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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<sup>2</sup> for vehicle parking and a storage room of 12 m<sup>2</sup>.

The first floor has an interior usable area of 56 m<sup>2</sup>, 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 m<sup>2</sup> where the main door of the house is.

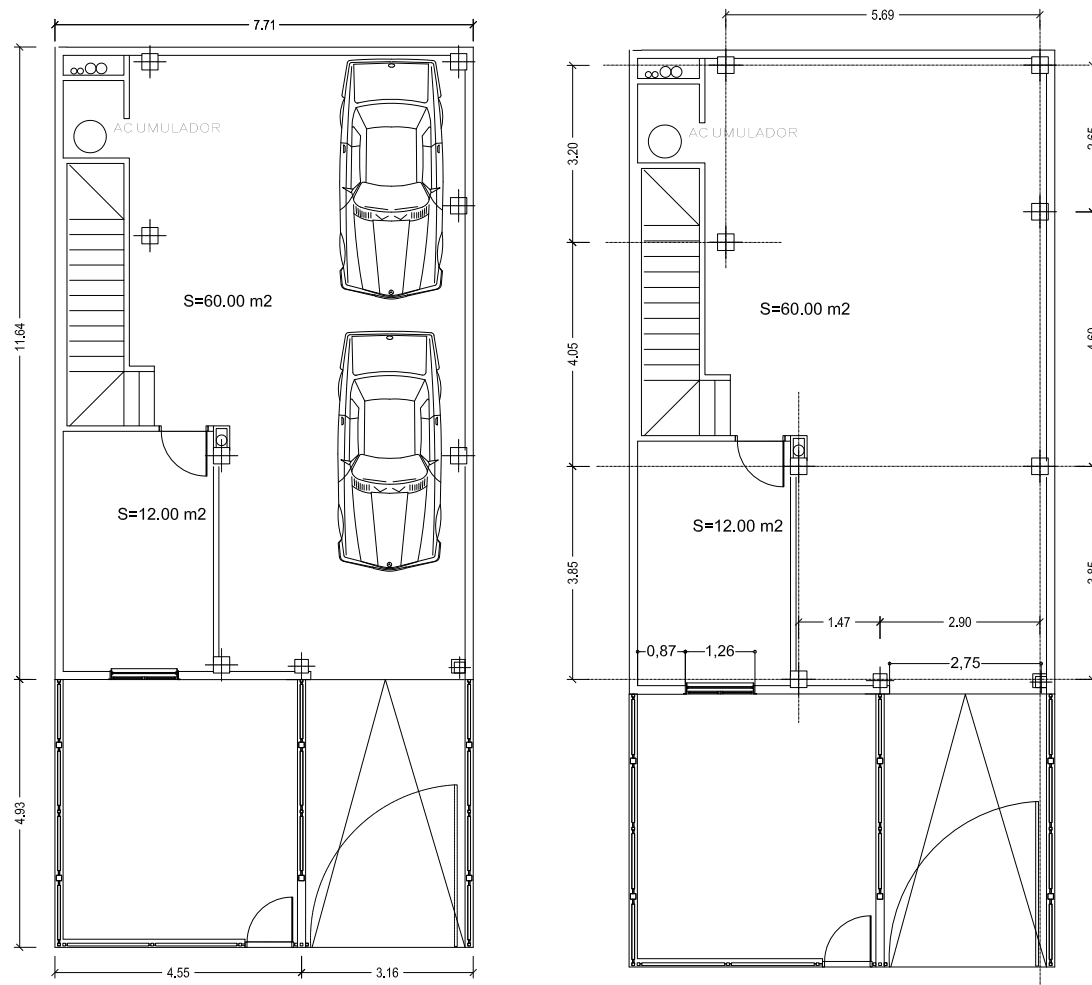
On the second floor it has an interior usable area of 54.6 m<sup>2</sup>, not including the staircase. This floor consists of 3 bedrooms, and a bathroom. On the outside of this floor, one of the bedrooms has a balcony of 3 m<sup>2</sup> useful.

