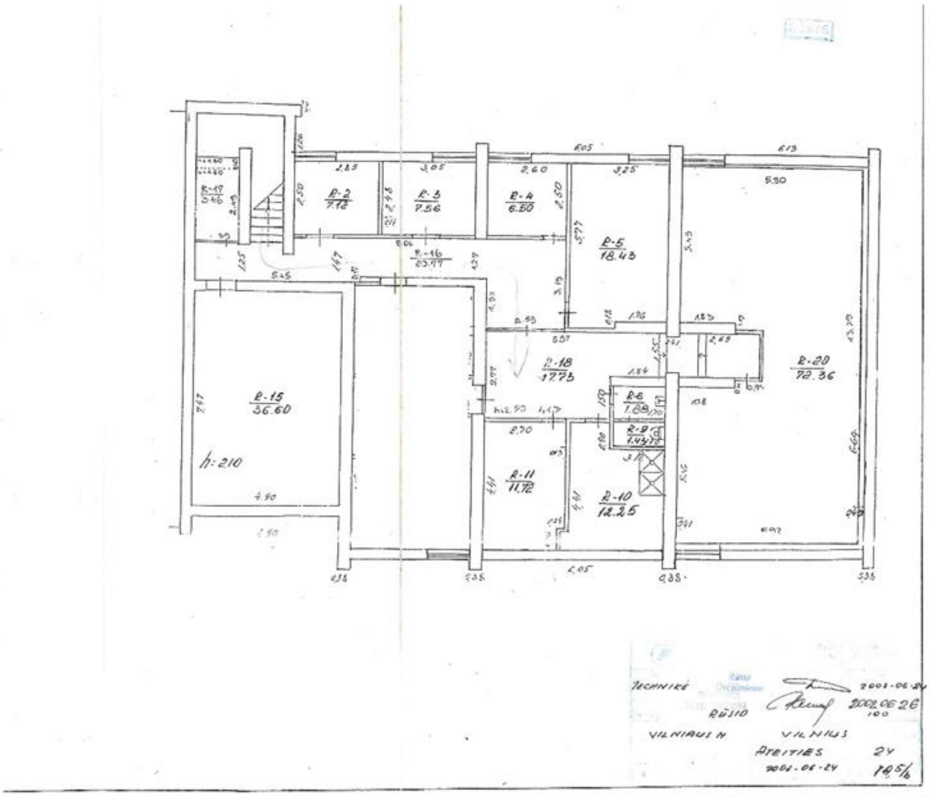

Figure 18 Basement plan.

