DREAMERS

Design REsearch, implementation And Monitoring of Emerging technologies for a new generation of Resilient Steel buildings

Executive Architectural Project

Deliverable D2.1-WP2 – D8

WP 2: Executive architectural and structural design of the building

Task 2.1 – Executive architectural design of the demonstration building

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

This deliverable is aimed to provide a summary of the design choices concerning the executive architectural project of C3 Building of the University Campus within the framework of RFCS DREAMERS project.

This deliverable is related to Task 2.1. Within this task, starting from the definitive architectural design of the building, the executive design has been finalized. The architectural drawings have been provided by UNISA that, through its technical office, has produced the executive architectural project of the building. The project complies with the quality standards set by the Italian law for executive projects (Decree Law 50/2016). The building is regular both in plan and elevation, TS has provided the executive drawings for the realization of an appealing façade of the building. TS has also interacted with KNAUF to ensure the full feasibility of the solution since KNAUF will supply the external claddings during the construction. The concept of the façade has been integrated into the process of sustainability, complying with the instructions specified in Task 1.3.

The elements of the facade have been selected appropriately to accommodate all the possible movements that the structure exhibits under a severe seismic event, without conflicting with the structural elements and assuring no damage. Such a scope is ensured by the cooperation between TS and KNAUF that has provided the solutions able to accommodate the lateral sway displacements of the building considering properly the role of the connections between the façade and the structural elements.

The executive architectural project of the demonstration building that will be used for the public tender and the subsequent realization of the building is the result of this task.

According to the Grant Agreement all the design documentation is due in Italian language, because it has to fulfil the Italian Code provisions and has to be delivered to the National local authorities to obtain the relevant authorizations. Therefore, in this report only a brief discussion is provided. However, the detailed design documentation is also listed at the end of this report and fully delivered (in Italian) on the project website (www.dreamersproject.eu).

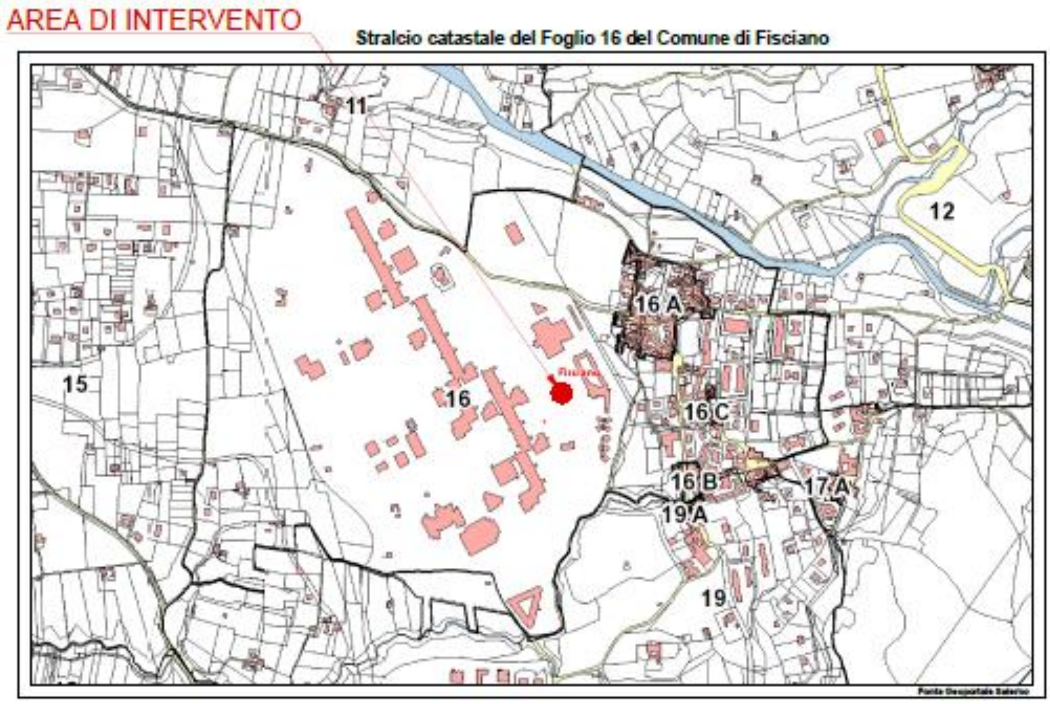


***Figure 1**: The area where the demonstration building will be located*

2. The area of intervention

The demonstration building will be realized within the Salerno University Campus in an area close to the refectory and the students' residences. The red bullet in Figure 1 shows the of the University Campus where the demonstration building will be located.

