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-ATTACHED DOCUMENT: BUDGET

1. ARCHITECTURAL PART

1.1. INTRODUCTION

The object of this work is the new construction of a building for residential use, located in Žirmūnų street 1L, in Vilnius. The project is composed of three buildings, but our work will study the building located in the center. The project consists in a four-storey building with 19 apartments and two garages. Each floor is formed by five apartments except the ground floor that contains four apartments, two garages and five pantries. The plot counts with 14 parking spaces and one disabled parking space.

Plot's area: 1503m²

Building area: 1260,22m²

Shape building area: 851,01m²

Building height: 13.50m

In the past there was a construction in the plot where the project is placed, but it is demolished and removed from registration. The nearest constructions are 50 meters from the building and they are 70 years old, most of them also for residential use but some for commercial use.

1.2. LOCATION

The building is located in Žirmūnų street 1L, in Vilnius (Lithuania) (see Figures 1 and 2). It is placed next to the river Neris and near the center of the city. It's a residential zone with a good accessibility and well connected with public transport, there is a bus stop very close to the plot that connects it with the center and also to the Vilniaus University and Vilniaus Gedimino Technikos Universitetas. Near the building there is a supermarket with a pharmacy and a restaurant. Very close to it we have a big park and a leisure area for kids.

Vilnius is the capital of Lithuania and it is situated at the South-East of the Country. The city has a population of 539.939. The climate of Vilnius is humid continental, with very cold winters (temperatures can get below -25 degrees Celsius) and warm summers.



Figure 1. Location



Figure 2. Plot location

1.3. FIELD

The plot area is 1503m² but the building occupies 851,01m². The only access to the plot is by Žirmūnų street and the closest building is 50m.

1.4. DISTRIBUTION OF FLOORS

The building is composed of a ground floor and three more floors. The building is divided in two having different level each part. One part starts at ±0,00m and the other +0,76m. that difference of level is in all floors.

In the ground floor we count with four apartments and a garage. In the three floors there are five apartments. In the following picture we can see the distribution of the second floor which is the standard one (see Figure 3).

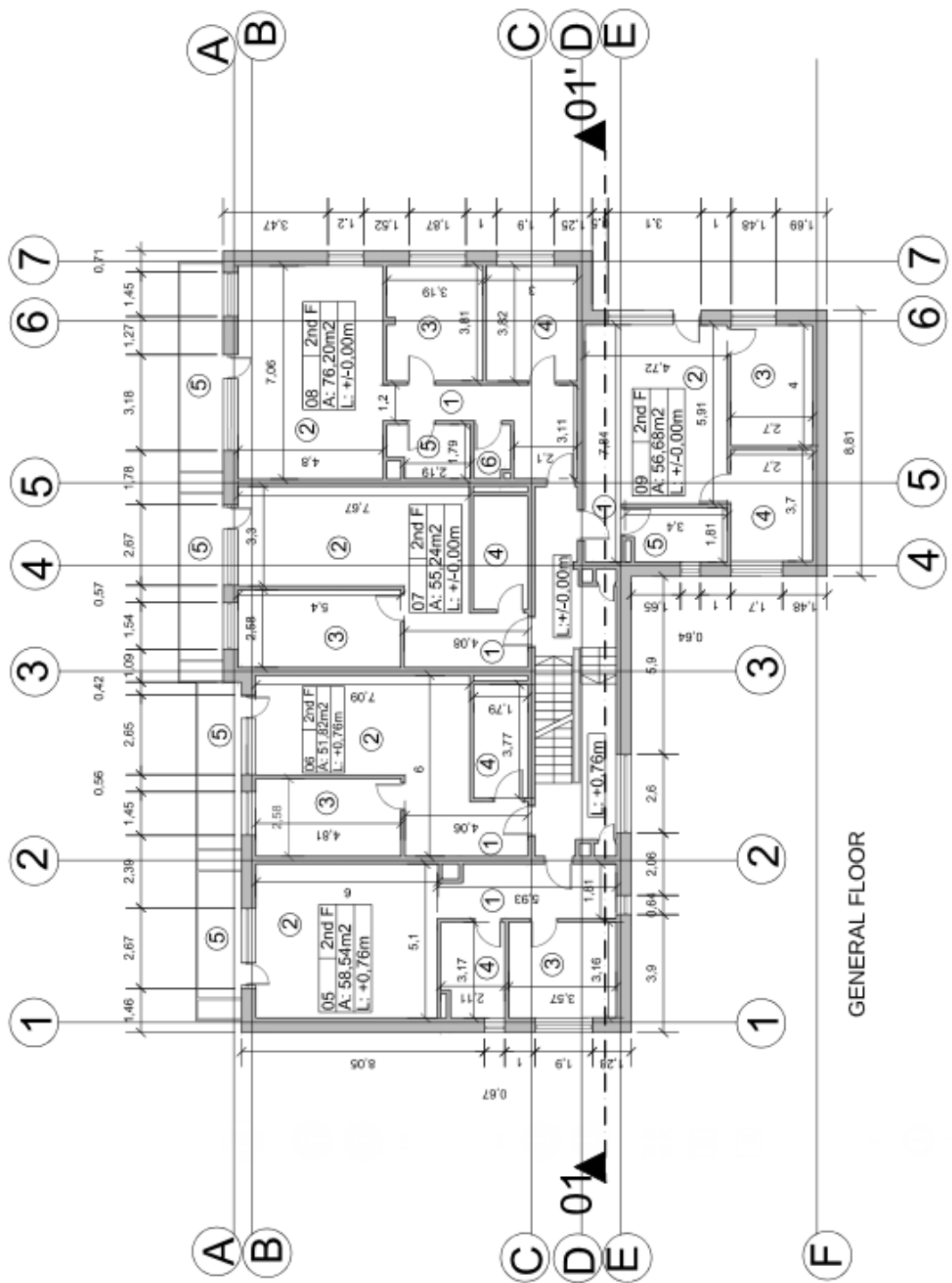


Figure 3. Standard floor

Here is a table with the areas of the different apartments (see Table 1):

		AREA	
		BALCONY	APARTMENT
APARTMENT 05			
1	CORRIDOR		10,19
2	LIVING ROOM/ KITCHEN		30,6
3	BEDROOM		11,32
4	BATHROOM		6,43
5	BALCONY	6,06	
			58,54m2
APARTMENT 06			
1	CORRIDOR		3,48
2	LIVING ROOM/ KITCHEN		29,14
3	BEDROOM		12,38
4	BATHROOM		6,82
5	BALCONY	8	
			51,82m2
APARTMENT 07			
1	CORRIDOR		3,47
2	LIVING ROOM/ KITCHEN		31,09
3	BEDROOM		13,93
4	BATHROOM		6,75
5	BALCONY	7,95	
			55,24m2
APARTMENT 08			
1	CORRIDOR		11,76
2	LIVING ROOM/ KITCHEN		34,03
3	BEDROOM		12,21
4	BEDROOM		11,57
5	BATHROOM		4,57
	WC		2,06
	BALCONY	9,98	
			76,20m2
APARTMENT 09			
1	CORRIDOR		4,3
2	LIVING ROOM/ KITCHEN		25,71
3	BEDROOM		10,77
4	AUXILIARY ROOM		10,04
5	BATHROOM		5,86
6	BALCONY	9,02	
			56,68m2

SECONDARY AREAS(HOME STAIRCASE)		
STAIRCASES/CORRIDOR		20,29
		20,29m2
		318,77m2

Table1. Local areas

1.5 CONSTRUCTION MEMORY

1.5.1. FOUNDATION

As there is no information about foundation in the information given, I've considered that the best option is strip footings. There will be strip footings under all masonry outside walls and under all monolithic walls. According to the EHE-08 Spanish normative the footing thickness won't be less than 0,25m if they are supported on the ground.

1.5.2. SLABS

I have decided that the slabs will be of prefabricated concrete for a faster construction of the building. They will have 1,2 of breadth but different longitude depending on the span they are covering. There are limited longitudes and we have found a commercial Spanish brand that meets our requisites with longitudes from 0 to 14 m when the largest one in our project will be of 7,83m.

In the next figure we can see the disposition of the slabs (see Figure 4).

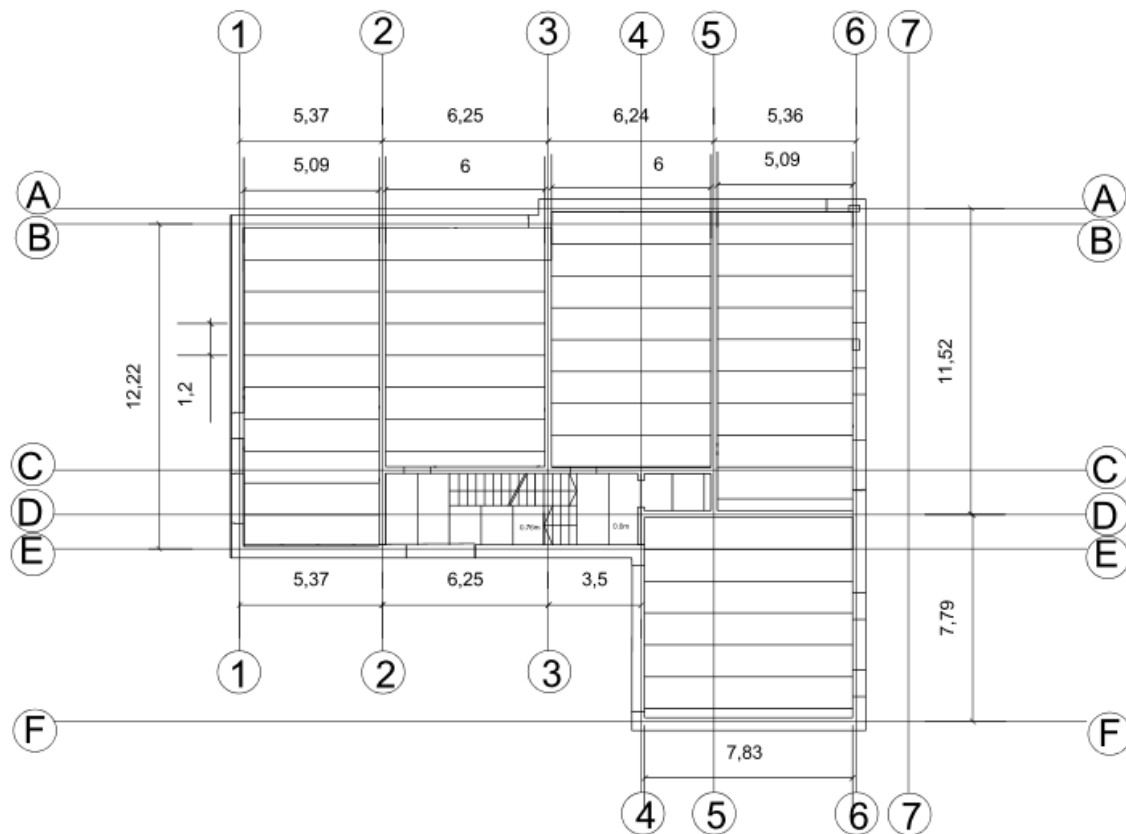


Figure 4. Disposition of slabs

1.5.3. MONOLITHIC WALLS

There are some monolithic walls made of reinforced concrete inside the building with a thickness of 25cm. the structure is made by these walls together to the outside walls made of expanded clay blocks. These walls will be the base for the slabs of the four floors of the building.

FAÇADE:

The façade is composed of different layers and coatings. The main layer is made of expanded clay blocks of 30x19x29cm. This wall will be part of the structure and this kind of blocks has thermal and acoustic insulation properties but with the hard temperatures of Lithuania it is necessary to add one more insulation layer. The insulation layer is made of mineral wool with 17cm of thickness.

There are different coatings in the façade, we can find ceramic tiles and white or grey plaster coating.

1.5.4. INTERNAL PARTITIONS

The building counts with two different types of partitions. The first one is made of silicate bricks with 0.12m of thickness. This type of wall is used in wet areas, bathroom and kitchen. The other one is composed of drywall system by plasterboards with a thickness of 0,12m (two boards of 0,025m, and a metal frame with isolation of 0,07m). In wet areas there is a covering of ceramic wall tiles and in the other rooms are coated with plaster with a painting finish.

1.5.6. FLOOR

There isn't information about the flooring so I have decided to put different coating depending on the local of the house. In the bathroom and the kitchen/living room, there will be ceramic tiles of 15x15cm with a grip of glue mortar. In the bedroom the coating will be laminated flooring as it is warmer than ceramic tiles. In common areas, as the corridor, there will be terrazzo tiles because it is a very resistant material and it is going to be the most crowded area. In the garage on the ground floor the coating is going to be a epoxy painting very resistant to the cars wear.

ROOF:

The roof is going to be a non passable flat roof composed of a steam barrier of polyethylene, a pitch former of cellular mortar, insulation of mineral wool and a last layer of two autoprotected sheets for the waterproofing. The roof is only going to be visited for repair or maintenance.

1.5.7. INSTALLATIONS

1.5.7.1. ELECTRICAL SYSTEM

According to the normative REBT in section 3 of ITC-BT-04, the electrical system corresponded to a residential building must be subject to a technical project with a power >100kW for general cargo protection. It will be equipped with low voltage.

Electrical power is taken from the electricity distribution network from the urban area object of the study. The energy distribution is performed by TT system, so the neutral of the supply system is directly grounded, the protective conductor and the masses of the installation are grounded separated from the grounding of the mains supply.

The electrical installation of the building starts from the supply connection that comes from the distribution network and ends at one of many lines that feeds any electrical device in the building. the installation consists in the following elements:

- Supply connection .
- General Protection Fund (CGP) .
- Liaison or General Line Power Line (LGA).
- General switch maneuver .
- Junction box .
- Centralization of counters.
- Single Bypass (DI) .
- Safety fuses .
- Counter .
- Box Controller Power Switch (ICP) .
- general control and protection devices (Differential Switches and Circuit Breaker) .
- line feeding circuit or electrical equipment.
- Grounding .

1.5.7.2. WATER INSTALLATION:

Cold sanitary water: The plumbing of the building cold water starts from the thrust coming from the distribution network and ends at one of any lines that feed any point of use anywhere in the building. the system consist in the following elements:

- Rush .
- General Installation
- Special constructions
- Collective Leads
- Monitoring systems and pressure regulation

Hot sanitary water: The plumbing of the building hot water starts from the central accumulator and one of the ends in different lines feeding any consumption points located in the building. The installation consist in the following elements:

- supply and return circuits
- inter accumulators
- Special constructions

1.5.8. FIRE SAFETY

The building will follow the CTE-SI (Technical edification code-Fire Safety) requirements. There will be a planning with a rout and exit of evacuation. The elements in the outside walls, the roof or partitions will be fire resistance.

1.5.9. ENVIRONMENT

The apartment building is designed in accordance with hygiene rules of living environment.

-The building ensures regulatory insulation.

-Residential environmental noise levels are not exceeded of regulation.

1.5.9. DISABILITY NEEDS

The projected building is less than 500m from public transport stops.

The building is supplied with disable needs. There is an apartment that provides a basement floor of the building. There is access to the apartment from outside without stairs and inside it is designed so that a person with disability can be freely moved.