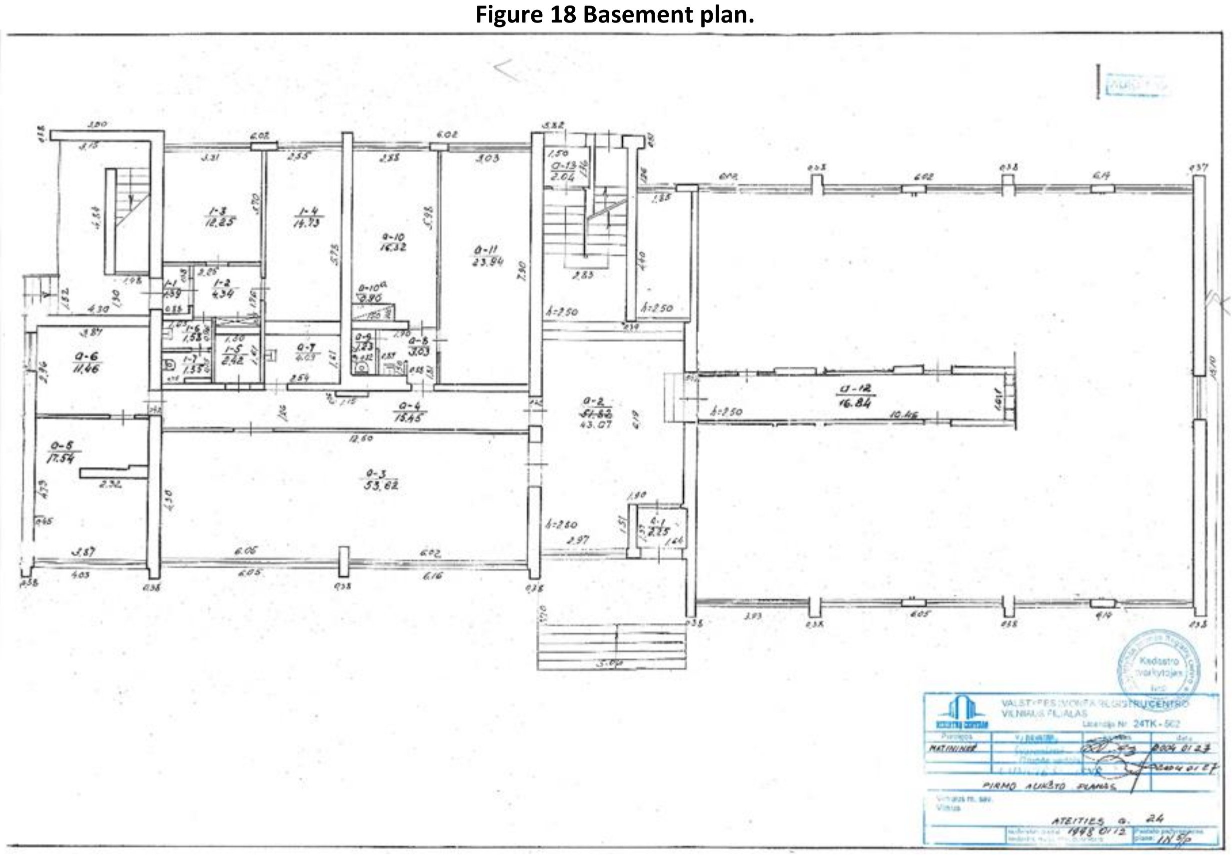

Figure 19 First floor plan (Ground floor).