Figure 2 shows an aerial view of the University Campus located in Fisciano in province of Salerno. It is the main campus hosting all the faculties with the only exception of the Faculty of Medicine which is located in a second Campus in Baronissi, a town close to Fisciano.

Figure 2: *Aerial view of the Campus.*

3. Description of the building

The building has as primary destination the “Life Science Hub Laboratory” with the ground floor partially open to host a parking area, the first floor devoted to the laboratory and the second floor devoted to offices. In addition, the roof floor will host a photovoltaic plant. All the floors are connected by a three-flight staircase made of hybrid steel-concrete structure.

The covered area is of about 350 sqm while the volume is about 3000 mc. The main dimensions of the building are 25x14 m for a rectangular shape. The ground floor inter-storey height is 3.5 m, while the first and second floor inter-storey heights are equal to 4.20 m.

At the first and second floor there are also toilets for ladies, gentlemen and handicapped.

The Ground floor is devoted to the main mechanical and electrical equipment and to storage. Half part of the storey is arcaded to allow the parking of the cars (Figure 3). The staircase is located on one side of the building.

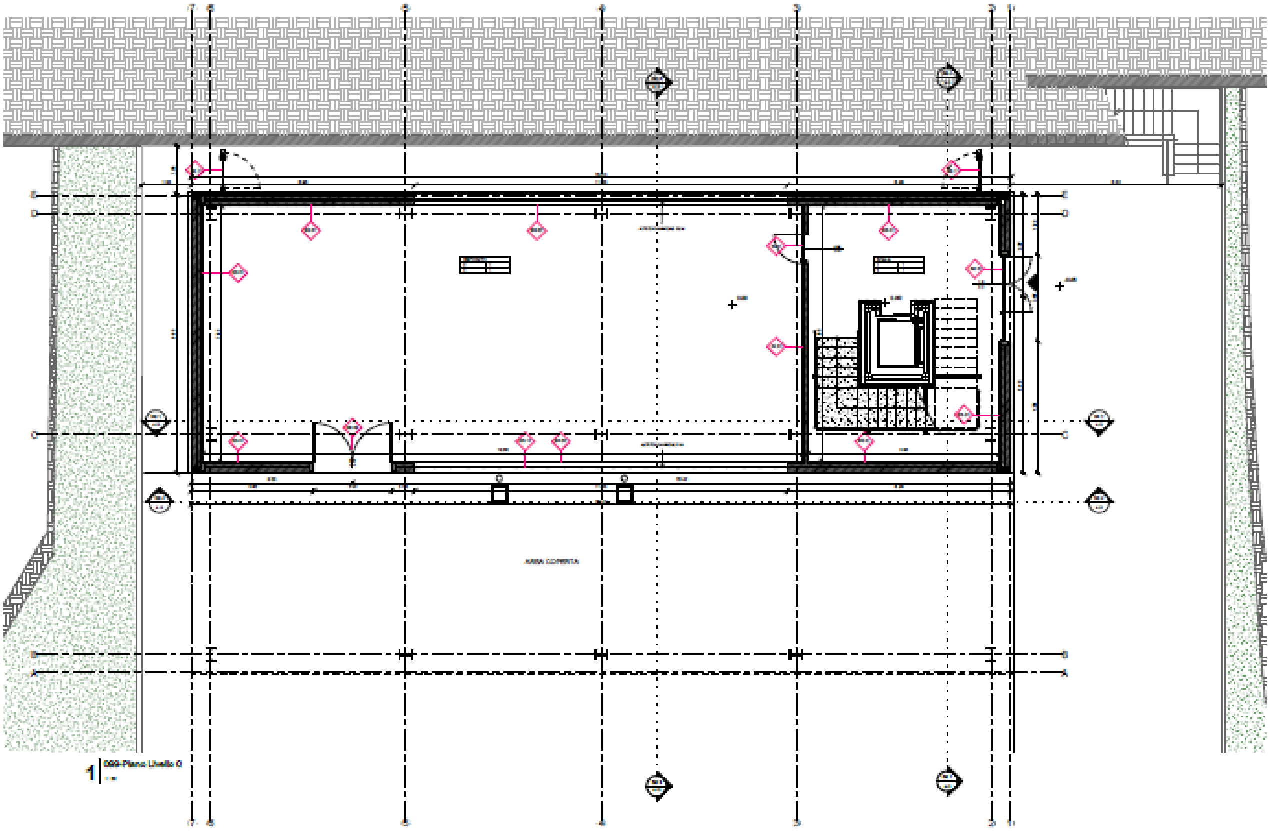


***Figure 3**: Storey plan of the ground floor*

The first floor is completely devoted to laboratory activities. All the rooms have been dimensioned to accommodate the instrumentations for the laboratories. In particular, the rooms are listed as follows:

- Analysis laboratory
- Sample preparation room
- Weighing room
- Molecular modelling
- Discovery and development of lead compounds room
- Meeting room
- Samples reception
- Dressing room
- Samples preparation room
- Data processing room
- Toilet for ladies, gentlemen, and handicapped

A hallway allows the access to all the rooms. The plan configuration of the first floor is reported in Figure 4.