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 m<sup>2</sup> 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**

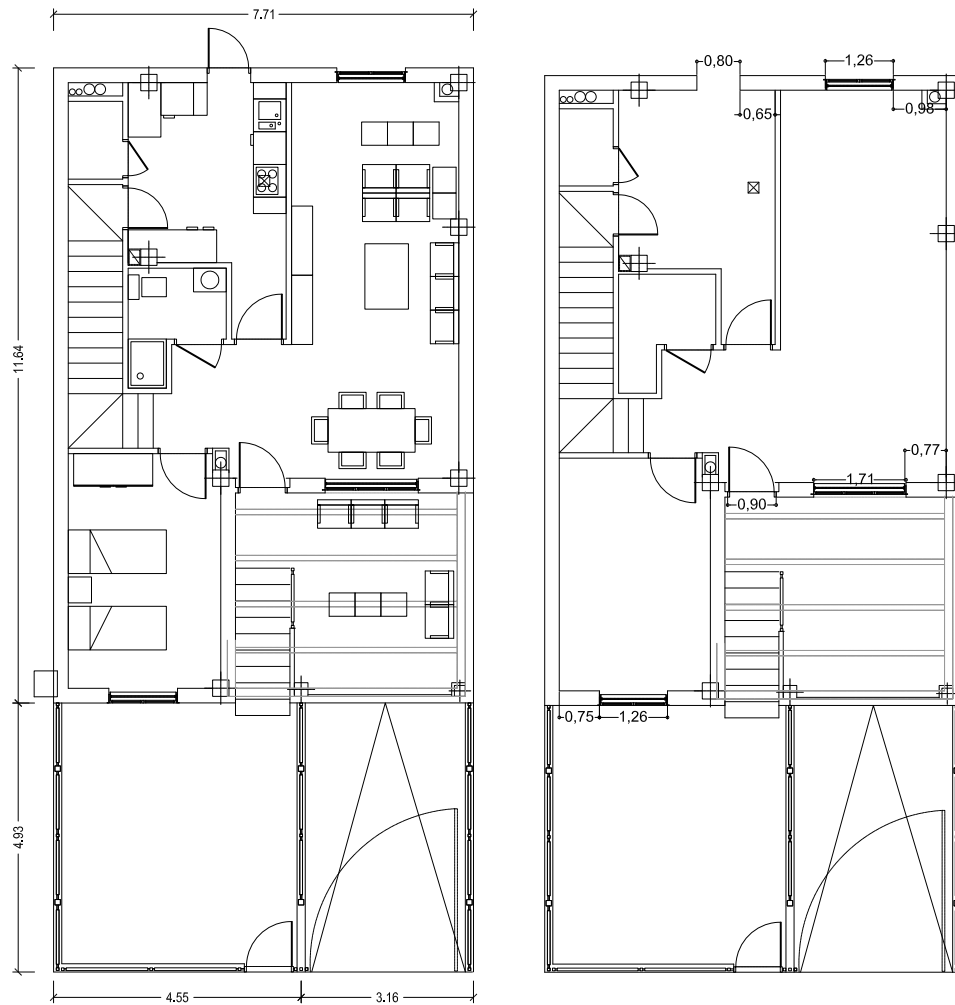