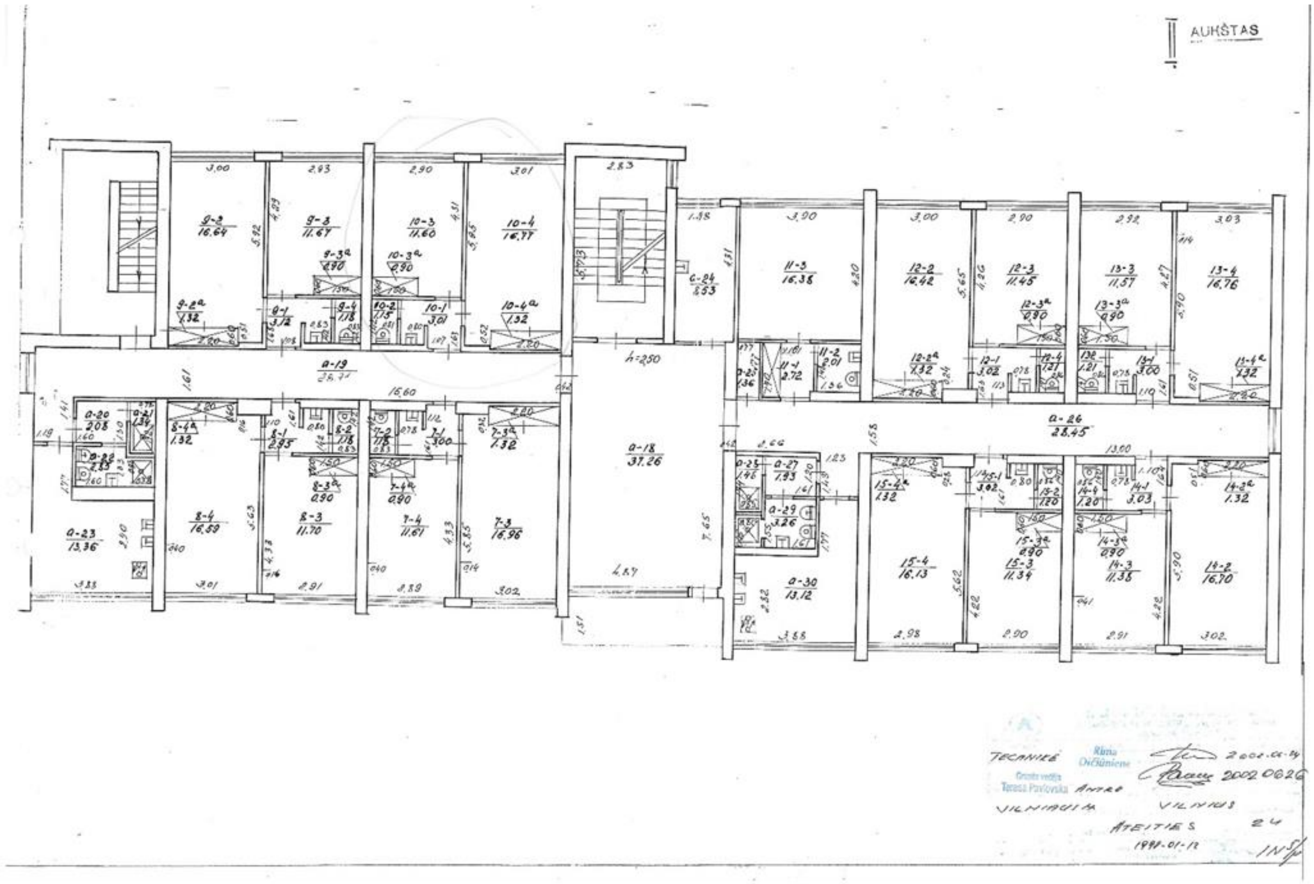

Figure 20 Second floor plan (First floor).

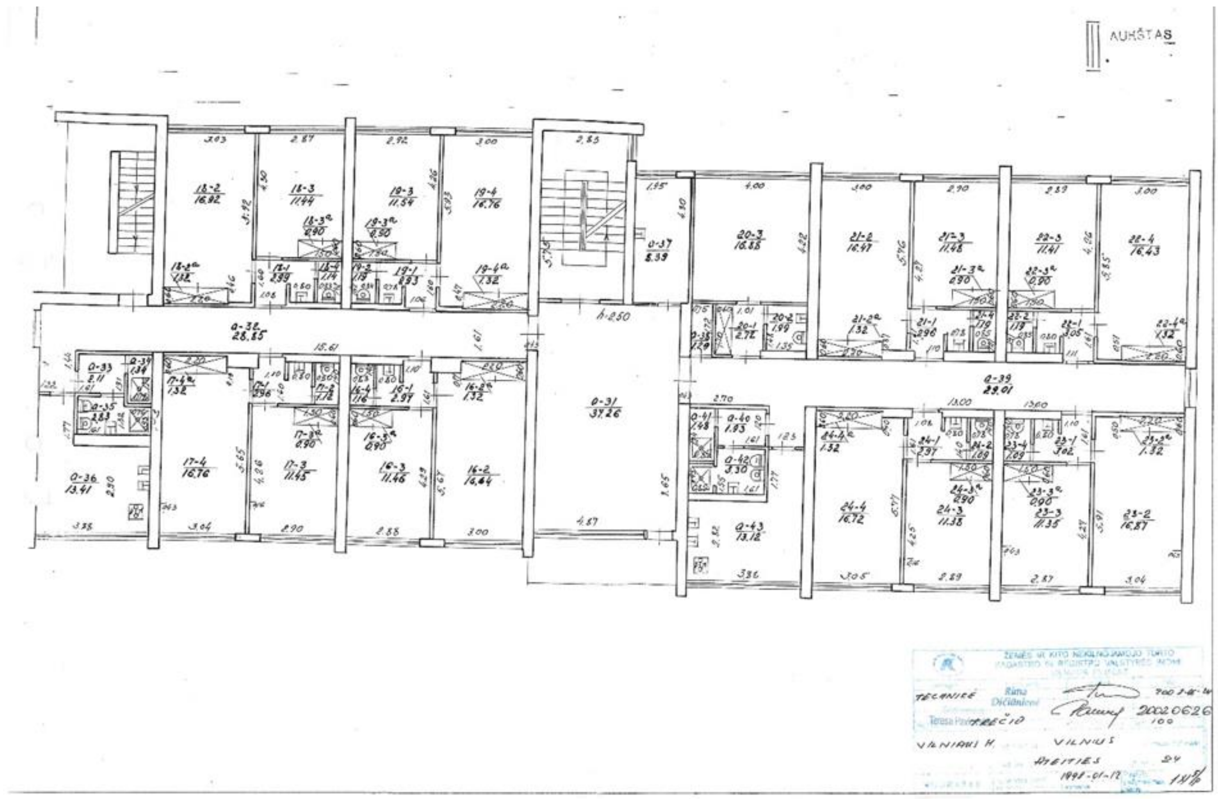

Figure 21 Third floor plan (Second floor).