The first storey will constitute the “Life Science Hub Laboratory” and will be assigned to the Department of Farmacy of the University of Salerno.

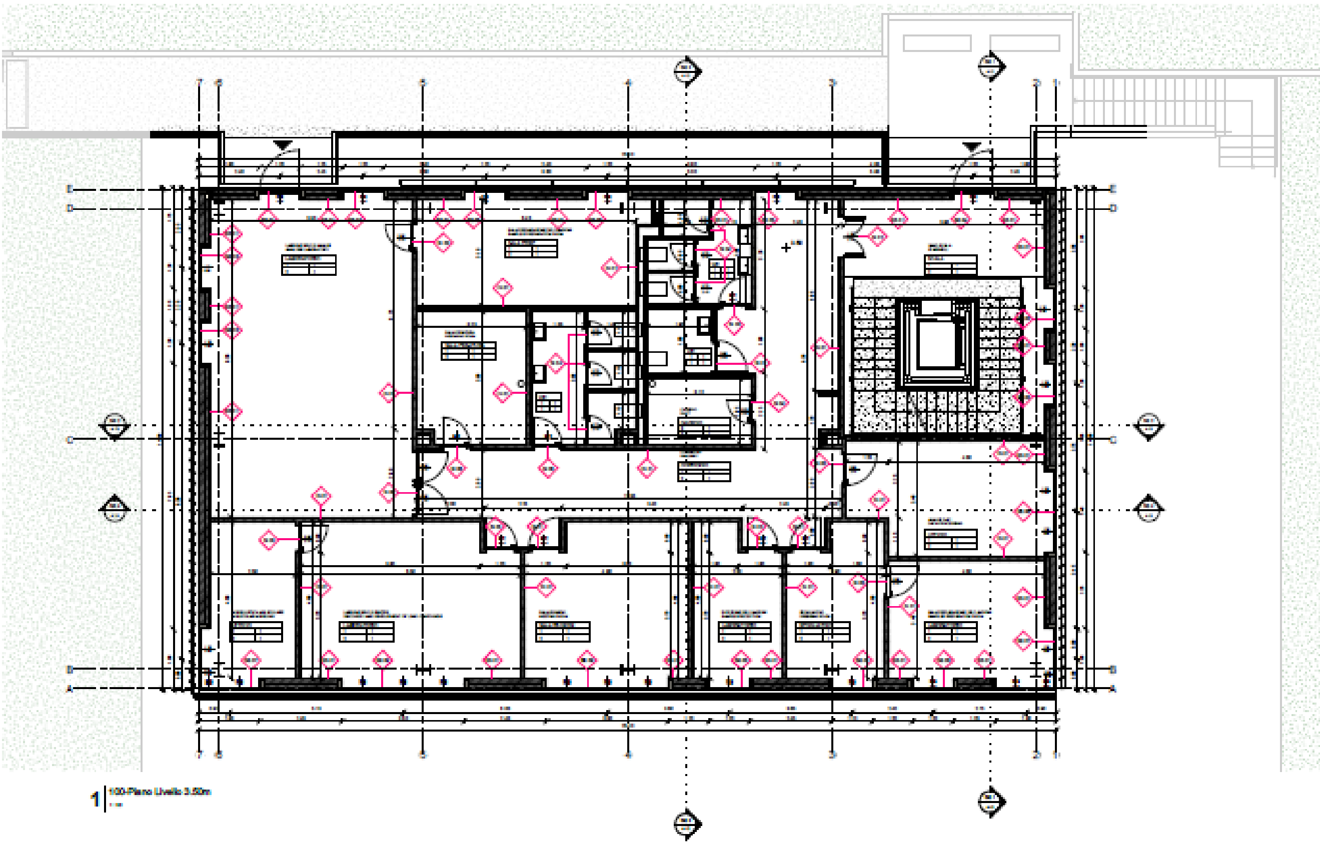


***Figure 4**: Storey plan of the first floor*

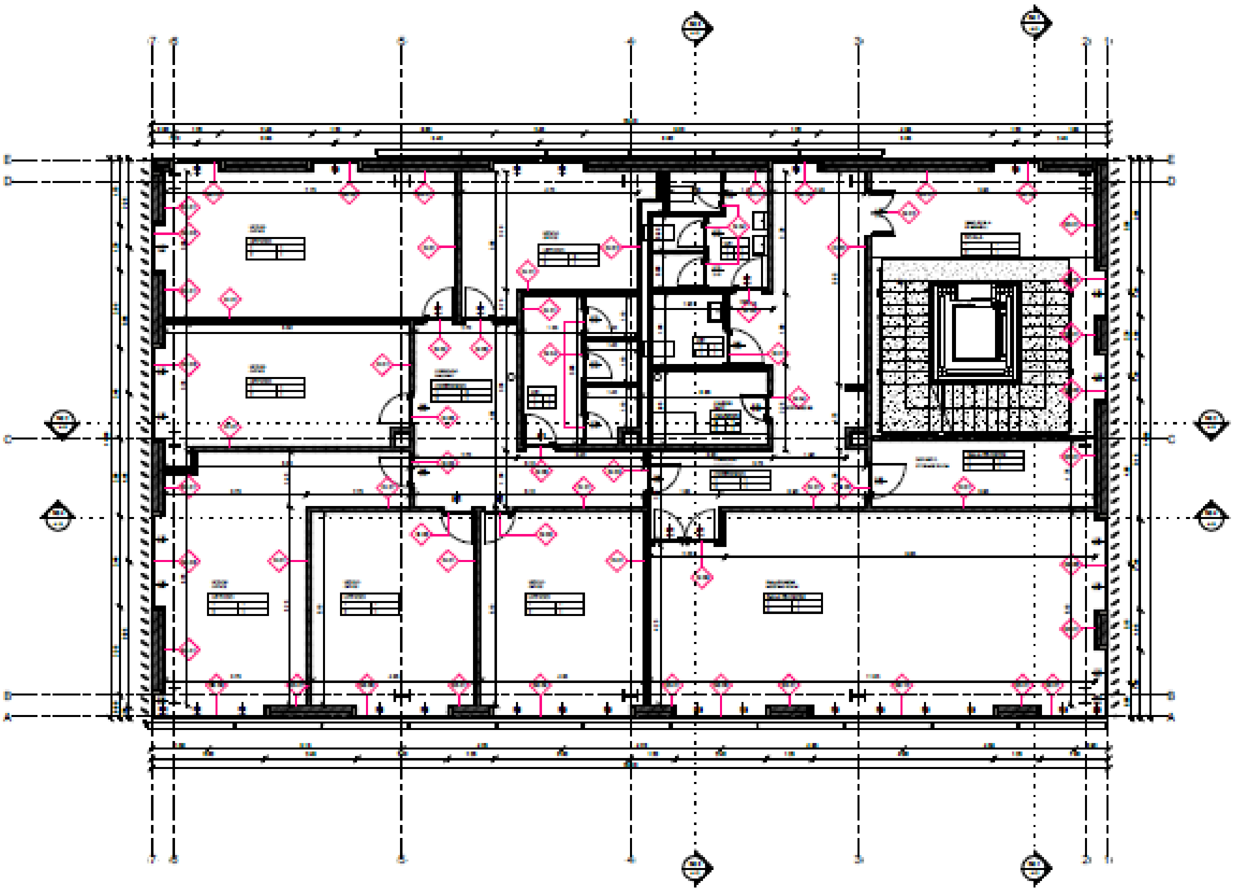


***Figure 5**: Storey plan of the second floor*

The second floor (Figure 5) is destined to offices. Seven office rooms, one meeting room and a storage room are located at the second floor. The hallway allows the access to all the rooms. In the same floor toilet for ladies, gentlemen, and handicapped are also located.

Energy efficiency is no longer just an option. The Kyoto protocol has encouraged governments around the world to approve legislation that guarantees a more intelligent and conscious use of energy in buildings. In March 2007, the European Union undertook to achieve a 20% reduction in CO2 emissions by 2020. This plan of measures, known as the "3x20 by 2020", also provides for a 20% increase in the level of Energy Efficiency and the achievement of 20% of the energy produced from renewable energy sources. Real changes will be needed to achieve these goals; governments are stepping up efforts to enact laws, regulate and set standards for better energy efficiency. This new move towards stricter energy efficiency regulations began with the Kyoto Protocol. Laws such as the US Energy Policy Act set the standard for the energy future.
In Italy it was published, with the D.L. no. 192 of 08/19/2005, the European directive 2002/91/EC (EPBD) relating to energy efficiency in buildings and, more recently, the D.M. 26/06/2009 (national guidelines for the energy certification of buildings). On 18/06/2010 the new European directive 2010/31/EC on energy performance in buildings was published, within which the importance of active control systems such as automation, control and monitoring systems aimed at saving energy was recognized. This directive is applied in the community standard UNI EN 15232:2012, which clearly indicates the benefits obtainable by opting for a specific efficiency class.