2. TECHNOLOGICAL CARDS

2.1. TECHNOLOGICAL CARD I: MASONRY WORKS

2.1.1 GENERAL DESCRIPTION

In this card we are going to talk about the masonry works of the outside walls. They are composed of expanded clay blocks and they are going to be part of the structure. In the project we count with some monolithic walls inside the building that are going to be built in a parallel way, they are made of reinforced concrete and there are also internal partitions of clinker bricks and plasterboards. The outside walls are going to be part of the structure as there are no pillars in the project. For an optimal performance the wall is going to be composed of several layers of different materials explained in the next point. In this card we are not going to explain the collocation of the different coatings, first the whole wall, part of the structure, will be built and finished this work we can proceed to make the coating but will be part of a different technical card

2.1.2. LOCATION OF THE WALLS

As we can see in the next figure the masonry walls, object of this technical, card are located in the façade, closing the building. There are also represented the partitions distinguished between its composition. The red one are the masonry walls of expanded clay blocks, the grey ones are monolithic walls made of reinforced concrete, that are also part of the structure, the green ones are partitions of clinker bricks and the blue are plaster board partitions (see Figure 5).

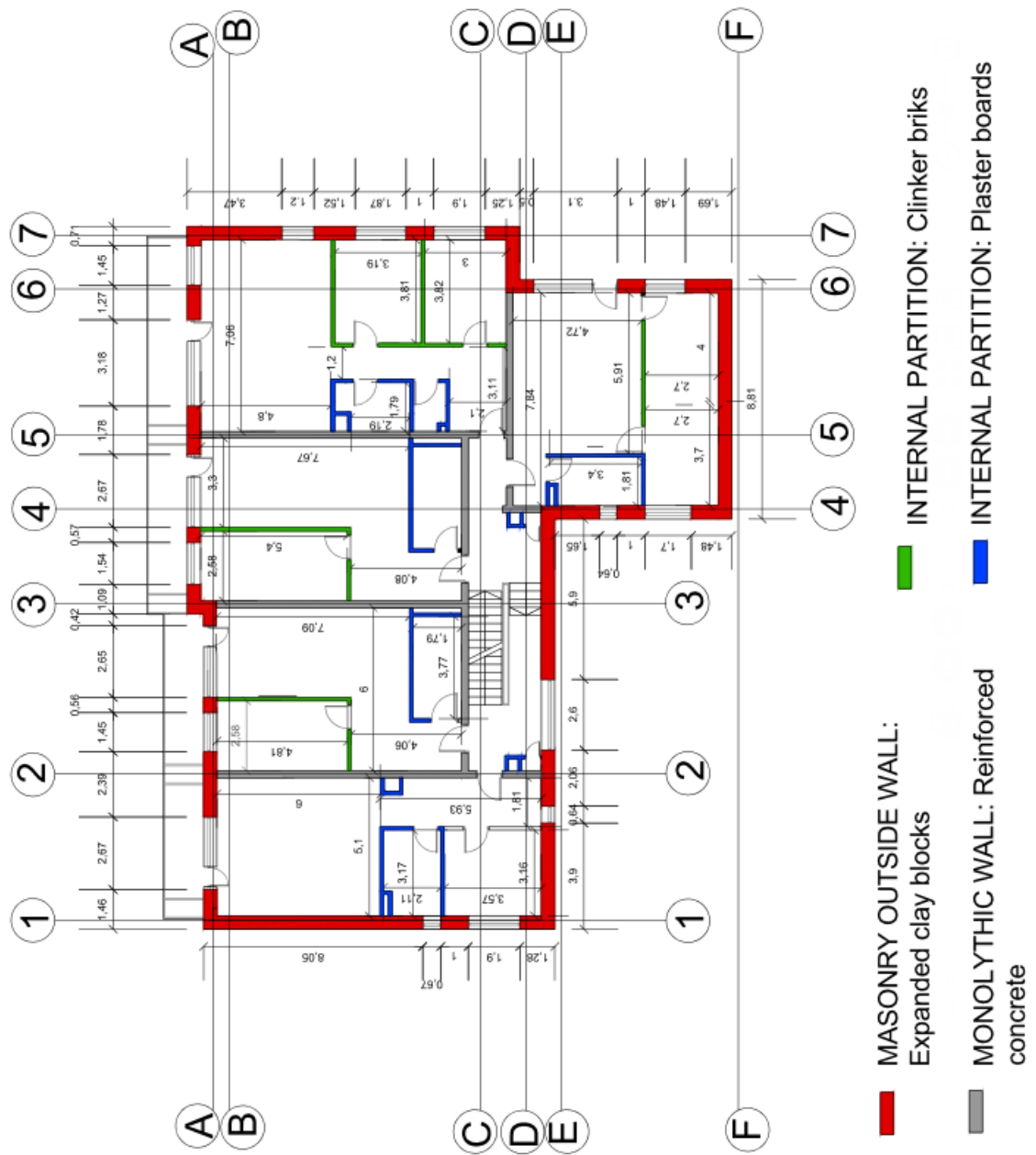


Figure 5. Location of walls

2.1.3. DESCRIPTION OF TECHNOLOGY AND SEQUENCE OF WORKS

In this point we are going to talk about the materials that compose the masonry walls, their qualities and the sequence of how to do this work.

In the given information of the project there is no mention about the composition of the walls, we only know that they are of masonry and have a thickness of 50cm.

I have considered that the expanded clay blocks for the main leaf of the wall are the best option because of its characteristics and requirements of the project:

-There are no pillars, so they are going to be part of the structure and that kind of blocks can be used for that requisite.

-They have a thickness of 50cm including insulation and coating. We are going to use blocks of 19cm of thickness so we can add the necessary layers with the common measures and complete the required thickness.

-The expanded blocks have insulation properties, and this will increase that property with the same thickness of the additional insulation.

The expanded clay blocks don't have vertical mortar joints instead of that they have dovetail joints (Figure 6). The horizontal joints will be of mortar but they will have to be discontinuous, the joint will be formed of two pieces of mortar separated 2cm in the center.

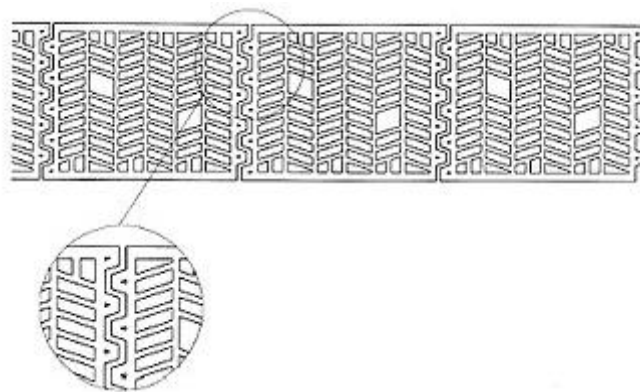


Figure 6. Expanded clay blocks

In the next details we can see the main layer that compose the wall including the posterior insulation and coating that will be part of other technical card, and also the difficult parts of the wall where we must put attention to guarantee the proper working order and keep the properties required to the building as thermal insulation, waterproofing or mechanical specifications (see Figures 7, 8, 9 and 10).

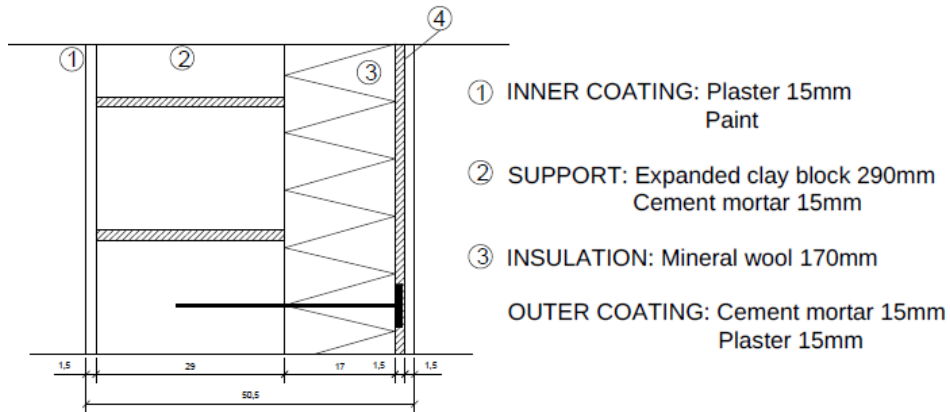


Figure 7. General detail with plaster coating

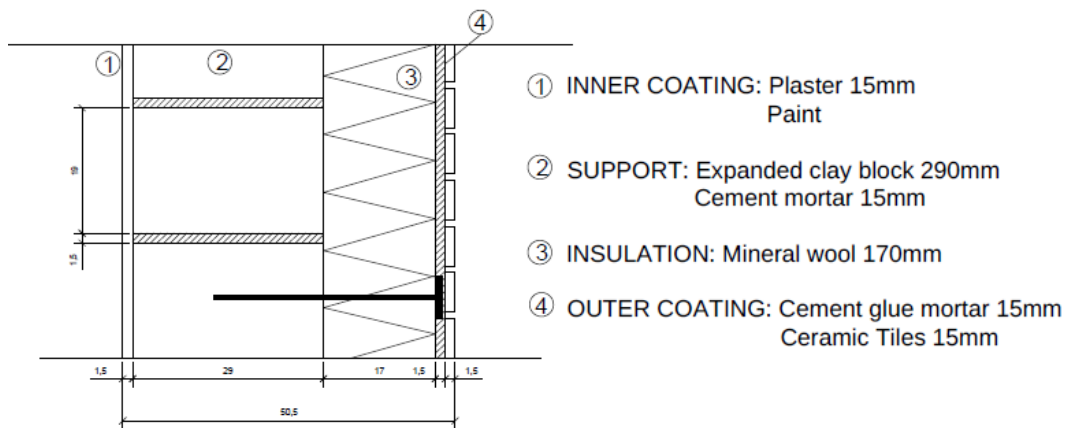


Figure 8. General detail with ceramic tiles coating

These are two details of the different coating we can find in the masonry outside walls, with all the necessary layers to guarantee the requests of the project. As we can see, there are places with a coating of ceramic tiles and other areas with a covering of plaster.

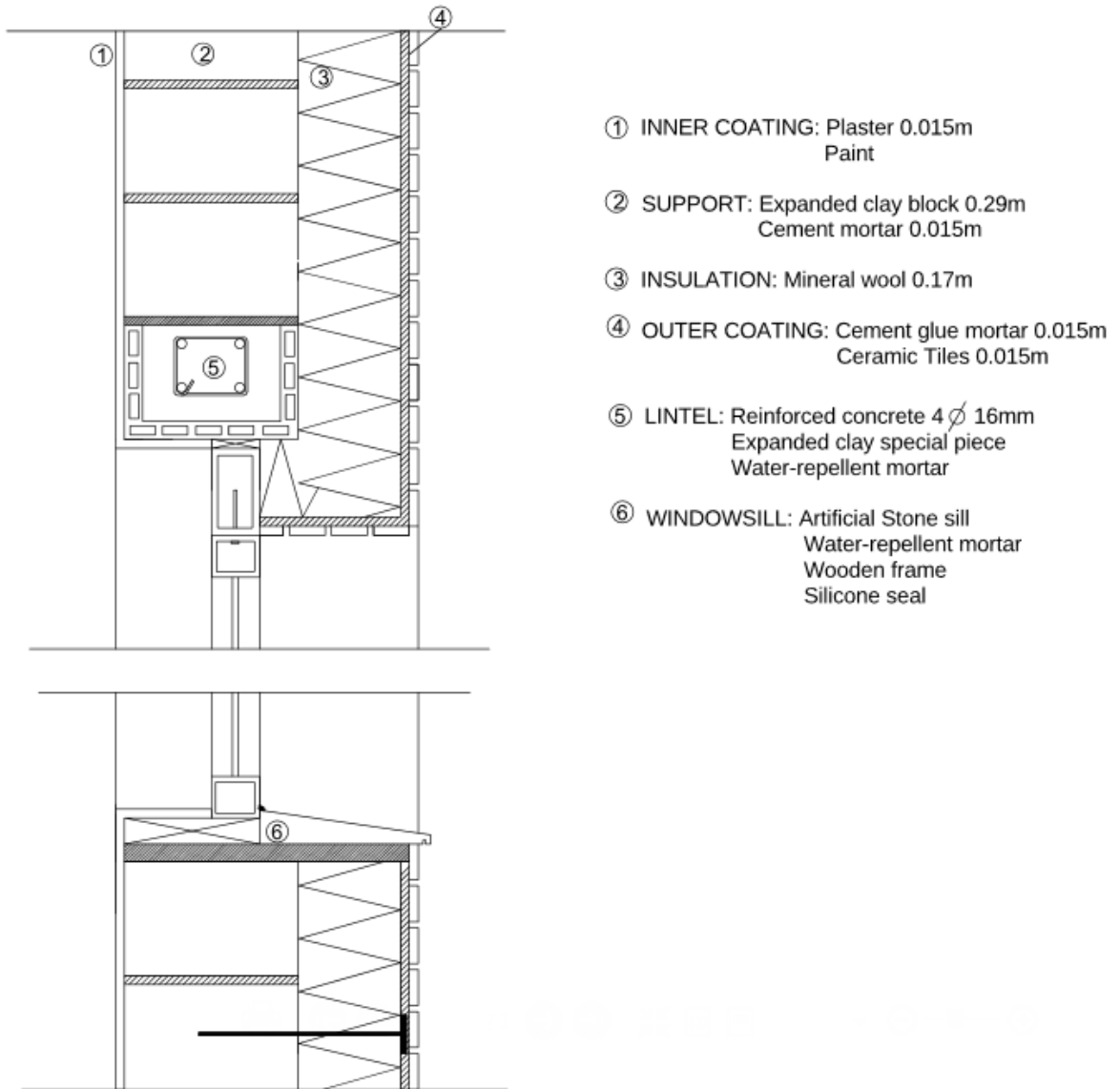


Figure 9. Lintel and windowsill detail

It is very important to take care in this detail because with an incorrect construction we can have a thermal bridge, and we need to have a continuous insulation. The window will be sealed by silicone so water won't get inside. It is also important the windowsill to have a little slot so the water from the rain won't get to the wall.

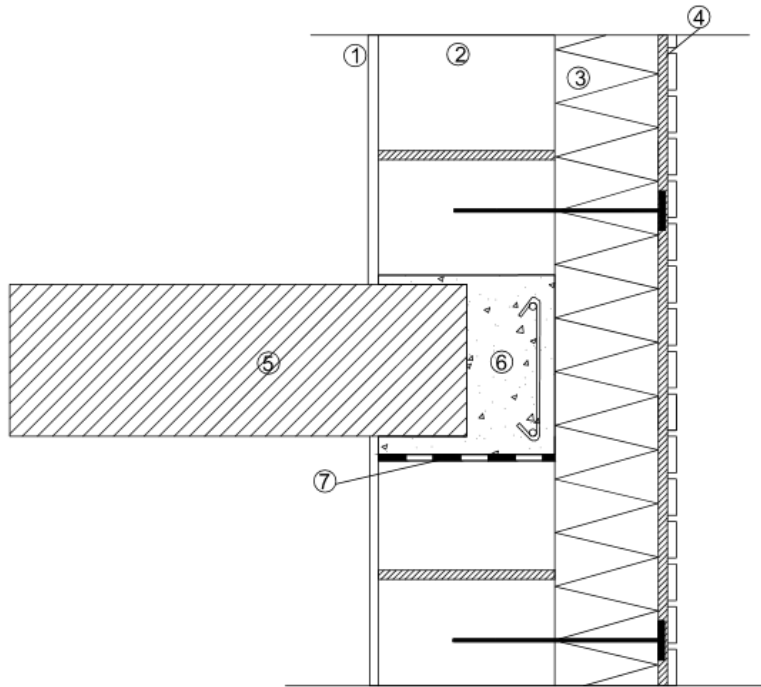


Figure 10. Detail of slab and masonry wall

- ① INNER COATING: Plaster 15mm
Paint
- ② SUPPORT: Expanded clay block 290mm
Cement mortar 15mm
- ③ INSULATION: Mineral wool 170mm
- ④ OUTER COATING: Cement glue mortar 15mm
Ceramic Tiles 15mm
- ⑤ SLAB: Prefabricated concrete
- ⑥ BEAM IN BORDER: Reinforced concrete $2\phi 12$
- ⑦ PVC film

Other singular point in the wall is in the union with the slab. The slab can stand directly on the ceramic block, so we will build a little beam of reinforced concrete.