Figure 3: First Floor Plans

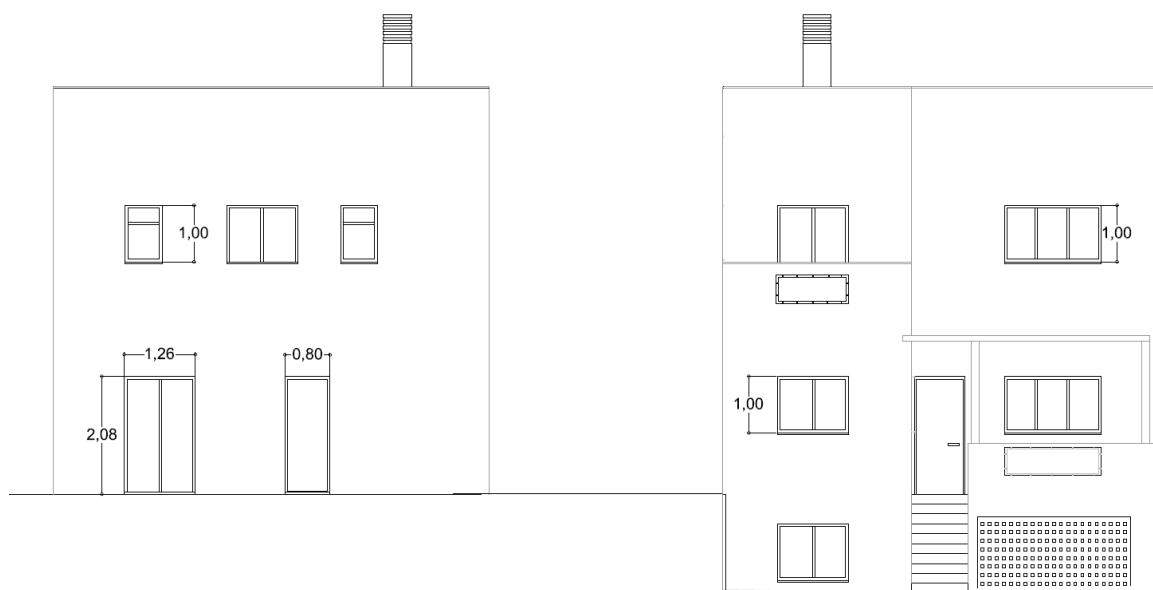
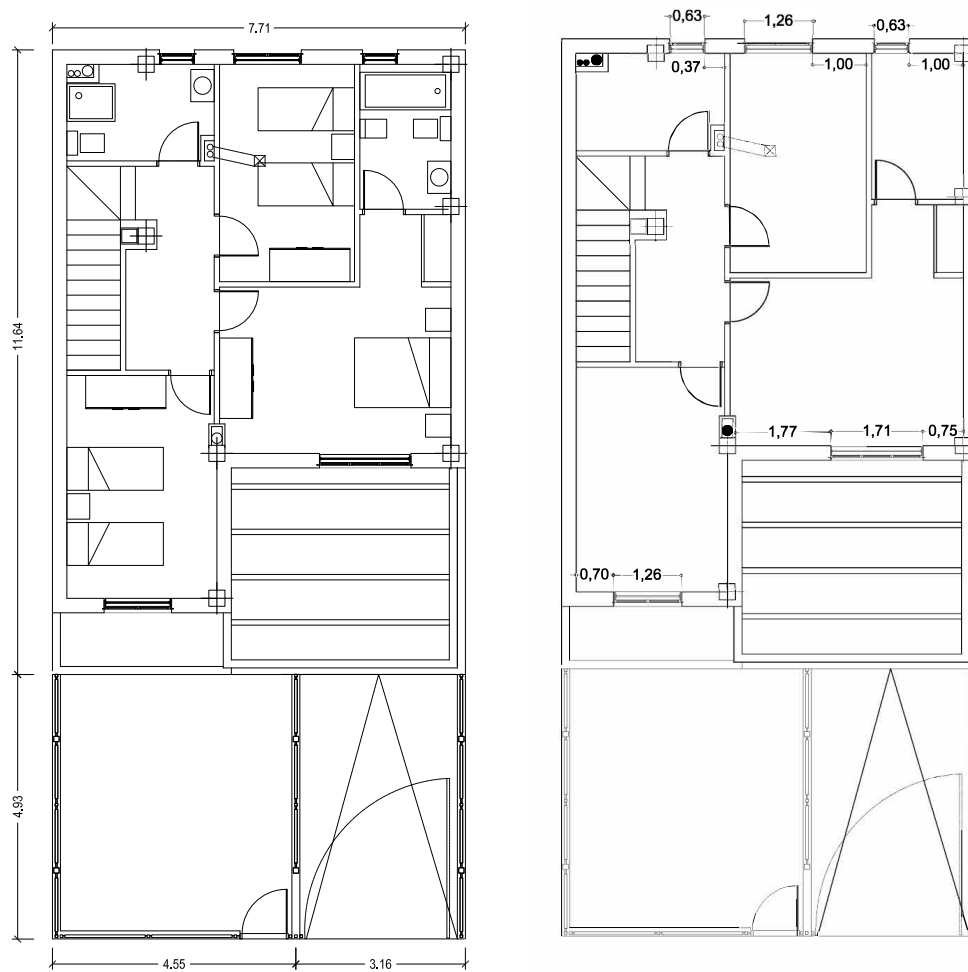
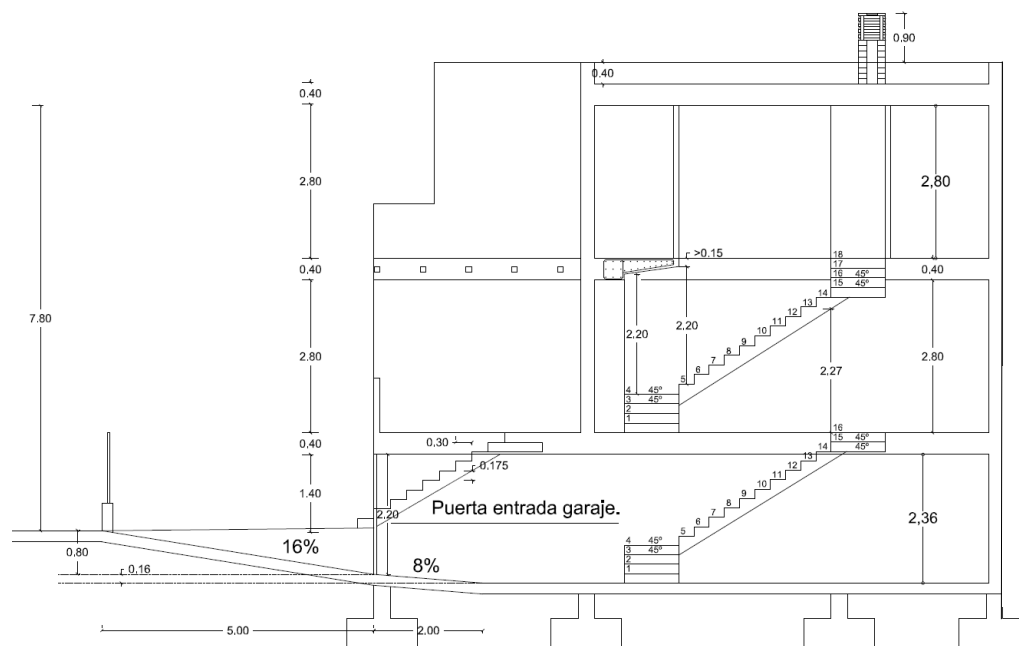