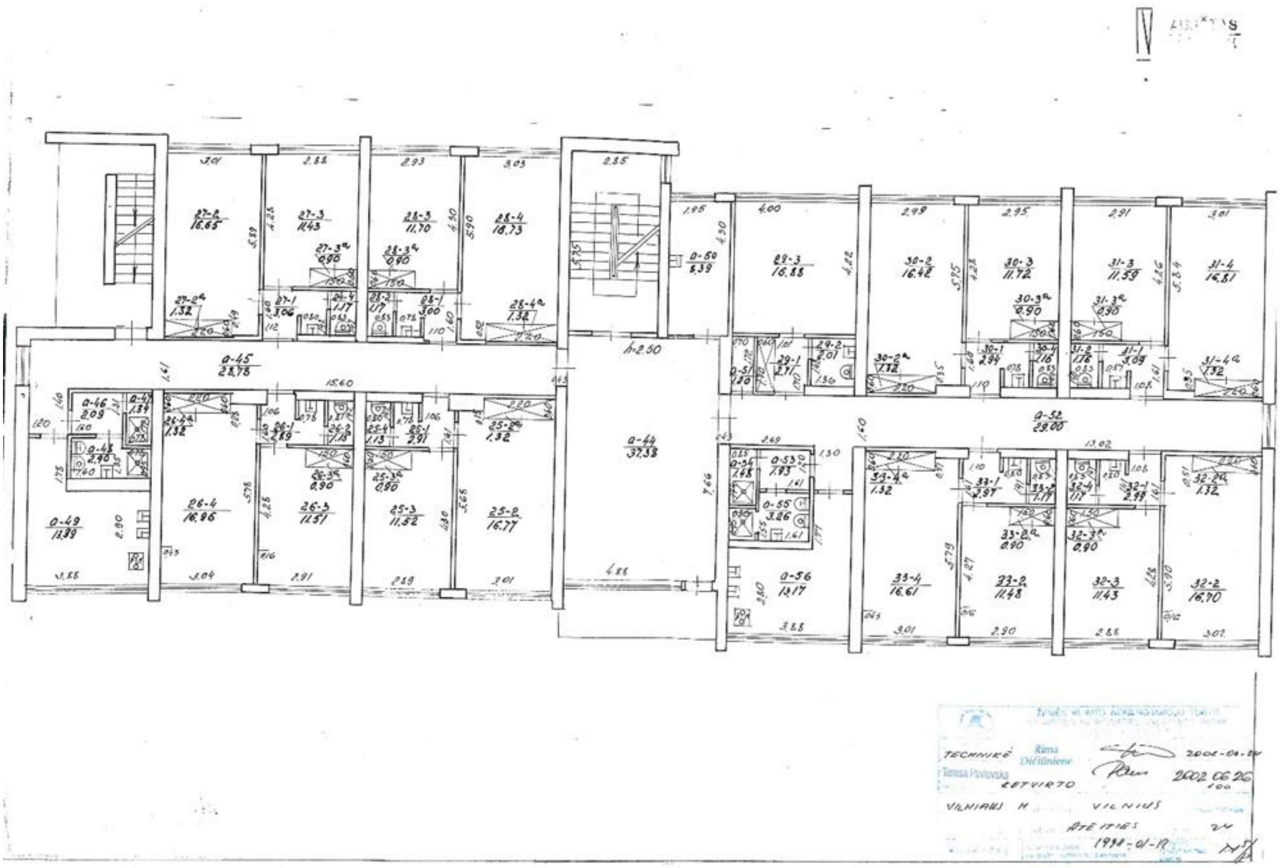

Figure 22 Fourth floor plan (Third floor).