-SEQUENCE OF WORKS:

The works start when the concrete slab in the ground floor is finished.

-STOCKED UP OF MATERIALS: First of all the materials, equipment and tools, will be stocked up near the place of working.

-PREPARATION OF MORTAR: Then the mortar must be prepared according to the regulation and the project.

- CLEAN SURFACE: When we have everything prepared we have to clean the surface of the concrete for a good adhesion.

-STAKEOUT: We mark the position of the wall and the modulation of the courses by sight and strings to keep the verticality and the horizontality of the wall. There will be collocated sights in a distance of 4 meters and always in:

- Corners
- Expansion joints
- Jambs
- Start and finish of each wall

There will be marks on the sights indicating the high of each row to ensure that the courses of the wall are horizontal. There will be also a taut wire between two sights, serving as reference for horizontal courses to be correctly placed. The vertical marks will indicate:

- The high of each course
- The high of the ledge of the windows
- The position of the slab

-WETTING OF BRICKS: we have to wet the bricks so when we put the mortar it won't lose its humidity and won't change its consistence.

-COLOCATION OF BRICKS: We start laying the bricks from one of the ends of the wall. This kind of bricks doesn't have mortar in the vertical joints, instead of that they have a tongue and groove. These joints will be separated from the vertical joints of the next row 7cm or more.

When we have done all the walls of the ground floor (including the monolithic ones), we must build the slab of the ground floor to start the wall of the next floor and repeat the steps of the construction till the last floor.

NOTE: We should use special pieces in singular points (corners, ledges, expansion joints...). We will put the coating and the isolation when the whole wall will be built.

2.1.4. HUMAN SAFETY

In the activity of masonry there are several risks that we must identify, evaluate and resolve. First of all, the workers will have studies about security and prevention. And there will be a meeting before starting the work to know the risks and the prevention measures adopted in the plan. All the workers have to wear helmet and security boots. The working area will be clean and tidy and there will be a specific area for storage. In case of cutting pieces workers will have to wear security gloves. One of the most important risks is working on height, so there will be a gallow type safety net (figure 11). The net will save two floors, when the second floor is finished the net must be moved to the third floor so it always saves less than 6m of fall.

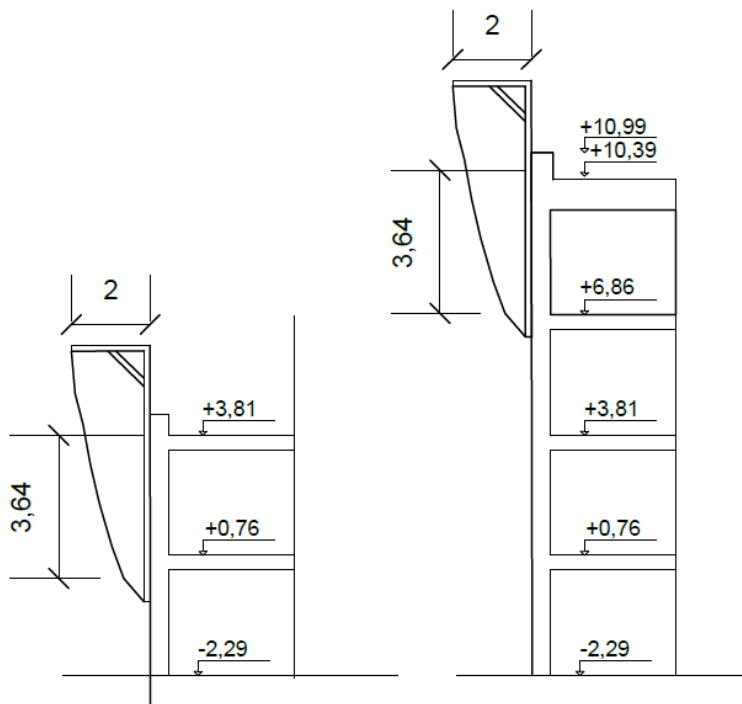


Figure 11. Gallow security net

Here is a table with the different risks, protections and safety measures (see Table2).

RISKS	CAUSES	COLECTIVE PROTECTIONS	INDIVIDUAL PROTECTIONS	SAFETY MEASURES
<ul style="list-style-type: none"> · Falls of personal at different level · Falls of personal at the same level · Cuts · Fall of elements or materials · Stuck by objects · Overexertion 	<ul style="list-style-type: none"> · Working at height · manipulate heavy elements · Disorder and dirtiness. · Materials stoked up in a wrong place · Same position for a long time · Exposure to harmful substances 	<ul style="list-style-type: none"> · security rail in the border of the slab · Net · Boards in holes 	<ul style="list-style-type: none"> · Security boots · Helmet · Security gloves 	<ul style="list-style-type: none"> · Keep the working area clean and tidy · Mark the stocking areas

Table 2 . Human safety. Masonry

2.1.5. QUALITY CONTROL

It is important to follow the indications of the project with the execution of the wall, keeping in touch the singular details explained before. Apart from the execution first there must be a quality control of the materials that are going to be used. The constructor must inspect the wall while being built.

RECEPTION: There will be a control in the reception, where all the products will have to get with them the information of their qualities, the commercial brand, and the first quality mark in case. It is obligatory to all the pieces to have the European Certificate (CE) . All the documents will be according to the project and according to the Spanish normative CTE(Technical Code) its Basic Document about fabrics DB-SE-F they will bring the supplier's declaration's on its strength and manufacturing category.

FOR THE EXPANDED CLAY BLOCKS:

-In the zone of work there will be a checking of the pieces to verify that any piece is broken or any characteristic is affected by its transport or storage.

-There will be assay for some inspection lots to guarantee the required characteristics in the project.

-The pieces will be properly storage in an specific area and put in a correct way that don't deteriorate the pieces. They will be collected on a site far from substances or environments that can damage the physical or chemical material of the pieces

THE CEMENT MORTAR:

-The cement mortar will be used following the manufacturer's instructions that shall include the type of mixer, the mixing time and the amount of water.

-The mortar must be used before expiry of the period of use defined by the manufacturer. If the water is evaporated it may be added only during the period of use that the manufacturer defines. The mortar will be used before starting to set, the mortar that has started to set will be refused and not reused.

-The resistance of the mortar will be test according to the UNE EN 1015-11;2000.

2.1.6. ORGANIZATION OF WORKS

For the masonry Works we will have a team of 5 workers composed by two 1st class experts of bricklaying and three workmen of bricklaying. While doing the masonry works there will be other works in activity. In Table 4 there are the different activities with the order of carrying out each one, and also with the time we are going to need to make it. To calculate the duration of each activity we will use the next formula:

$$D = \frac{\text{Area}(m^2) \times \text{Performance}\left(\frac{h}{m^2}\right)}{\text{Hours}\left(\frac{h}{\text{day}}\right) \times N^{\circ}\text{workers}}$$

(D=Duration of work in days)

For the calculation we are considering 8 hours of work per day and 5 working days per week. According to the Costs and performances base data of construction works (2015) the workers will have different performance in each work. The necessary data for the calculation is the next table (see Table 3):

	WORK	PERFORMANCE (h/m2)	AREA (m2)	Nº WORKERS	DAYS
ground floor	MASONRY OUTSIDE WALLS	0,438	179,07	5	2
	MONOLITHIC WALLS	0,41	137,54	5	1,5
	SLABS + STAIRS	0,163	327,92	5	1,5
	PARTITIONS of brick	0,41	95,22	3	1,5
	plaster board partitions	0,263	93,96	2	1,5
1st Floor	MASONRY OUTSIDE WALLS	0,438	214,9	5	2,5
	MONOLITHIC WALLS	0,41	137,54	5	1,5
	SLABS +STAIRS	0,163	352,2	5	1,5
	PARTITIONS of brick	0,41	120,3	3	2
	plaster board partitions	0,263	102,6	2	2
2nd Floor	MASONRY OUTSIDE WALLS	0,438	214,9	5	2,5
	MONOLITHIC WALLS	0,41	137,54	5	1,5
	SLABS + STAIRS	0,163	352,2	5	1,5
	PARTITIONS of brick	0,41	120,3	3	2
	plaster board partitions	0,263	102,6	2	2
3rd Floor	MASONRY OUTSIDE WALLS	0,438	214,9	5	2,5
	MONOLITHIC WALLS	0,41	137,54	5	1,5
	SLABS + STAIRS	0,163	352,2	5	1,5
	PARTITIONS of brick	0,41	120,3	3	2
	plaster board partitions	0,263	102,6	2	2

Table 3. Organization data

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DAYS	29 DAYS																	
MASONRY WORKS	3workers																	
MASONRY OUTSIDE WALLS	3workers																	
MONOLITHIC WALLS	3workers																	
SLABS + STAIRS	3workers																	
PARTITIONS of brick	3workers																	
PLASTER BOARD PARTITIONS	2workers																	
MASONRY OUTSIDE WALLS	3workers																	
MONOLITHIC WALLS	3workers																	
SLABS +STAIRS	3workers																	
PARTITIONS of brick	3workers																	
PLASTER BOARD PARTITIONS	3workers																	
MASONRY OUTSIDE WALLS	3workers																	
MONOLITHIC WALLS	3workers																	
SLABS + STAIRS	3workers																	
PARTITIONS of brick	3workers																	
PLASTER BOARD PARTITIONS	3workers																	
MASONRY OUTSIDE WALLS	3workers																	
MONOLITHIC WALLS	3workers																	
SLABS + STAIRS	3workers																	
PARTITIONS of brick	3workers																	
PLASTER BOARD PARTITIONS	3workers																	

	19	20	21	22	23	24	25	26	27	28	29	
MASONRY WORKS	3workers											
MASONRY OUTSIDE WALLS	3workers											
MONOLITHIC WALLS	3workers											
SLABS + STAIRS	3workers											
PARTITIONS of brick	3workers											
PLASTER BOARD PARTITIONS	2workers											
MASONRY OUTSIDE WALLS	3workers											
MONOLITHIC WALLS	3workers											
SLABS + STAIRS	3workers											
PARTITIONS of brick	3workers											
PLASTER BOARD PARTITIONS	3workers											

Table 4. Organization of masonry works

2.1.7. MATERIAL AND TECHNICAL RESOURCES

In the next table there is a list quantifying the materials, tools, machinery, auxiliary resources and workers (see Table 5).

U	MATERIALS	QUANTITY
u	Expanded clay block	14704,3
m ³	Water	7,41
t	Cement mortar M-5	38,71
m	Prestressed concret joist, T-18, Lmedium = <4 m	148,27
u	Expanded clay tile, 30x19x4,8 cm	1235,65
MACHINERY AND TOOLS		
u	forklift	1
u	cutting machine	1
u	tower crane	1
u	trowel	2
u	level	2
u	hammer	2
u	plumb	2
AUXILIARY RESOURCES		
u	loading and unloading platform	1
WORKERS		
u	1 ^a class expert of bricklaying.	1
u	Workman of bricklaying.	1

Figure 5. Material and technical resources

2.1.8. PRICE OF MASONRY WORKS

To calculate the price of the masonry works we have taken the information from Cype data base. This point will be developed in the organization part with the budget of all the project.

2.1.9 TECHNICAL-ECONOMIC INDICATORS

QUANTITY OF WORKS:

823,77m² of expanded clay blocks layer.

CONSTRUCTION AND WEDGE COSTS:

Expanded clay block layer: $37,44\text{€}/\text{m}^2 \times 823,77\text{m}^2 = 30.841,95\text{€}$

DURATION OF THE WORKS:

For the duration of the works we consider 8 hour of working per day and 5 days per week. The duration of days of masonry works are calculated according to this formula:

$$D = \frac{\text{Area}(\text{m}^2) \times \text{Performance}(\frac{\text{h}}{\text{m}^2})}{\text{Hours}(\frac{\text{h}}{\text{day}}) \times \text{N}^\circ \text{workers}}$$

WORK	PERFORMANCE (h/m ²)	AREA (m ²)	Nº WORKERS	HOURS (h/day)	DAYS
MASONRY OUTSIDE WALLS	0,438	823,77	5	8	9

Figure 6. Technical indicators

In the point Organization of masonry works there is a schedule with the duration of the works and the works being done in a parallel way.

2.2. TECHNOLOGICAL CARD II: FLOORING

2.2.1. GENERAL DESCRIPTION

As it isn't specified in the given information, I have chosen different types of covering for the building depending on the characteristics and needs of each areas.

In the common areas of the building we are going to put terrazzo because it is going to be the most crowded part inside the building and it is a very resistant material so it will work very good against the wear of the floor.

Then inside each apartment we are going to put two different coverings: in the bathroom, the living room and the kitchen there is going to be ceramic tiles. I have chosen it because it is a perfect material for wet areas in consequence of its impermeability, their resistance to impacts and washing. The living room is united to the kitchen so there will be also the same covering as in the kitchen by reason of aesthetic. In the bedroom there is going to be laminated flooring because its warmth and aesthetic. In the garage located on the ground floor it is going to be a coating of self-leveling mortar with an epoxy painting, indicated for parking because it has a high level of abrasion resistance.

2.2.2 LOCALIZATION OF DIFFERENT FLOORINGS

In the next picture there are represented the different floorings in a general floor. The epoxy painting will be in the garage located in the ground floor under the apartment number 9. It is specified in the section drawn in the next point (see Figure 12).