Figure 5: Rear and front elevations.



**Figure 4:** Second Floor Plans



**Figure 5:** Building section.

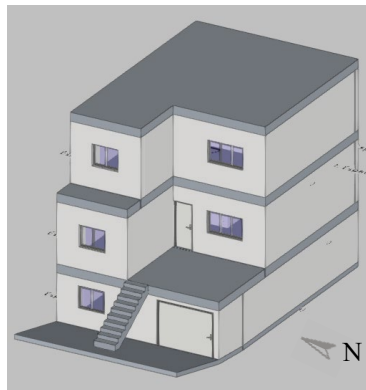
### 2.3. Location

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

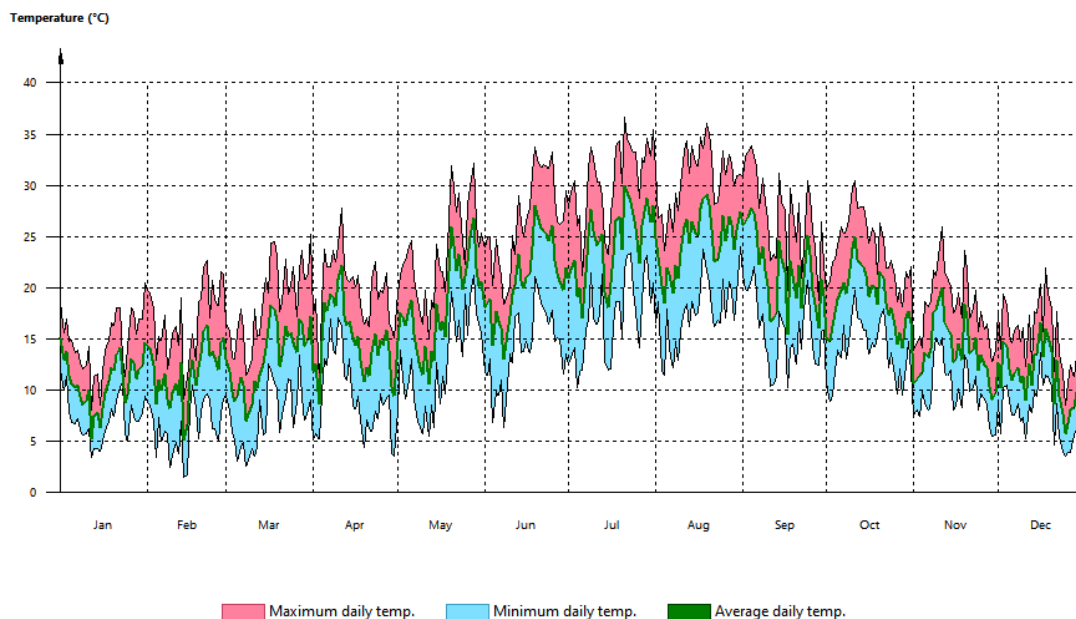
The main façade of the house faces west.