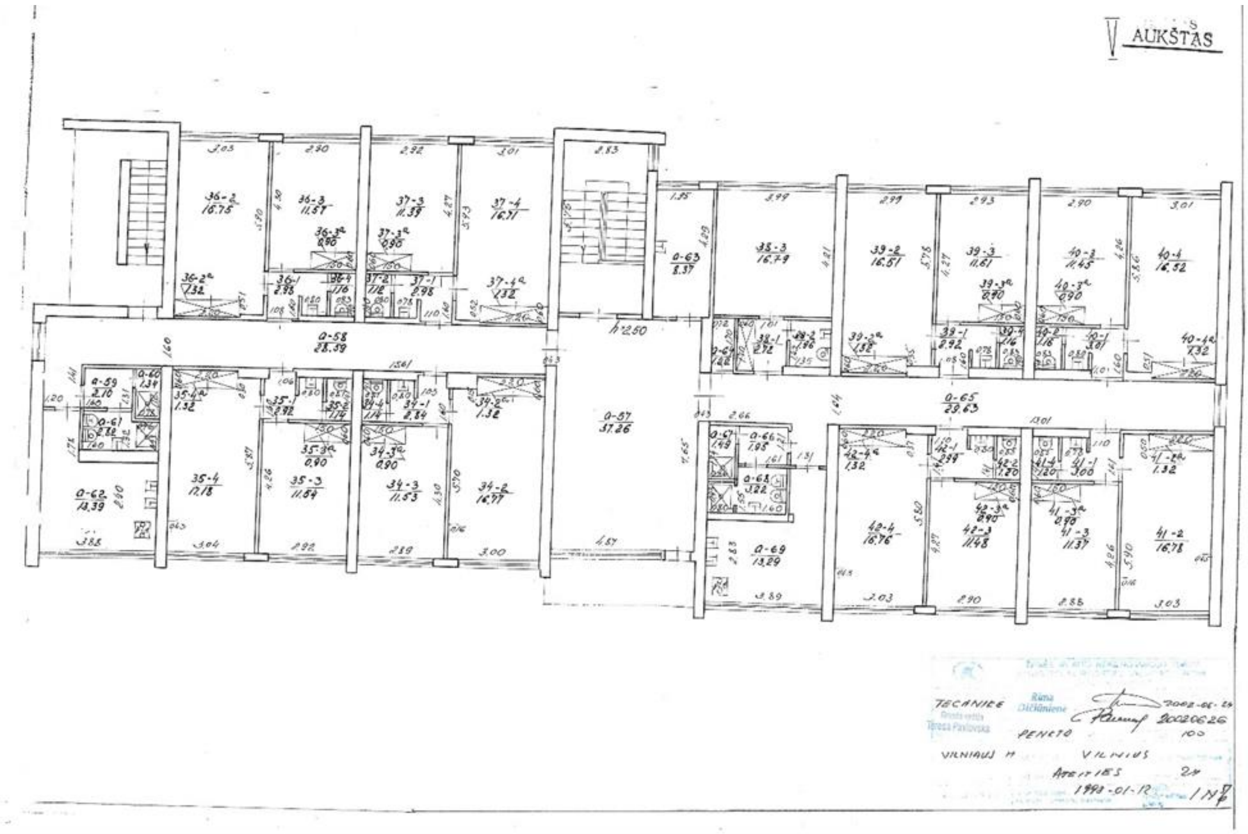

Figure 23 Fifth floor plan (Fourth floor).

6. Information about building

Purpose: Residential (social group)
Name: Dormitory facilities
Description of object: with common use space in the basement
Area of the plot: 1970 m^2 (see Fig. 4).