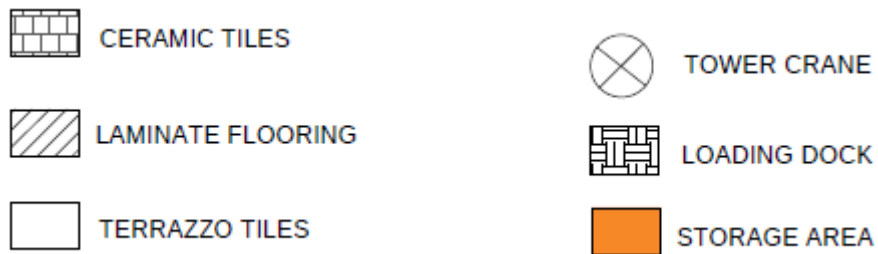
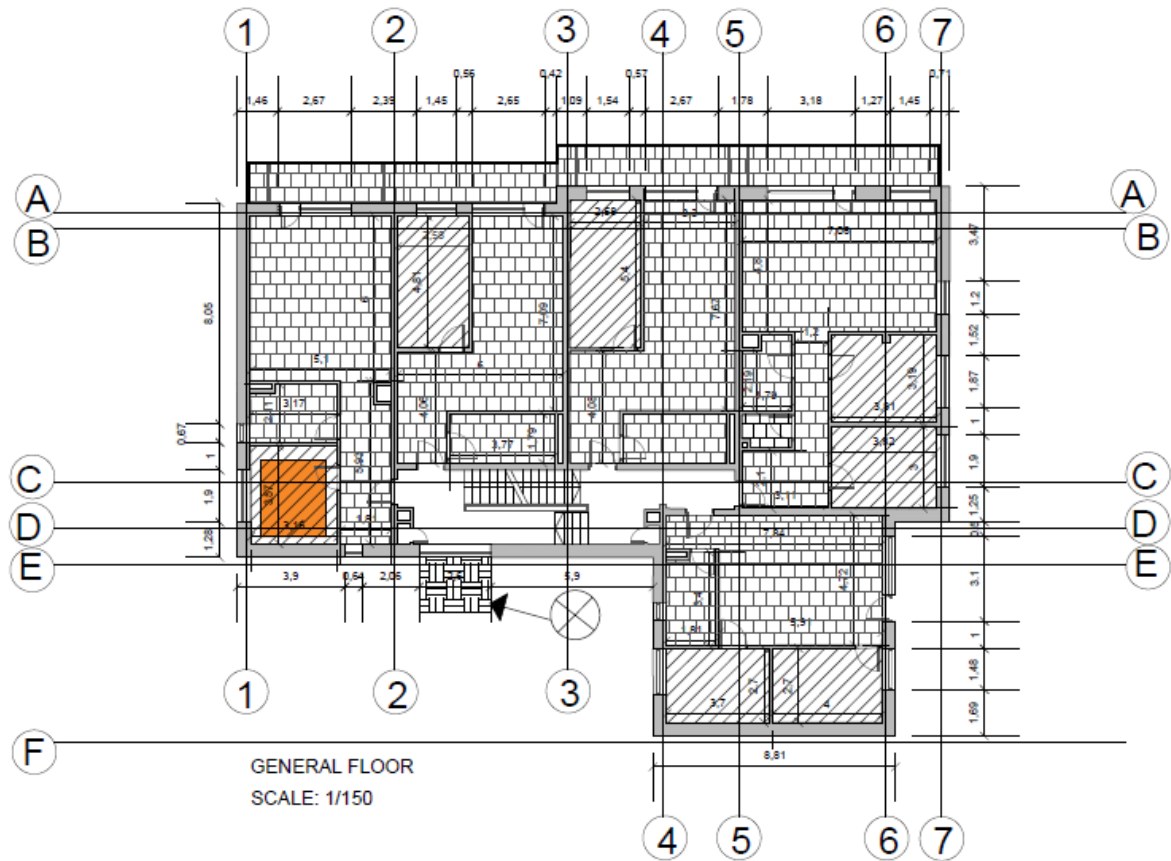


Figure 12. Location of floors

2.2.3 DESCRIPTION OF TECHNOLOGY AND SEQUENCE OF WORKS

Each coating needs different layers for the right finish and running (see Figure 14, 15, 16, 17, 18, 19, 20, 21 and 22).

- PREPARATION OF THE BASE: First of all we have to prepare the base. In the floors where the base are concrete slabs it will be necessary to clean the

surface of the slab and guarantee a level surface. In the areas where the base is directly the ground, we have to compact it to have a stable base.

- **LEVELING LAYER:** This layer is to assure a good horizontal finishing of the pavement. We have to put a layer of cement mortar between 2 or 5 centimeters to correct imperfections and some slope. It must be a dosage 1:6.
- **INSULATION:** to guarantee the protection of warmth and noise we will put a mineral wool of 5, 10 or 15 cm depending on the area where we work. It is a great material for heat insulation and sound absorption. This material also is incombustible and does not fuel fire or propagate flames.
- **WATERPROFFING AND STEAM BARRIER:** the polyethylene film is a perfect element to solve the waterproofing, it also has a great mechanical characteristics and its use is associated with preventing condensation formed on the thermal insulation. It is always placed in the warm side of the insulation, the side with higher vapor pression.
- **DRAINAGE LAYER:** In the floors that are in contact with the ground there must be a drainage layer of 15cm made of gravel and separated from the ground by a geotextile.

Each covering has specific indications:

CERAMIC TILES:

The grip mortar must have mechanical and chemical adhesion, it is going to be used a glue mortar of a very thin coat over a leveling mortar. The adhesive will be apply with a ridged trowel in a very thin layer. It will be spread in small sections (1-2 m²) and comb with a ridged trowel adapted to the shape to install. The workers have to make the planning of the tile pattern with the aid of a white rubber hammer and a level. The joints of these tiles will be of 2mm.

TERRAZZO TILES:

These tiles have a different sequence of works:

- LAYER OF SAND:** first over the base must be a layer of sand of 3cm.
- MORTAR LAYER:** then a layer of mortar of 2cm minimum and a geotextile between sand and mortar layers.

-WETTING: The tiles have a wetting

-COLOCATION: We lay them and they are fit by a rubber mallet.

-GROUT COAT: We must throw a slurry bond coat covering the joints.

-POLISHING: The last step is the polishing of the tiles.

LAMINATED FLOORING:

These pieces will be put over a polyethylene base and glue between the dovetail joints. After cleaning the rest of adhesive the fixation will be hidden by a putty layer.

In the next section there are marked the location of the next details where we explain all the layers required for each flooring and placement (see Figure 13).

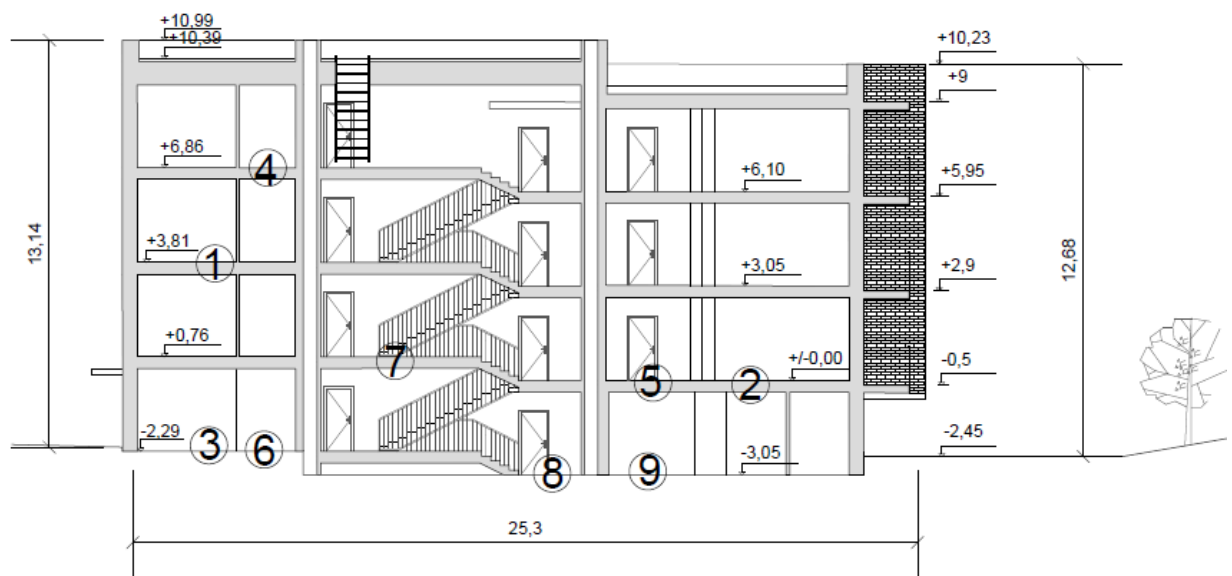
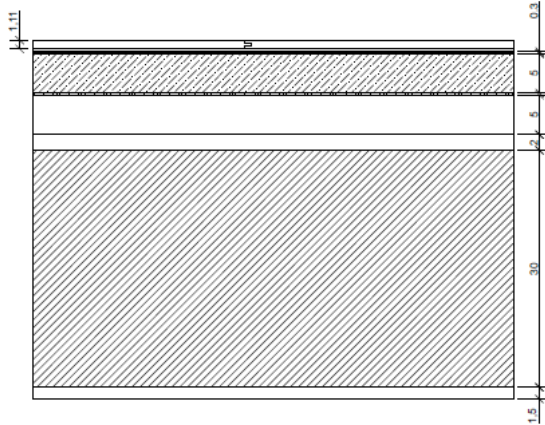


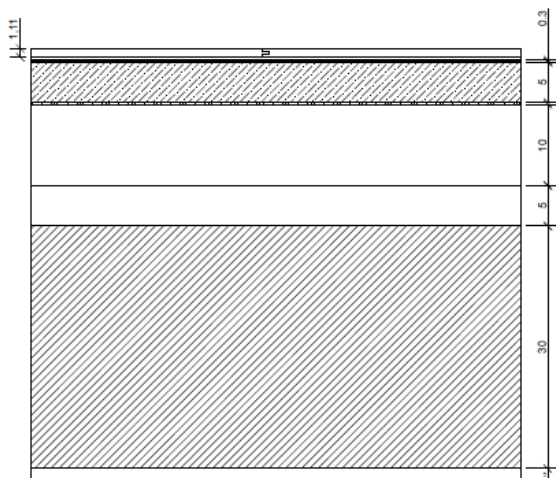
Figure 13. Location of details



1-BEDROOM-BEDROOM

- COATING: laminate flooring
- GRIP: adhesive D3 (anti-humidity)
- INNERLAYER: polyethylene foam of high density 3mm
- LEVELING: Cement mortar
- STEAM BARRIER: Polyethylene film
- INSULATION: Mineral wool
- LEVELING: Cement mortar
- SUPPORT: Reinforced concrete
- COATING: Plaster

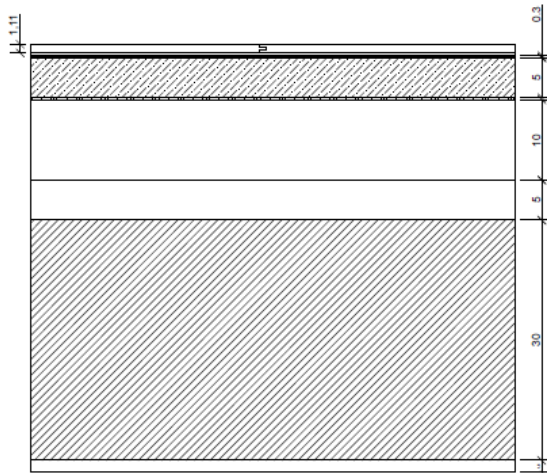
Figure 14. Laminate flooring



2-BEDROOM-GARAGE

- COATING: laminate flooring
- GRIP: adhesive D3 (anti-humidity)
- INNERLAYER: polyethylene foam of high density 3mm
- LEVELING: Cement mortar
- STEAM BARRIER: Polyethylene film
- INSULATION: Mineral wool
- LEVELING: Cement mortar
- SUPPORT: Reinforced concrete
- COATING: Plaster

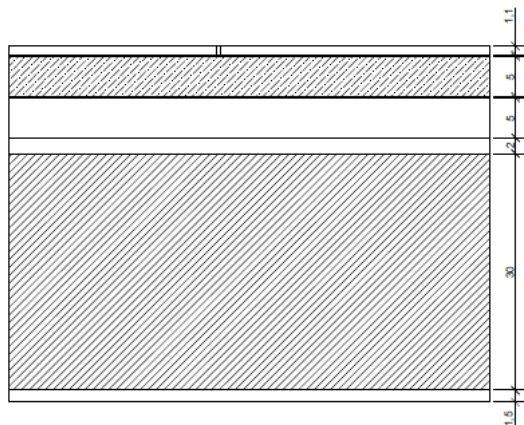
Figure 15. Laminate flooring



2-BEDROOM-GARAGE

- COATING: laminate flooring
- GRIP: adhesive D3 (anti-humidity)
- INNERLAYER: polyethylene foam of high density 3mm
- LEVELING: Cement mortar
- STEAM BARRIER: Polyethylene film
- INSULATION: Mineral wool
- LEVELING: Cement mortar
- SUPPORT: Reinforced concrete
- COATING: Plaster

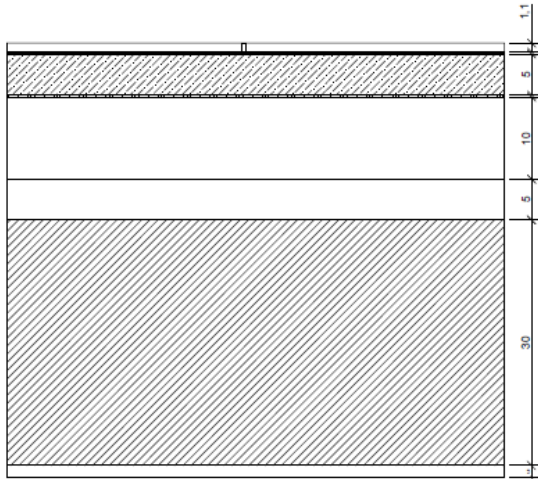
Figure 16. laminate flooring



4- LIVING ROOM/KITCHEN -
LIVING ROOM/KITCHEN

- COATING: Ceramic tiles
- GRIP: Cement glue
- LEVELING: Cement mortar
- STEAM BARRIER: Polyethylene film
- INSULATION: Mineral wool
- LEVELING: Cement mortar
- SUPPORT: Reinforced concrete
- COATING: Plaster

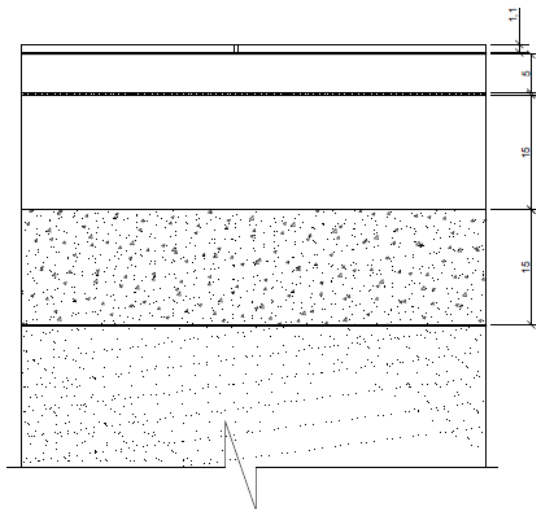
Figure 17. Ceramic tiles



- COATING: Ceramic tiles
- GRIP: Cement glue
- LEVELING: Cement mortar
- STEAM BARRIER: Polyethylene film
- INSULATION: Mineral wool
- LEVELING: Cement mortar
- SUPPORT: Reinforced concrete
- COATING: Plaster

5- LIVING ROOM/KITCHEN-GARAGE

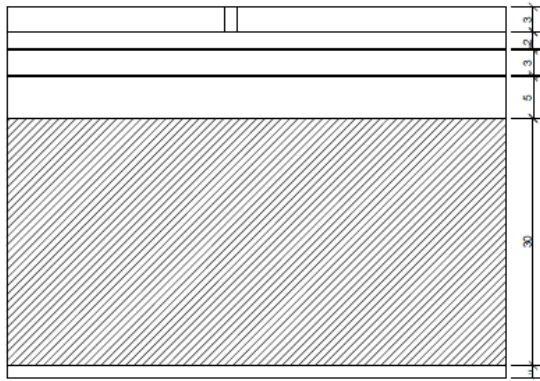
Figure 18. Ceramic tiles



- COATING: Ceramic tiles
- GRIP: Cement glue
- LEVELING: Cement mortar
- STEAM BARRIER AND WATERPROOFING: Polyethylene film
- INSULATION: Mineral wool
- DRAINAGE: Gravel
- Geotextile
- SUPPORT: Ground