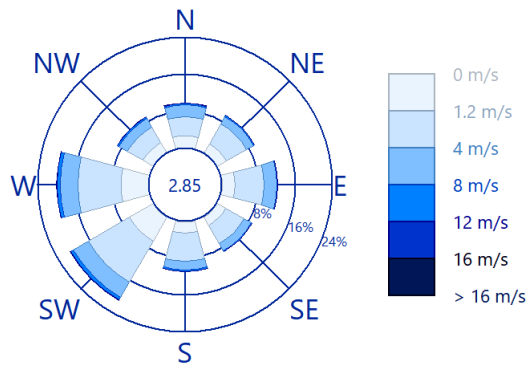
### 2.4. Climatic zone

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:



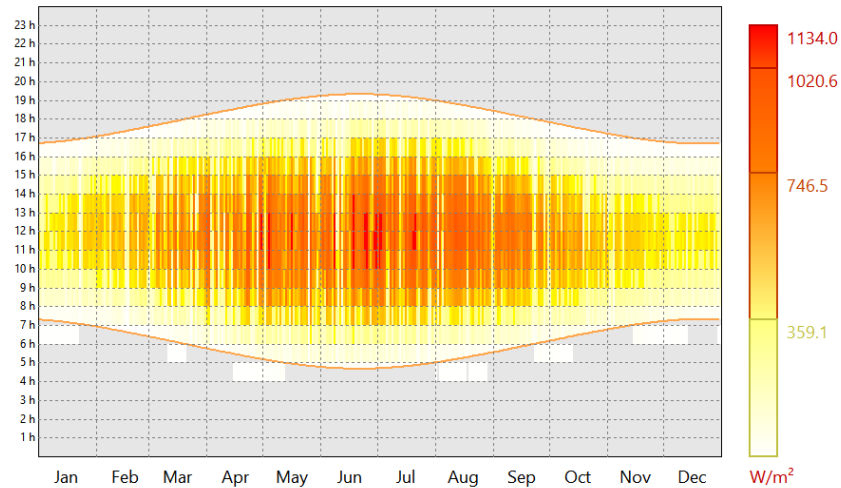
### Wind distribution:



### Solar irradiation on the site of the house:

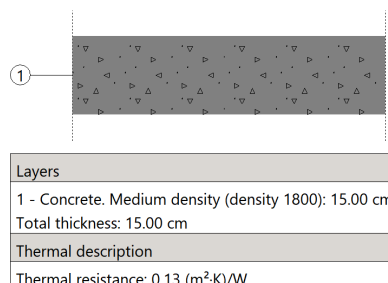
The graph below shows the global irradiance on a horizontal surface

$$Q = 73.8 + 88.9 + 130.5 + 156.7 + 194.2 + 204.3 + 219.7 + 197.9 + 150.2 + 113.8 + 79.0 + 66.0 = 1675.01 \text{ kWh/m}^2$$

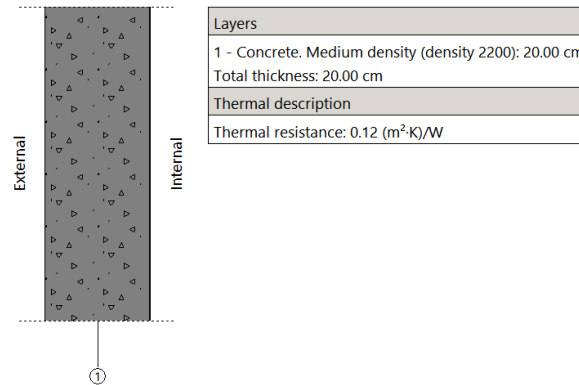


## 2.5. Thermal Envelope Materials

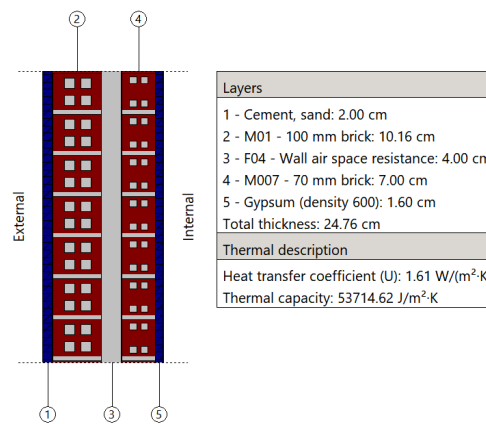
### Floors in contact with the ground (screed)