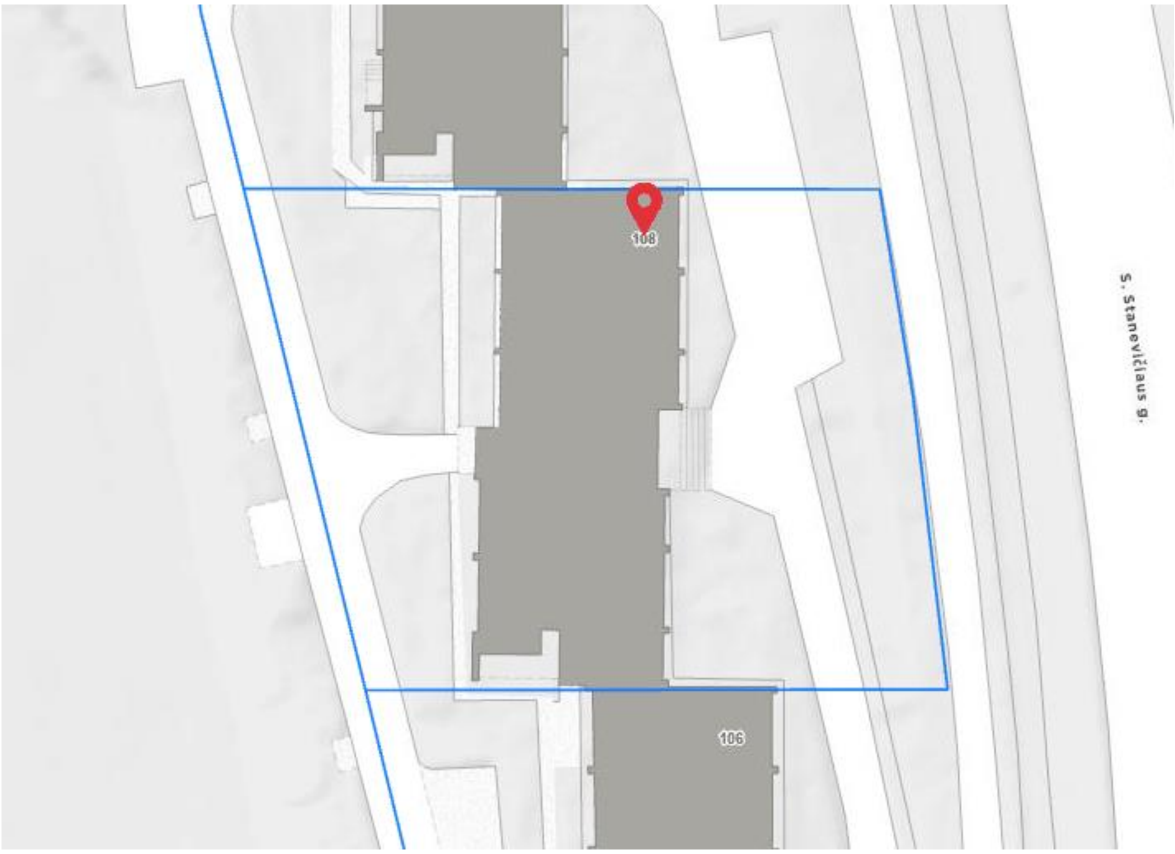

Figure 24 Site plan.

6.1. General characteristics

Indicator	*Unit of measurement*	*Value of indicators*
Year of construction	-	1981 - 1981
		Typical project
Area	m^2	2470,03
Cubature	m^3	8970
Number of floors	Units	5
Staircases	Units	2
Number of entrances	Units	2

Number of dormitory apartments	Units	195

6.2. Construction elements/structure

Indicator	*Measurement*	*Description*
Foundation	-	Strip foundations of reinforced concrete slabs.
Basement walls		Monolithic concrete sealing in foundations and basement walls made of concrete M100. In shallow depths, groundwater does not affect the foundations.
Basement internal walls	80 mm	Masonry (bricks).
Staircase to basement walls		Large slabs, made of large prefabricated elements, resting on brickwork.
Slab over basement		Basement slab made of precast reinforced concrete panels with round voids.
External walls	380 mm 190 mm	Masonry (bricks). Gas silicate blocks.
Internal walls	80 mm	Gypsum concrete partition wall.
Slabs	120-160 mm	Hollow core concrete panels, concrete M200
Roof		Flat roof
Windows		Plastic windows, 1 pack, single-chamber, 2 glass panes.

Walls and ground floor R 1 m^2K/w.

Roof (reconstruction in 2014, thermo isolation installed) R 6,5 m^2K/w.

6.3. Services

Heating	District central heating from centralised systems
Water supply	City water supply
Ventilation	Self – current ventilation
Drainage	City sewerage
Hot water	Yes
Stoves	Electrical
Bathrooms	Yes

The dormitory receives its heat through centralized district heating. Heat is supplied to the dormitory via an automated heat unit (heating control system), which automatically measures the outdoor (outdoor temperature sensor is located on the outside wall of the dormitory building) and indoor temperature. District heating is switched on throughout Lithuania when the average daily outdoor air temperature is at or below 10 °C for 3 continuous days. Analogously, it is switched off when the average daily outdoor temperature is above 10 °C for 3 continuous days.

In Lithuania, air conditioning is not relevant and is not compulsory under the regulatory framework.

The district heating generation/production equipment is located at a distance from the dormitory building (here is no power generation inside the dormitory building), and the heat supply is piped underground via a water Heat Transfer Fluid* (thermofix). Heat consumption regulation to every dormitory (block of apartments) is organized/executed by automatic regulation in substation (which is placed in dormitory basement level). Substation regulates heat consumption, according to weather temperature outside and debit of heat consumption pump.