6- LIVING ROOM/KITCHEN-GROUND

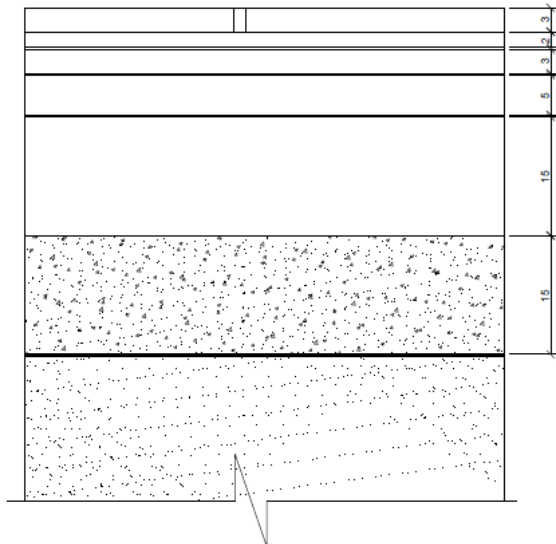
Figure 19. Ceramic tiles



COATING: Terrazzo tiles
 GRIP: Cement mortar
 INTER-LAYER: geotextil
 LEVELING : Sand
 STEAM BARRIER: Polyethylene film
 INSULATION: Mineral wool
 SUPPORT: Reinforced concrete
 COATING: Plaster

7- COMMON AREA-COMMON AREA

Figure 20. Terrazzo tiles



COATING: Terrazzo
 GRIP: Cement mortar
 INTER-LAYER: geotextil
 LEVELING : Sand
 STEAM BARRIER AND
 WATERPROOFING: Polyethylene film
 INSULATION: Mineral wool
 DRAINAGE: Gravel
 Geotextile
 SUPPORT: Ground

8- COMMON AREA-GROUND

Figure 21. Terrazzo tiles

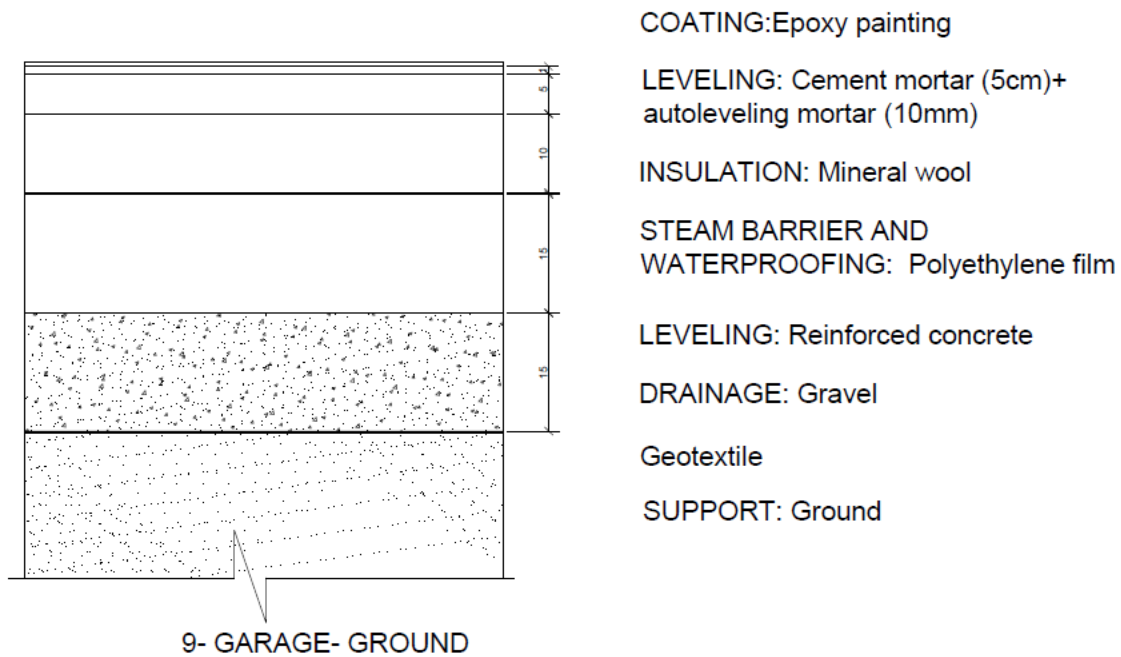


Figure 22. Epoxy painting

2.2.4. ORGANIZATION OF WORKS

In this point we are going to calculate and organize the duration of the flooring works.

For this works we are going to have a team of two workers; one of first class expert of construction and one workman of flooring. The performance of each flooring is taken from the Costs and performances base data of construction works, each flooring has a different performance of work and different areas, so depending on both of these factors and having 8hours per day and working 5 days per week we will use the next formula to plan the time of these works:

$$D = \frac{\text{Area}(m^2) \times \text{Performance}\left(\frac{h}{m^2}\right)}{\text{Hours}\left(\frac{h}{\text{day}}\right) \times N^{\circ}\text{workers}}$$

(D=Duration of work in days)

First we have calculated the duration of each coating in a floor, with all the layers, and then we have a general table with the duration of all coatings in the whole building.

CERAMIC TILES:

For the ceramic tiles we have two workers with a performance of 0,304h/m² and an area of 222,12m² in each floor. In the next table there is the works and the duration of the collocation of the ceramic tiles in one floor. This work will take 4,5 days.

TERRAZZO TILES:

These tiles occupy an area of 30m² in each floor of the building. The work will be done by two workers with a performance of 0,192h/m². We can see in the following table the duration and order of collocation of each layer in one floor. The duration of terrazzo tiles in one floor will be 1,5day.

LAMINATED FLOORING:

This coating has an area of 83m² in each floor. The work will be done by a team of two workers with a performance of 0,091h/m². The collocation of this flooring will take 4,5 hours.

EPOXY FLOORING:

There is an area of 36,91m² of this covering and it is only in the ground floor. The work will be done by a two workers team with a performance of 0,091h/m². This work will be done in 4 hours.

In the next tables there is a schedule of each work for a general floor and in figure 6 a schedule for all the building with the total duration of flooring works (see Table 7, 8, 9 and 10).

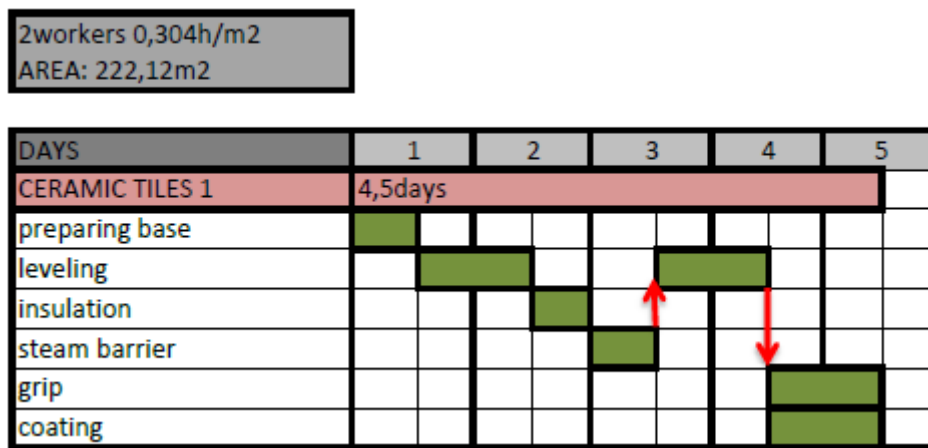


Table7. Schedule of ceramic tiles works

2 workers 0,091h/m²
 AREA: 83m²

HOURS	1	2	3	4	5
LAMINATED FLOORING	4,5 hours				
preparing base	█				
leveling		█		█	
insulation			█		
steam barrier			█		
grip					█
coating					█

Table.8

Schedule of ceramic tiles works

2 WORKERS: 0,192h/m²
 AREA: 30m²

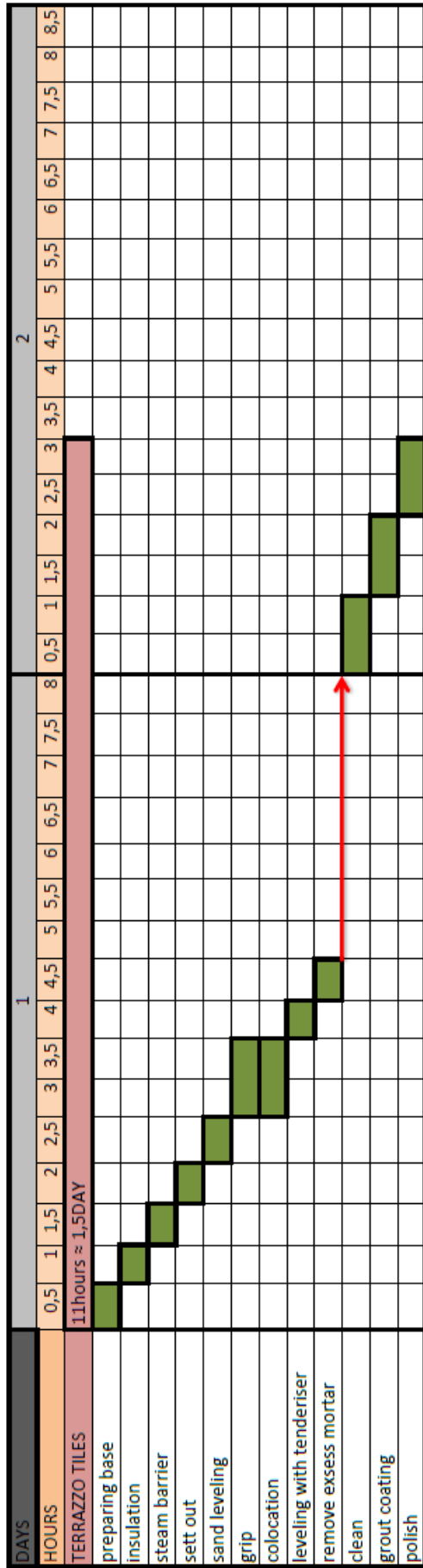


Table 9. Schedule of terrazzo tiles works

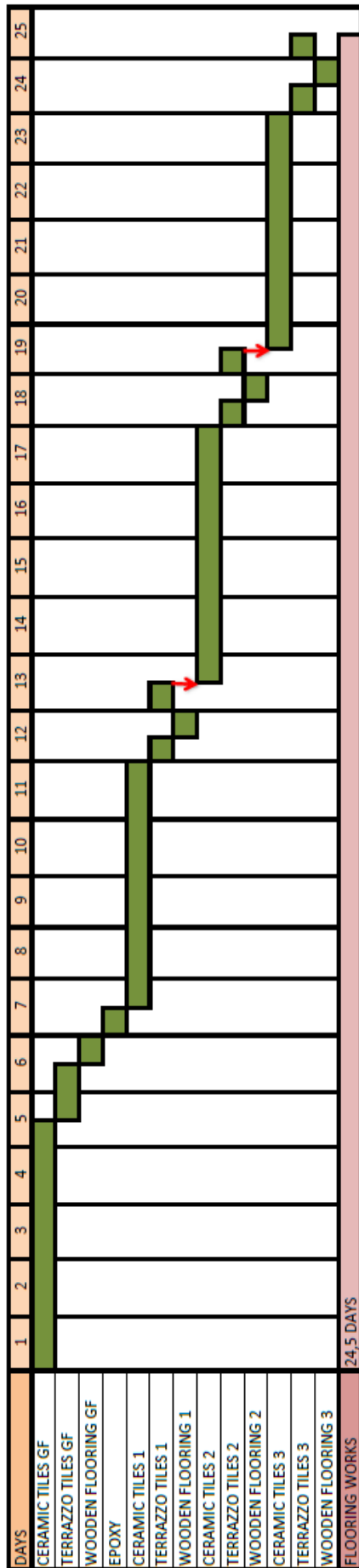


Table 10. Schedule of flooring works

2.2.5. QUALITY CONTROL

The flooring works will be controlled to be executed according to the project. Apart from the execution there will be a control of the materials received in the construction. They would have the specific characteristics that the project asks. All the coating pieces will be marked on them or their packing by:

- The commercial brand.
- First quality marck (in case).
- Reference to the normative UNE-EN14411:2006.
- Nominal and manufacture dimensions.
- it is obligatory the european certificate CE mark.**

RECEPTION:

Documental control in the reception of each consignment:

- All the marks and documents will be verify to be the same as in the project.

INSPECTION IN THE WORK PLACE:

- It must be ensured that the tiles do not present clear signs of deterioration
- It will check that the tiles do not present signs of having been subjected to transport or improper storage that may have affected the characteristics of the same.

ASSAY CONTROL:

- The products will be split in inspection lots , formed by consignment tiles of the same manufacturer with the same properties and uniform conditions.

- A full assay will be made to inspection lots of more than 2.000m².

- The assays will be done according to the assay methods specified on the European regulation UNE-ENUNE-EN ISO 10545-1:1997

- If the results meet the requirements demanded for each feature the lot will be accepted, if not, the Director of Works will decide its rejection or depreciation in view of the studies.

2.2.6. HUMAN SAFETY

First of all the workers must have knowledge about prevention and security, and the responsible person must give them the necessary information for that. There will be a meeting before starting flooring works to know the prevention measures adopted. In the next table (Figure 7) there are exposed the different risks that we can

find in this work and also the security measures approved, the individual and the collective protections.

RISKS	CAUSES	COLLECTIVE PROTECTIONS	INDIVIDUAL PROTECTIONS	SAFETY MEASURES
<ul style="list-style-type: none"> · Falls of personal at the same level · Cuts · Objects falling on workers · Stuck by objects · Overexertion · Hurts by handling objects and hand tools · Particles into the eyes 	<ul style="list-style-type: none"> · manipulate dangerous tools · Disorder and dirtiness. · Materials stoked up in a wrong place · Same position for a long time · bad illumination 	<ul style="list-style-type: none"> · Boards in holes 	<ul style="list-style-type: none"> · Security boots · Helmet · Security gloves · respiratory mask · security belt 	<ul style="list-style-type: none"> · Keep the working area clean and tidy · Mark the stocking areas · don't work in the same position for a long time · temporary lights

Table11. Human safety

2.2.7. BUDGET

The price of this work will be developed in the organization part.

2.2.8. MATERIAL AND TECHNICAL RECOURSES

In the next table there is a list quantifying the materials, tools, machinery, auxiliary recourses and workers (see Table 12).

U	MATERIALS	PERF.	AREA M2	QUANTITY
m ³	Adhesive exclusive use for interiors, Ci, color grey.	3,000	222,120	666,36
m ²	Ceramic tile enamelled 2/0/-/-, 25x25 cmEN 14411.	1,050	222,120	233,226
kg	White cement BL-22,5 X, for pavement UNE 80305.	1,000	222,120	222,12
kg	White cement grout BL 22,5 X.	0,001	222,120	0,22212
m ²	Foam blanket for noise insulation from impact, covered by a polyethylene film for foam barrier of 2 mm de espesor.	1,100	83,000	91,3
m	autoadhesive tape for sealing joints.	0,440	83,000	36,52
m ²	Laminated flooring FINfloor Fiesta Premium LC "FINSÁ", 1200x189 mm	1,050	83,000	87,15
kg	Epoxy paint.	0,450	36,910	16,6095
m ³	Cement mortar CEM II/B-P 32,5 N type M-5	0,032	30	0,96
m ²	Terrazzo tile for interior and normal use	1,050	30	31,5
kg	White cement BL-22,5 X, for flooring, según UNE 80305.	1,000	30	30
kg	Color for terrazzo tiles.	0,500	30	15
U	WORKERS	PERF.	AREA M2	QUANTITY
h	1st class expert in flooring	0,192	30	5,76
h	Workman of flooring	0,192	30	5,76
h	1st class expert in flooring	0,405	222,120	89,9586
h	Workman of flooring	0,202	222,120	44,86824
h	1st class expert in flooring	0,091	83,000	7,553
h	Workman of flooring	0,071	83,000	5,893
h	1st class expert in paint	0,091	36,910	3,35881
h	Workman of paint	0,091	36,910	3,35881
U	MACHINERY AND TOOLS	PERF.	AREA M2	QUANTITY
u	forklift			1
u	cutting machine			1
u	tower crane			1
u	trowel			2
u	level			1
u	hammer			2
u	plumb			2
U	AUXILIARY RECOURSES	PERF.	AREA M2	QUANTITY
u	loading and unloading platform			1

Table12. Material and technical recourses of flooring works

2.2.9. TECHNICAL-ECONOMIC INDICATORS

QUANTITY OF WORKS:

-Ceramic tiles: $222,12\text{m}^2 \times 4 = 888,48\text{m}^2$

-Terrazzo tiles: $30\text{m}^2 \times 4 = 120\text{m}^2$

-Laminated flooring: $83\text{m}^2 \times 4 = 332\text{m}^2$

-Epoxy paint: $36,91\text{m}^2$

CONSTRUCTION AND WEDGE COSTS:

-Ceramic tiles: $20,59 \text{ €/m}^2 \times 888,48\text{m}^2 = 18.298,80\text{€}$

-Terrazzo tiles: $20,37 \text{ €/m}^2 \times 120\text{m}^2 = 2444,4\text{€}$

-Laminated flooring: $17,04 \text{ €/m}^2 \times 332\text{m}^2 = 5657,28\text{€}$

-Epoxy paint: $7,11\text{€/m}^2 \times 36,91\text{m}^2 = 262,43\text{€}$

Total Flooring works: **26657,91€**

TOTAL PRICE FOR FLOORING WORKS: 26.657,91€.