### Walls in contact with soil



## Façades



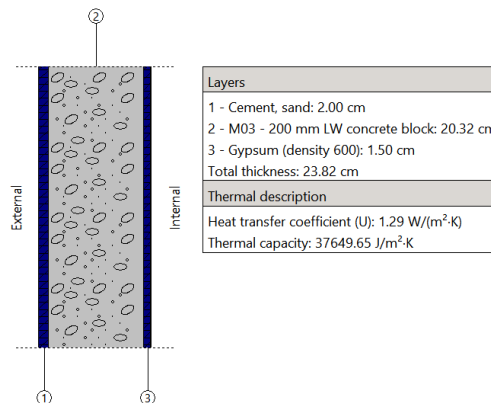
## Façade openings

Windows with aluminum frame and monolithic glass

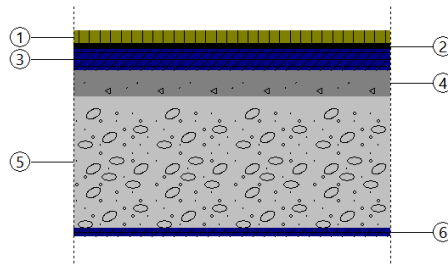
Heat transfer coefficient (U)  W/(m<sup>2</sup>·K)

Solar heat gain coefficient

## Party walls



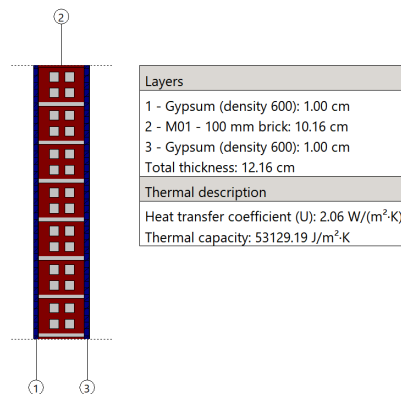
## Roofs



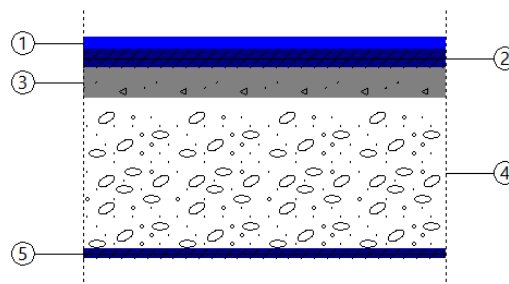
Layers
1 - F18 - Terrazzo: 2.54 cm
2 - Asphalt: 1.00 cm
3 - Cement, sand: 4.00 cm
4 - Concrete. Reinforced (with 2% of steel): 5.00 cm
5 - M04 - 300 mm LW concrete block: 25.00 cm
6 - Gypsum (density 600): 1.50 cm
Total thickness: 39.04 cm
Thermal description
Heat transfer coefficient (cooling): 1.36 W/(m <sup>2</sup> ·K)
Heat transfer coefficient (heating): 1.51 W/(m <sup>2</sup> ·K)
Thermal capacity: 145567.19 J/m <sup>2</sup> ·K

## 2.6. Interior partitions and Intermediate slabs.

### Interior partitions



### 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/(m <sup>2</sup> ·K)
Heat transfer coefficient (heating): 1.16 W/(m <sup>2</sup> ·K)
Floor slab
Heat transfer coefficient (cooling): 1.16 W/(m <sup>2</sup> ·K)
Heat transfer coefficient (heating): 1.00 W/(m <sup>2</sup> ·K)
Floor slab exposed to open air
Heat transfer coefficient (cooling): 1.25 W/(m <sup>2</sup> ·K)
Heat transfer coefficient (heating): 1.15 W/(m <sup>2</sup> ·K)
Thermal capacity: 141371.08 J/m <sup>2</sup> ·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.

**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.

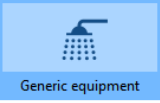
Production set

Reference


DHW equipment - Electric hot water boiler

Covered DHW demand percentage

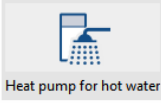
100 %




Generic equipment



Air-source heat pump



Heat pump for hot water



Geothermal

Production set

Overview

Type of energy vector

Electricity

Rated capacity

1500.00 W

Average seasonal efficiency

0.36

☒ Storage tank

Global loss coefficient, UA

1.20 W/K

Average storage temperature

60.0 °C

Ambient temperature

20.0 °C