Automatic module of heat substation regulates heat consumption by two options:
- by increasing or decreasing amount of Heat Transfer Fluid* to internal heating system of dormitory.
- by increasing or decreasing debit to the internal dormitory heating system.

References:

1. Climate Atlas of Lithuania https://www.researchgate.net/profile/Donatas-Valiukas/publication/310463050_Climate_Atlas_of_Lithuania/links/5f67363c458515b7cf418ff5/Climate-Atlas-of-Lithuania.pdf (accessed 2024 04 05).

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Technical characteristics of the building

Romanian case study - School

1. Data on the thermal envelope

The school building features continuous foundations made of stone and concrete, with walls constructed from solid brick or stone masonry. The attic floor is supported by wooden beams, and the roof is wooden, covered with bituminous corrugated boards. Inside, the walls are finished with washable paint or tiles, while the exterior is adorned with decorative plaster. The concrete floors are topped with either parquet or tiles. The building lacks insulation, and the windows are PVC with double glazing.

Figures 1 and 2 highlight the internal structure and roofing system of the school, while Table 1 summarizes the characteristics of the building elements.

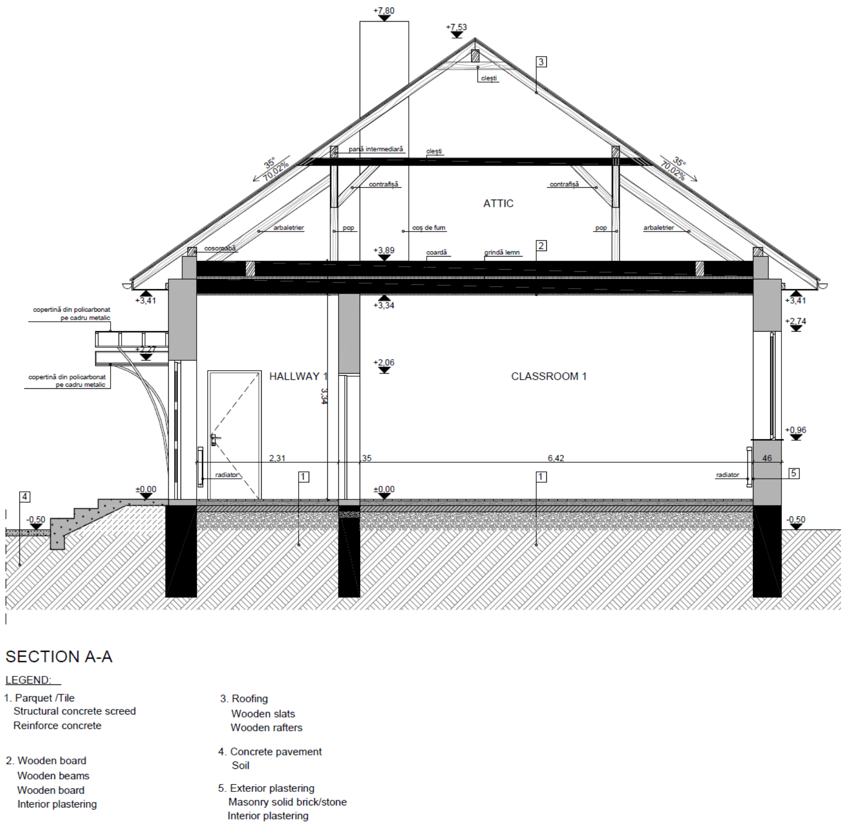

Figure 1. School from Romania – section

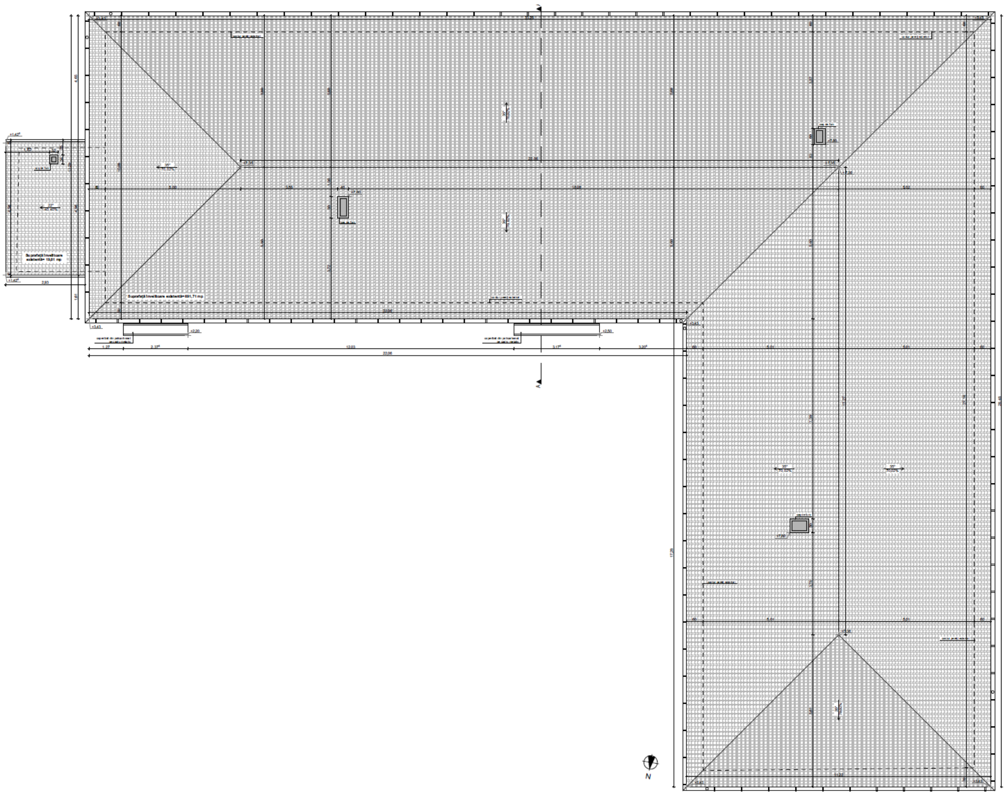

Figure 2. School from Romania – roofing

Table 1. School from Romania - building elements

Type of building element	No. [-]	Layer [-]	Description [-]	Thermal resistance R [m²K/W]	Heat transfer coefficient U [W/m²K]
Exterior wall 50	1	Interior plastering	Mortar cement and lime		
	2	Masonry	Solid brick		