DURATION OF THE WORKS:

For the duration of the works we consider 8 hour of working per day and 5 days per week. The duration of days of masonry works are calculated according to this formula (see Table 13):

$$D = \frac{\text{Area}(\text{m}^2) \times \text{Performance}(\frac{\text{h}}{\text{m}^2})}{\text{Hours}(\frac{\text{h}}{\text{day}}) \times \text{N}^\circ \text{workers}}$$

WORK	PERFORMANCE (h/m ²)	AREA (m ²)	Nº WORKERS	HOURS (h/day)	DAYS
Ceramic tiles	0,304	222,12	2	8	4,5
Terrazzo tiles	0,192	30	2	8	1,5
Laminated flooring	0,091	83	2	8	0,5
Epoxy paint	0,091	36,91	2	8	0,5

Table 13. Duration of works

2.3. TECHNOLOGICAL CARD III: ROOF WORKS

2.3.1. GENERAL DESCRIPTION

In this technological card we are going to explain the roof works of the project. The top covering of the building is going to be formed by a non passable flat roof composed of 13 gables with pitches of 3% that have the purpose of picking up the rainwater to four points of the rainwater harvesting system. The roof can only be accessed form maintenance or repair. The total area horizontally projected of the roof is 348,3m².

As there isn't information about the composition of the roof we have considered that the best option is gravel autoprotected asphaltic sheet as the top coating of the roof.

In this card we are going to study some problematic points that we must put attention to do it in a correct way so the roof makes perfectly its function keeping the waterproofing or thermal and noise insulation in the whole area of the roof.

2.3.2 DESCRIPTION OF TECHNOLOGY AND SEQUENCE OF WORKS

The solution adopted for the roof is a non passable flat roof with a coating of boulder gravel. For that we have followed the Spanish normative NTE-QUA about roofs, and the CTE DB-HS1 and CTE DB-HE1(Technical Code of Edification). According to this normative we have the next guideline of design:

PITCH: Autoprotected sheet must have a pitch between 1%<P<15%.

EXPANSION JOINTS: The roof must be provided of expansion joints and the distance between them musn't exceeds the 15m. The joint must cut all the layers of the roof till the support. There must be also expansion joints between roof and a vertical wall. The joint must have a width of 3cm or more.

THERMAL INSULATION: When the thermal insulation is in contact with the waterproofing layer, they must be compatible or it should be provided of a separating layer between them.

NUMBER OF DRAINS: If the area of the roof horizontally projected is 200<A<500m there must be almost 4 drains.

PITCH FORMER: The material that forms the pitch will have a compression strength $>200\text{KPa}$ (20.000 Kg/m^2).

In Figure 23 is represented the roof floor with the different objects that we can find there and the location of the different details that follow it, with the different layers that compose the roof and the solution to the difficult points of the roof to guarantee the demanded qualities (see Figure 24, 25, 26, 27 and 28). It is very important the continuity of the layers and the compatibility between them. In case of incompatibility we will use a geotextile between the layers.

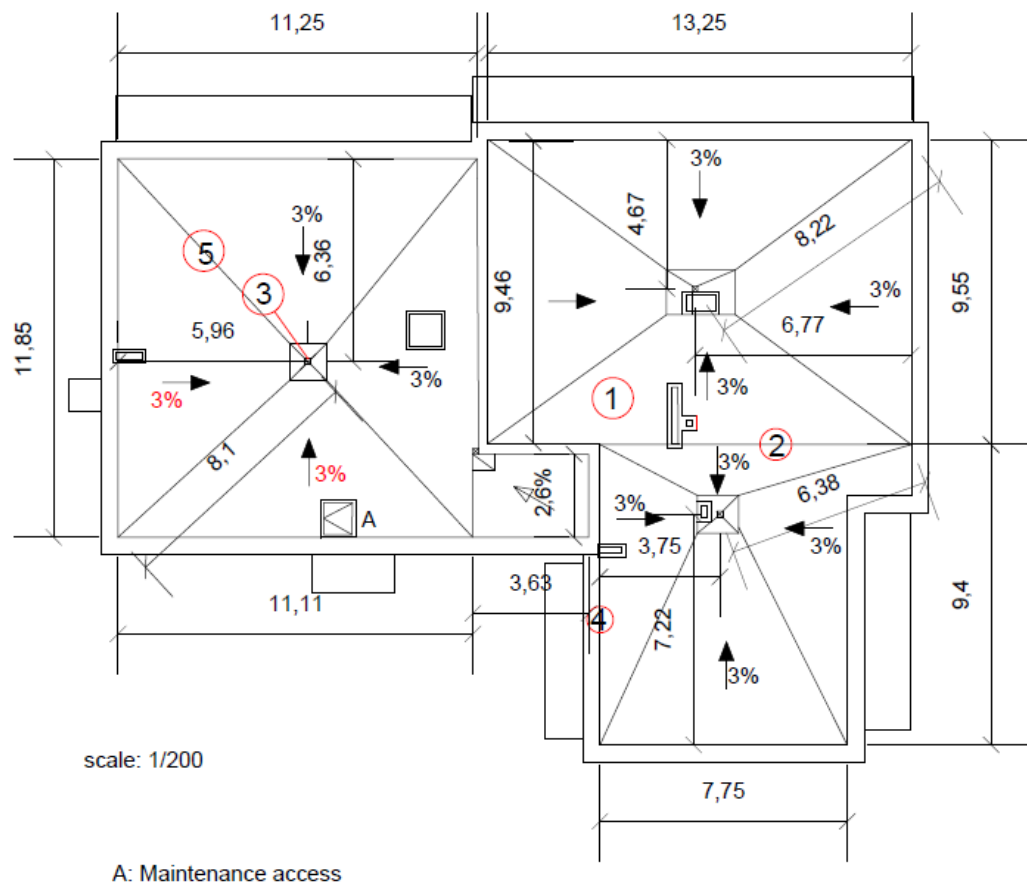


Figure 23. Roof floor

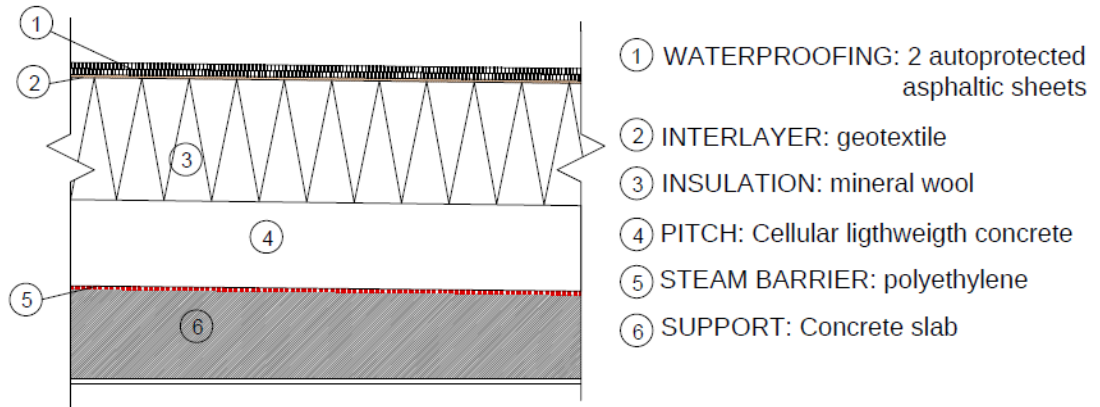


Figure 24. General detail

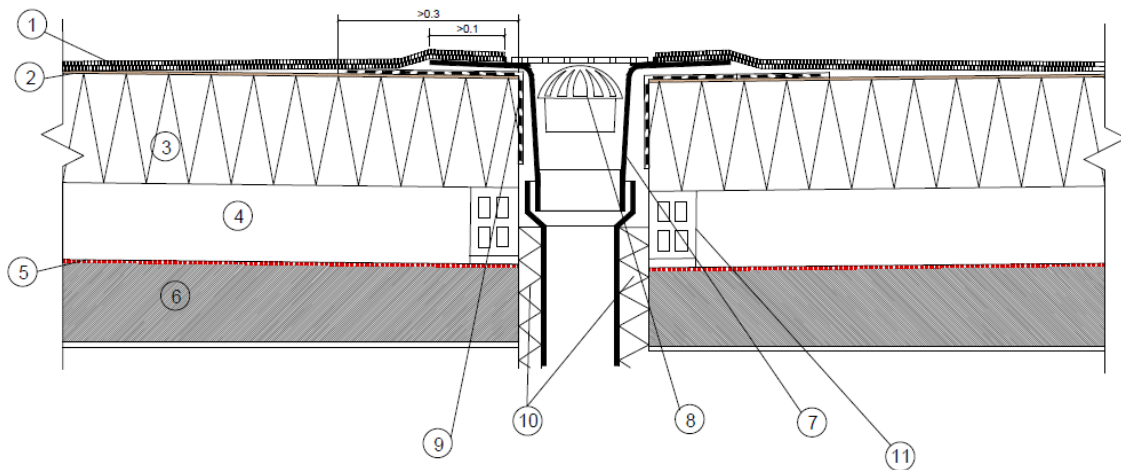


Figure 25. Drain detail

- ① WATERPROOFING: 2 autoprotected asphaltic sheets
- ② INTERLAYER: geotextile
- ③ INSULATION: Styrofoam 0.2m
- ④ PITCH: Cellular lighthweigth concrete 0.15m
- ⑤ STEAM BARRIER: polyethylene
- ⑥ SUPPORT: Concrete slab
- ⑦ DRAIN
- ⑧ COVER/PROTECTION
- ⑨ WATERPROOF REINFORCE: Elastomer

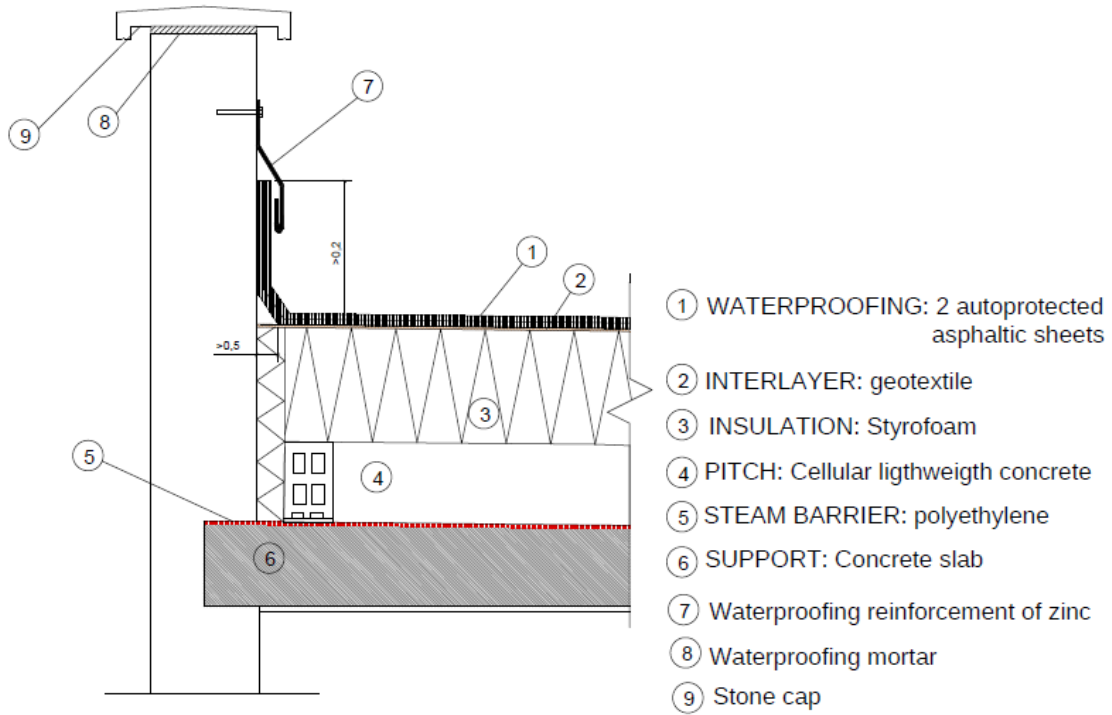
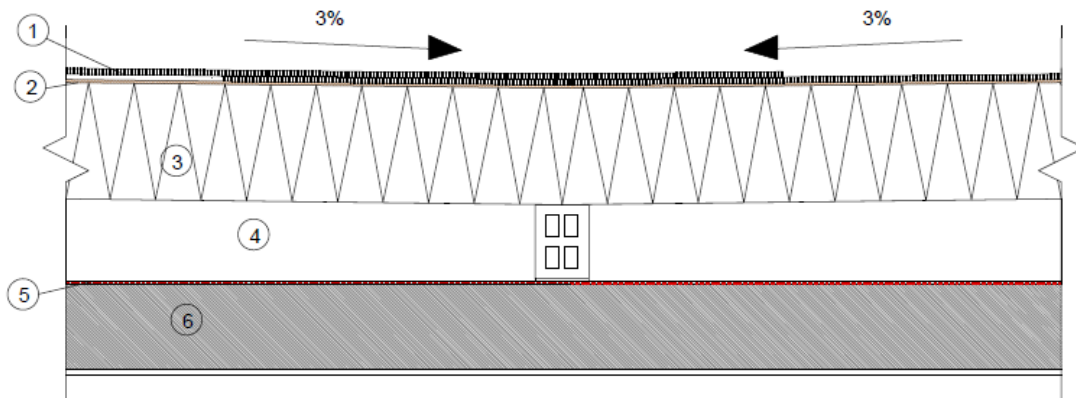


Figure 26. Wall and roof detail



- ① WATERPROOFING: 2 autoproTECTED asphaltic sheets
 ② INTERLAYER: geotextile
 ③ INSULATION: Styrofoam
 ④ PITCH: Cellular lighthweigth concrete
 ⑤ STEAM BARRIER: polyethylene
 ⑥ SUPPORT: Concrete slab

Figure 5. Valley detail

Figure 27. Valley detail

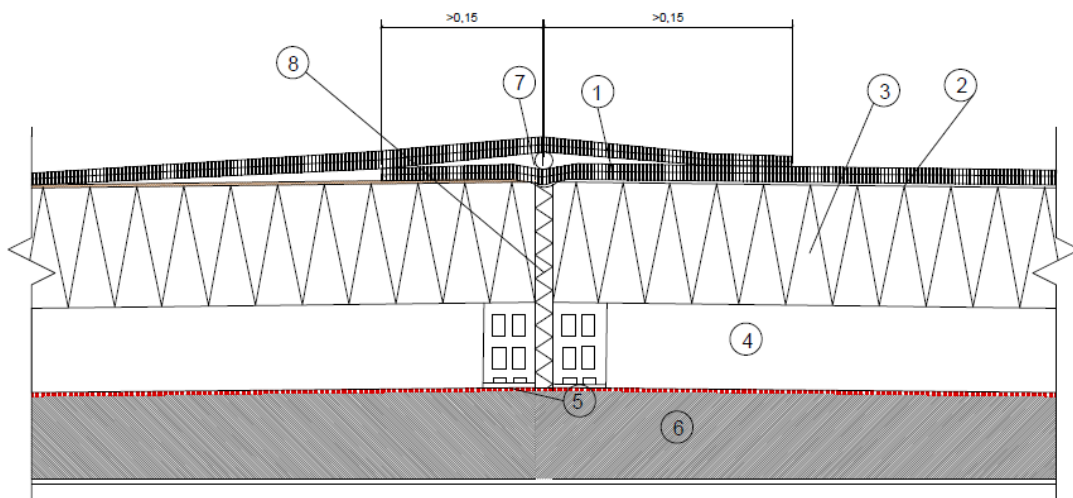


Figure 28. Ridge detail

- ① WATERPROOFING: 2 autoprotected asphaltic sheets
- ② INTERLAYER: geotextile
- ③ INSULATION: Styrofoam
- ④ PITCH: Cellular lightweight concrete
- ⑤ STEAM BARRIER: polyethylene
- ⑥ SUPPORT: Concrete slab
- ⑦ Elastic filler material
- ⑧ INSULATION/INTERLAYER: extended polystyrene

SEQUENCE OF WORKS:

-The first step is cleaning the surface of the support, it is important that there isn't oil, grease, paint or other impurities.

-Then we have to mark with ceramic bricks the gables, and the pitch. They will mark the hips and valleys of the roof and it will be used as the concrete formwork. When we finish we will remove the debris from bricks (see Figure 29).



Figure 29. Concrete formwork

-We will put the steam barrier composed of a polyethylene film and over it we can proceed to put on the cellular concrete as the pitch former. The cellular concrete will have a thickness of 20cm with a pitch of 3% and it will be mixed put by a pump located in the working zone (see Figure 30).



Figure 30. Cellular concrete installation

-After the cellular concrete we will put on the thermal and acoustic insulation, mineral wool of 20cm (see Figure 31).



Figure 31. Thermal and sound insulation

-Then we will put a geotextile to separate the insulation from the last layer, two autoprotected sheets composed of polymeric bitumen. These sheets have very good tension resistance, shear reinforcement and also very good performance in open sky. They will be stuck on the surface by a blowlamp (see Figure 32).



Figure 32. Waterproofing

-When the roof is finished we must do the watertightness test to guarantee the perfect performance of the roof. It will consist in closing the drains and flooding the roof 5cm with water by 24 hours. After the time has finished there will be an inspection on the lower plane of the slab and the walls that close it. In case that the test is rejected, it will be repaired and we will repeat the test again.



Figure 32. Watertightness test

2.3.3. HUMAN SAFETY

Before starting the works there will be a meeting to know the security measures adopted and the risks that we will find. All the workers will be formed in security and prevention area, they will know about works in height, the individual and collective protections they will use and about the measures they will take (see Table 14).

The access will be by a fixed ladder. There will be a door closed by key and a rail at the end of the stair with a dispositive to be closed automatically.

There will never be alone a worker on the roof doing the activities.

If there are bad weather conditions as rain or speed of wind higher than 50Km/h the work will be cancelled and all materials and tools will be moved away from the roof.

The area down of the roof will be marked by beacons and people external to the construction work won't have access to the area.

The workers will walk on resistance supports, there will be footbridges so they won't walk by the sheets.

RISKS	CAUSES	INDIVIDUAL PROTECTION	COLLECTIVE PROTECTION	SAFETY MEASURES
Falls at different level	Absence of protection against falls on height.	Helmet	Gallow Net	The working area will be clean and tidy There will be an area for storage Footbridges for walking Don't work in bad weather conditions Don't leave tools and objects around the roof
Falls at same level	Break the roof by walking on non passable roof and don't walking on the footbridges.	Security gloves		
	Trickle by working on wet surface.	Boots		
Hitten by fallen objects	Bad or excessive storage.	Glasses		
	Leave tools around the roof.	Mask		
Cuts	Working with dangerous tools and materials.			
Electrification	working near electricity systems with any protection.			
Overstrain	Handling heavy objects and tools			
	Working in the same position for a long time			

Figure 14. Human safety table

2.3.4. QUALITY CONTROL

The roof works will be controlled to be executed according to the project. Apart from the execution there will be a control of the materials received in the construction. They would have the specific characteristics that the project asks. In the reception there will be a control to guarantee that all the elements have:

- The commercial brand.
- First quality marck (in case).
- Reference to the normative
- Nominal and manufacture dimensions.
- it is obligatory the european certificate CE mark.**

CERAMIC BRICKS:

There will be a control on the its arrival to work, they must be in good conditions and respond to request in ters of type, quality and measurements.

- Compressive stress, according to UNE 670: 1984
- Suction, according to UNE-67031:1986
- Bulk density, UNE – 67019: 1984
- Frost resistance according to UNE-67028: 1993
- Efflorescence, UNE 67029:1995

AUTOPROTECTED SHEETS:

The sheets will be delivered in protected rolls from factory to prevent damage during transport and storage.

They will have a nominal minimum width of 1 meter. Differences between effective and nominal width won't be admitted, by default or by excess, in the order of 1%.

The minimum nominal length is 5meters and the effective length won't be less than the nominal.

On the label of each roll there will be the specifications listed under NBE QB-90.

2.3.5. ORGANIZATION OF WORKS

The roof works are divided in the order of putting the different layers that compose it. The works will be done by a team of two workers, one 1stclass expert of waterproofing and one workman of construction. According to Costs and performances cype base date (2015) they will have a performance of 0,323h/m² and the total area of the roof is 348,3m². We are going to consider 5 working days per week and 8 hours of working per day. With this information we are going to apply the next formula:

$$D = \frac{\text{Area}(m^2) \times \text{Performance}\left(\frac{h}{m^2}\right)}{\text{Hours}\left(\frac{h}{\text{day}}\right) \times N^{\circ}\text{workers}}$$

(D=Duration of work in days)

In the next table there is the schedule calculated for the roof works, with a total of 5 days. When we put on the cellular concrete we will need to wait a day till put the next layer so it will be strong enough.

Team: 5Workers 0,323m2/h
 Roof Area: 348,3m2

DAYS	1								2								3								4								5							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
ROOF WORKS																																								
Preparing base																																								
Concrete Formwork																																								
Steam Barrier																																								
Pitch former:cellular concrete																																								
Insulation																																								
Waterproofing																																								
Test																																								

Table 15. Schedule of roof works

2.3.6. MATERIAL AND TECHNICAL RECOURSES

In Table 16 there is quantified the materials, workers, machinery and auxiliary recourses that we are going to need for the roof works.

U	MATERIALS	QUANTITY
Ud	Double air ceramic brick, 24x11,5x9 cm, according to UNE-EN 771-1.	1393,2
m ³	Cellular concrete	34,83
m ³	Cement grout 1/3 CEM II/B-P 32,5 N.	3,483
m ²	Expanded polystyrene panel , according to UNE-EN 13163, 20 mm of thickness , thermal resistance 0,55 (m ² K)/W, thermal conductivity 0,036 W/(mK), For expansion joints.	3,483
m ³	Cement mortar CEM II/B-P 32,5 N type M-5,made in worksite 250 kg/m ³ of cement and a volume ratio of 1/6.	13,93,2
Ud	Roof drain	4
m ²	Mineral wool rigid panel, according to UNE-EN 13162, thermal resistance >= 1,25 (m ² K)/W, thermal conductivity 0,039 W/(mK).	365,715
m ²	Autoprotected asphaltic sheet50/G-FP (150R), according to UNE-EN 13707	766,26
MACHINARY AND TOOLS		
u	Mixer/pump	1
u	blowtorch	1
u	forklift	1
u	cutting machine	1
u	tower crane	1
u	trowel	2
u	level	2
u	hammer	2
u	plumb	2
AUXILIARY RESOURCES		
m2	footbridge	15
u	loading and unloading platform	1
WORKERS		
u	1st class expert of insulation and construction.	1
u	Workman of insulation and construction.	1

Figure 16. Material and technical recourses

2.3.7. PRICE OF ROOF WORKS

To calculate the roof works we have taken the prices and performances from Cype database. This point is developed in the organization part.

2.3.8. TECHNICAL-ECONOMIC INDICATORS

QUANTITY OF WORKS:

348,3m² of roof formed of polyethylene film for the beam barrier, cellular mortar for create the pitch, mineral wool for the thermal and acoustic insulation and two autoprotected asphalted sheets for the waterproofing.

-Formwork:

Double air ceramic brick 24x11,5x9 cm : 0.4unity/m² → 140 units

Cement mortar 0.040m³/m² → 13,93m³

Polyethylene film 1,1m²/m² → 383,13m²

-Pitch:

Cellular concrete 0,1m³/m² → 34,43m³

-Insulation:

Mineral wool 1,050m²/m² → 365,7m²

-Waterproofing:

2 Autoprotected asphaltic sheets 1,1m²/m² → 766,26m²

CONSTRUCTION COSTS

-Formwork:

Double air ceramic brick 24x11,5x9 cm : 0,13€/U → 0,13€/U x 140Units= **18,2€**

Cement mortar: 115,3€/m³ → 115,3€/m³ x 13,93 m³=**1606,135€**

-Steam barrier:

Oxyasphalt film: 9,86 €/m² → 9,86 €/m² x 383,13m²= **3777,66€**

-Pitch:

Cellular concrete: 59,5€/m³ → 59,5€/m³ x 34,43m³= **2048,6€**

-Insulation:

Mineral wool: 1,34€/m² → 1,34€/m² x 365,7m²= **490,04€**

-Waterproofing:

2 Autoprotected asphaltic sheets: $10,42\text{€}/\text{m}^2 \rightarrow 10,42\text{€}/\text{m}^2 \times 766,26\text{m}^2$

= **7984, 43€**

TOTAL ROOF WORKS: **15.925,09€**

DURATION OF WORKS

The works are calculated according to Costs and performances cype base date (2015) data base and with the following formula:

$$D = \frac{\text{Area}(\text{m}^2) \times \text{Performance}\left(\frac{\text{h}}{\text{m}^2}\right)}{\text{Hours}\left(\frac{\text{h}}{\text{day}}\right) \times N^{\circ}\text{workers}}$$

(D=Duration of work in days)

WORK	PERFORMANCE (h/m ²)	AREA m ²	N ^o WORKER	HOURS (h/day)	DAYS
Preparing base	0,006	348	2	8	0,125
Concrete Formwork	0,023	348	2	8	0,5
Steam Barrier	0,02	348	2	8	0,375
Pitch former:cellular concrete	0,05	348	2	8	1
Insulation	0,02	348	2	8	0,375
Waterproofing	0,03	348	2	8	0,625

Figure 17. Duration of works

3. ORGANIZATION PART

3.1. DESCRIPTION OF THE CONSTRUCTION MASTERPLAN

3.1.1. DESCRIPTION OF THE TERRITORY

The object of the project is the construction of a residential multi-dwelling building at Zirmunai street 1L in Vilnius (Lithuania).

In this organization point we are going to plan all the works that we need to do to can start the construction.

Before the construction works start these are the activities to do:

- Close the perimeter of the working area by a fence.
- Create an access for vehicles and other for pedestrian.
- Security and preventing signals for workers and external people.
- Place the temporary buildings for workers and storage.
- Clean the plot area.
- Temporary systems of electricity and water supply for the building and the temporary buildings.
- Prepare the storage areas and the machinery routes.

3.1.2. SELECTION OF THE TOWER CRANE

For the selection of the crane we have chosen the commercial brand Liebherr. I have chosen the Tower crane 110 EC-B 6.FR.tronic following parameters:

1. Building dimensions and location.
2. Weights, dimensions and location of installing constructions.
3. Work conditions (building site particularities, soil characteristics and underground structures peculiarities).

We must check if crane technical characteristics match the inequalities:

$H_k > H_r$

$Q_k > Q_r$

$L_k > L_r$

Where:

H_k = reach of selected crane boom, m.

H_r = required reach of crane boom, m.

Q_k = ascension power of selected crane, t.

Q_r = required ascension power, t.

L_k = lifting height of selected crane hook, m.

L_r = required lifting height of hook, m.

According to the building characteristics we have calculated the technological parameters of crane to choose the required crane according to its technical parameters of the table given by the commercial house.

To calculate the height under hook of the crane, it must achieve the next formula:

$H_R = \text{Height of the building} + 3 = 13,50\text{m} + 3 = 16,50\text{m}$

$H_R = \text{Height under hook (m)}$

The load capacity:

$Q_r = P + P_{str} = 2,5 + 0,15$

P = Maximum weight of lifting (t). We consider 2,5t .

P_{str} = Weight of hitching equipment (t).

When the values of L_r , H_r and Q_r are calculated, the crane could be selected. For determining the reach of crane boom L_r , will be needed to know the under crane with of supports and dimensions of platform turn. These values are found in crane diagrams

The reach of crane boom L_r is calculated according to our needs

$L_r = 20\text{m}$

Now with all the values we can choose the crane by comparing the diagrams.

The selected crane is: Tower crane 110 EC-B 6.FR.tronic

$Q_k > Q_r \rightarrow 2.7 \text{ t} > 2.65 \text{ t}$

$H_k > H_r \rightarrow 20 \text{ m} > 16.5 \text{ m}$.

$L_k > L_r \rightarrow 40 \text{ m} > 25 \text{ m}$

The selected crane is able to do all the required works. It will be placed in the center of the plot, outside the building, so we can take its radio in the most optimal way.

There aren't buildings very near of the plot, the only one is from the project, and it's more than 20 meters from the crane. We will put a security device so the crane will only work in a radio of 20 meters.