	3	Exterior plastering	Mortar cement and lime		
	TOTAL 53. 5cm			0.832	1.202
Interior wall 28	1	Interior plastering	Mortar cement and lime		
	2	Masonry	Solid brick		
	3	Interior plastering	Mortar cement and lime		
	TOTAL 31 cm			0.634	1.576

Type of building element	No. [-]	Layer [-]	Description [-]	Thermal resistance R [m^2K/W]	Heat transfer coefficient U [W/m^2K]
Floor slab (cold)	1	Tile	Limestone		
	2	Structural concrete screed	Mortar cement		
	3	Reinforced concrete	Reinforced concrete		
	4	Structural concrete screed	Mortar cement		
	5	Gravel	Gravel filling		
	TOTAL 42 cm			**0.620**	**1.612**
Floor slab (warm)	1	Parquet	Wood		
	2	Structural concrete screed	Mortar cement		
	3	Reinforced concrete	Reinforced concrete		
	4	Structural concrete screed	Mortar cement		
	5	Gravel	Gravel filling		
	TOTAL 42 cm			**0.690**	**1.449**
Upper floor ceiling	1	Interior plastering	Mortar cement and lime		
	3	Wooden board	Spruce		
		Wooden beams	Spruce 13.5x23.5 cm		
		Stationary air	Air		
	4	Wooden board	Spruce		
	TOTAL 52.5 cm			**0.440**	**2.272**
Roof	1	Wooden rafter	Spruce 15x15 cm		
	3	Stationary air	Air		
		Wooden slats	Spruce		
	4	Roofing	Bituminous corrugated boards/ Onduline roofing sheets		
	TOTAL 32.8 cm			**0.549**	**1.823**

Windows are from PVC with double glazing R=0.48 [m^2K/W], U= 2.083 [W/m^2K]

2. Data on the existing heating and air conditioning system

The heating of the building is done through steel radiators, using as heat source a solid fuel heating plant (wood) and a boiler.

The wood heating plant has low efficiency and there is no individual heat control for each radiator according to usage duration (see Fig. 2).

The building has no ventilation or air conditioning system.

Figure 2. School from Romania – heating source