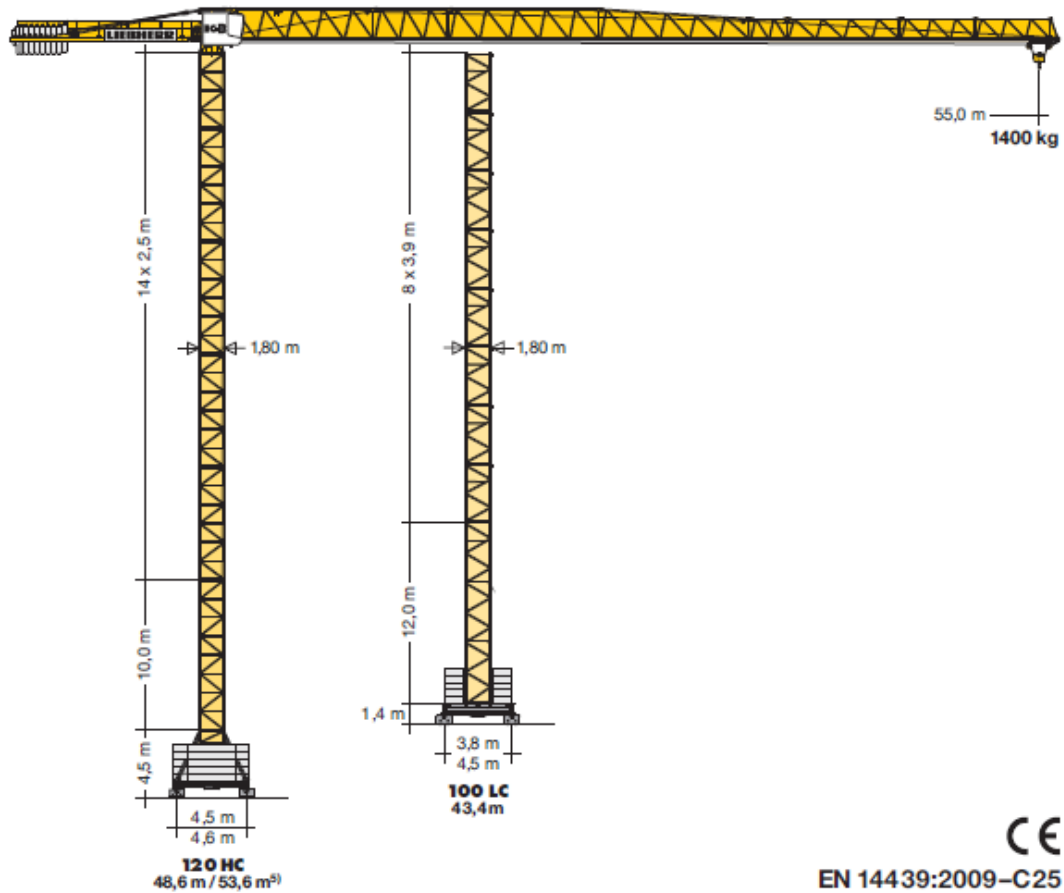


Figure 33. Tower crane

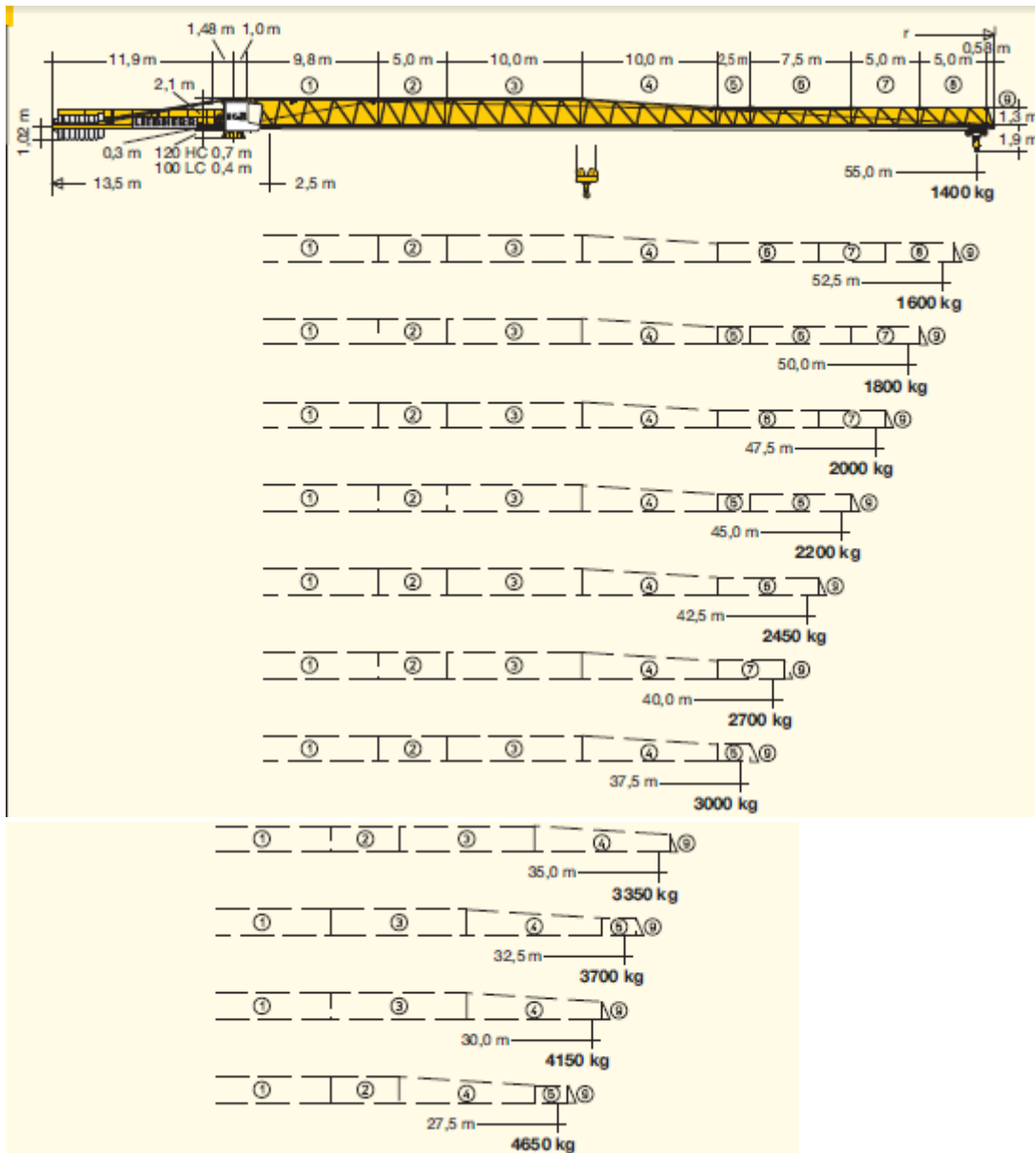


Figure 34. Tower crane radius

Ausladung und Tragfähigkeit

Radius and capacity / Portée et charge / Sbraccio e portata / Alcance y carga / Alcance e capacidade de carga / Вылет и грузоподъемность

		T10 EC-B 6 FR.tronic®																	
m	r	m/kg	m/kg																
			17,5	20,0	22,5	25,0	27,5	30,0	32,5	35,0	37,5	40,0	42,5	45,0	47,5	50,0	52,5	55,0	
55,0 (r = 56,5)	2,5-17,0 6000	5800	5000	4370	3870	3460	3120	2830	2580	2360	2170	2010	1860	1730	1610	1500	1400		
52,5 (r = 54,0)	2,5-17,8 6000	6000	5270	4610	4080	3650	3290	2990	2730	2500	2310	2130	1980	1840	1710	1600			
50,0 (r = 51,5)	2,5-18,4 6000	6000	5480	4800	4260	3810	3440	3120	2850	2620	2420	2230	2070	1930	1800				
47,5 (r = 49,0)	2,5-18,9 6000	6000	5650	4950	4390	3930	3550	3230	2950	2710	2500	2310	2150	2000					
45,0 (r = 46,5)	2,5-19,3 6000	6000	5770	5050	4480	4020	3630	3300	3020	2770	2560	2370	2200						
42,5 (r = 44,0)	2,5-19,8 6000	6000	5940	5210	4620	4140	3740	3410	3120	2860	2640	2450							
40,0 (r = 41,5)	2,5-20,2 6000	6000	6000	5310	4710	4230	3820	3470	3180	2920	2700								
37,5 (r = 39,0)	2,5-20,6 6000	6000	6000	5440	4830	4330	3910	3560	3260	3000									
35,0 (r = 36,5)	2,5-21,1 6000	6000	6000	5570	4950	4440	4020	3660	3350										
32,5 (r = 34,0)	2,5-21,3 6000	6000	6000	5630	5010	4490	4060	3700											
30,0 (r = 31,5)	2,5-21,7 6000	6000	6000	5750	5110	4590	4150												
27,5 (r = 29,0)	2,5-21,9 6000	6000	6000	5830	5180	4650													
25,0 (r = 26,5)	2,5-22,2 6000	6000	6000	5910	5250														
22,5 (r = 24,0)	2,5-22,3 6000	6000	6000	5950															
20,0 (r = 21,5)	2,5-20,0 6000	6000	6000																

Figure 35. Radius and capacity

		100 LC																	
3,9m 5,85m	5,85m	11,7m	C 25																
				11	9+1	7	-	-	-	43,7	-	-	43,8	-	-	43,1	-	-	42,0
10	8+1	6	-	-	-	39,8	51,4 ^o	51,4	39,9	51,5 ^o	51,5	39,2	50,8 ^o	50,8	36,1	50,0			
9	7+1	6	3	-	35,7	37,9	49,5	49,5	38,0	49,6	49,6	37,3	48,9	48,9	36,1	48,1			
8	6+1	5	3	33,8	33,8	35,9	47,5	47,5	36,0	47,6	47,6	35,3	46,9	46,9	34,2	46,1			
7	5+1	5	3	31,8	31,8	30,1	41,7	41,7	34,1	45,7	45,7	33,4	45,0	45,0	32,2	44,2			
6	4+1	4	2	29,9	29,9	26,2	37,8	37,8	32,1	43,7	43,7	31,4	43,0	43,0	30,3	42,2			
5	3+1	3	2	27,9	27,9	24,2	35,8	35,8	30,2	41,8	41,8	29,5	41,1	41,1	28,3	40,3			
4	2+1	2	1	26,0	26,0	22,3	33,9	33,9	28,2	39,8	39,8	27,5	39,1	39,1	26,4	38,3			
3	1+1	1	0	24,0	24,0	20,3	31,9	31,9	26,3	37,9	37,9	25,6	37,2	37,2	24,4	36,4			
2	0+1	0	0	22,1	22,1	18,4	30,0	30,0	24,4	34,0	34,0	23,6	35,2	35,2	22,5	34,4			
1	0	0	0	20,1	20,1	16,4	28,0	28,0	22,4	32,0	32,0	21,7	33,3	33,3	20,5	32,5			
0	0	0	0	18,2	18,2	14,5	26,1	26,1	20,4	30,0	30,0	19,7	31,3	31,3	18,6	30,5			
				16,2	16,2	12,5	24,1	24,1	18,5	30,1	30,1	17,8	29,4	29,4	16,6	28,6			
				14,3	14,3	10,6	22,2	22,2	16,6	28,2	28,2	15,8	27,4	27,4	14,7	26,6			
				12,3	12,3	8,6	20,2	20,2	14,6	26,2	26,2	13,9	25,5	25,5	12,7	24,7			
				10,4	10,4	6,7	18,3	18,3	12,6	24,2	24,2	11,9	23,5	23,5	10,8	22,7			
				8,4	8,4	4,7	16,3	16,3	10,7	22,3	22,3	10,0	21,6	21,6	8,8	20,8			
				6,5	6,5	2,8	14,4	14,4	8,7	20,3	20,3	8,0	19,6	19,6	6,9	18,8			
				4,5	4,5	0,9	12,4	12,4	6,8	18,4	18,4	6,1	17,7	17,7	4,9	16,9			
				-	-	-	-	-	4,8	16,4	16,4	4,1	15,7	15,7	3,0	14,9			
				-	-	-	-	-	-	12,5	12,5	-	11,8	11,8	-	11,0			

o = Ohne Kabine / Without cabin / Sans cabine / Senza cabina / Sin cabina / Sem cabine / Без кабины
 Weitere Hubhöhen sowie Klettern auf Anfrage. / Further hoist heights and climbing on request. / Hauteurs sous crochet plus élevées et hissage sur demande. / Altre altezze di sollevamento come pure telescopaggio, su richiesta. / Para alturas bajo gancho superiores y trepado, consultar. / Outras alturas de elevação e ascensamento, mediante consulta. / Другие высоты подъема и наращивание крана – по запросу.

Figure 36. Lifting height

3.1.3. SETTING OF DANGEROUS ZONE

The dangerous zones are

- Near the electrical equipment with non protection or insulation.
- Zones in high more than 1.3 meters with no fences.
- Zone down the crane, where there are objects lifting or being transported.
- Place with concentration of harmful substances in workplace air may exceed the limit values.
- Places where the machinery, their parts or work equipment are moving.

The next risk will be considered:

- Presence of obstacles.
- Areas of way.
- Jobs in proximity to high voltage power lines.

3.1.4. ACCESS TO THE TEMPORARY WORKING AREA

The only access to the plot is by Zirmunai street. There will be two accesses, one for vehicles and other for pedestrian. In the access there will be a control point where people will need to be identified to get inside. There will also be an information board and a safety board informing about the work of construction, risks and obligatory protection and prohibition access for people who don't belong to the work.

3.1.5. STORAGE ZONE

Storage will be in a specific areas so it will be easy to keep tidy the work zone. There will be a big storage area outside the building where there is access to the vehicle and its inside the crane radius. Inside the building there will be storage areas in different places depending on the work there will be a loading dock where the crane will leave the storage.

3.1.6. TEMPORARY BUILDINGS

The plot will have a temporary building for workers, with showers, toilettes and a dining-room, other building for the office and other for storage. They will be situated near the fence as farther as possible from the dangerous area of work. The dimensions will be enough to 5 workers. the workers will use . building for res, eat, or changing clothes. According to the "Royal Decree 486/1997, of 14 of April laying down general provisions minimum safety and health in the workplace" approaching the changing surface of 2 m² per worker.

3.1.7. TEMPORARY ELECTRICITY SUPPLY

The work zone needs electricity to work, they will be connected to the existing network. The electricity will be connected to temporary lightings, to the crane, to the temporary buildings and to the working zones where there is going to be machinery or electric tools.

This installation will have different derivation, one for crane, one for temporary buildings, one for other machinery and there will be a general electricity counter will connected to the electrical rush supply connected to the general electrical city system placed close the road, will be made an individual 4x16mm² derivation.

3.1.8. TEMPORARY WATER SUPPLY

We will install a general counter next to the building fence connected to the city water supply rush located very close to the access. The temporary water supply line will require an accountant, stopcock general, pipe tube 32 mm, wash step and tap.

3.1.9. CONSTRUCTION SITE LIGHTNING

The work zone will be provided of temporary lighting points. The temporary building, the temporary roads and inside the building the will be lighting points connected to the temporary electrical system.

3.1.10. TEMPORARY SEWERAGE

We will install a temporary sewerage system that will take the wasted water from the temporary buildings, from the showers or the toilettes and water from the rain It will be connected to and existing network of the city close to the fence.

3.1.11. TEMPORARY ROAD FOR VEHICLES

In the vehicles access there will be a prepared road till the storage zone. With enough space to maneuver big vehicles.

3.1.12. FENCE CLOSING THE PLOT

There must be a fence closing the perimeter of the plot so only authorized personal will enter to the work zone. The fence will be composed of an electrowelded wire mesh of 200 x 100mm forming fences of 350 x 200mm located over prefabricated concrete bases.

3.1.14. GENERAL REQUIREMENTS FOR LABOUR SAFETY

We have analyzed the different risks that will appear during the construction of the Project top ut the necessary safety measures to avoid them.

- Excavation works
- Working in height
- Working near electric systems
- Working in zones under the crane radius of work, while lifting charges
- Masonry outside walls and roof works
- Work with hand tools and machinery

The collective protections that we will use are:

- Gallow safety net during masonry and roof works
- Security harness
- Railing and tables in holes
- Working platforms

The individual protections are

- Helmet
- Different security gloves: dielectric, welder...
- Security boots
- Security belt
- Protection glasses
- Filter masks
- Hearig protections

3.1.15. ENVIRONMENTAL PROTECTION REQUIREMENTS

While the construction work we will manage the wastes generated. We will do a study of th wastes we will produce and classify them according to their nature and dangerousness and decide which of them will be recycled and which not.

There will be different containers for wastes and there won't be any waste when the construction will be finished.

3.1.16. FIRE PROTECTION REQUIREMENTS

According to CTE-SI we must study the fire prevention of the working zone.

There will be a panel in the working site with the safety measures, fire protection rules and emergency plan.

There will be

- Emergency exit ways
- Meeting points
- Two fire extinguishers per floor
- Two axes
- Two crowbars

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