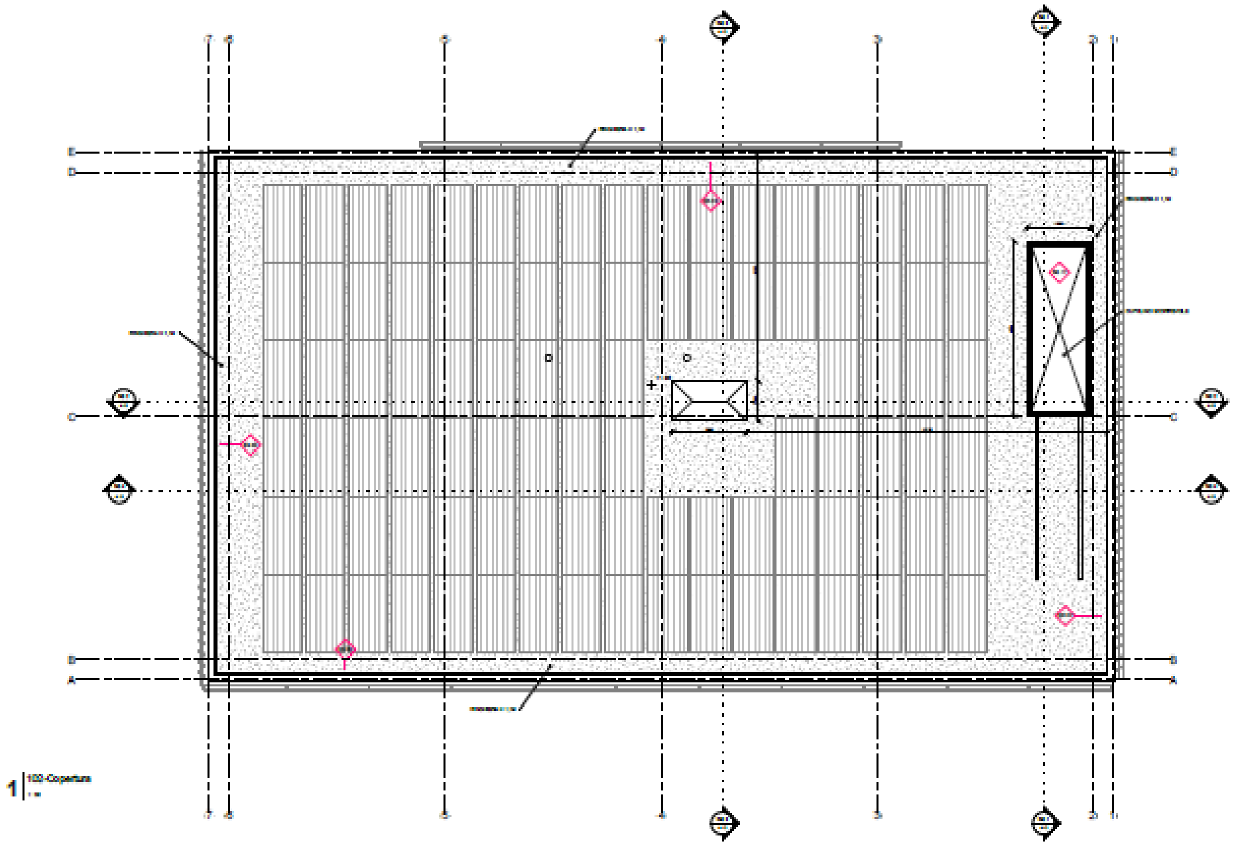


***Figure 6**: Photovoltaic park located on the roof of the building*

In order to comply with energy efficiency requirements, the building will be electrically connected to the general switchboard of the "Invariante 7E" electrical substation, through a section of new underground canalization and a section in the existing technological tunnel. On the ground level, in the dedicated room, there will be the general electrical panel, the centralized absolute electrical continuity group and the photovoltaic inverter. Most of all, at the roof level, the installation of photovoltaic generators (Figure 6) connected to the inverter located on the ground level is envisaged. The building, in any case connected to the university electricity system, will benefit from the energy benefits of the photovoltaic park in operation.

The stairs have been analysed in detail (Figure 7). They constitute a structure which is separated to the rest of the building by a seismic joint. Stairs are made by three-flight in reinforced concrete, supported by cantilever steel beams located at different heights. The main structure of the stairs is made of steel.

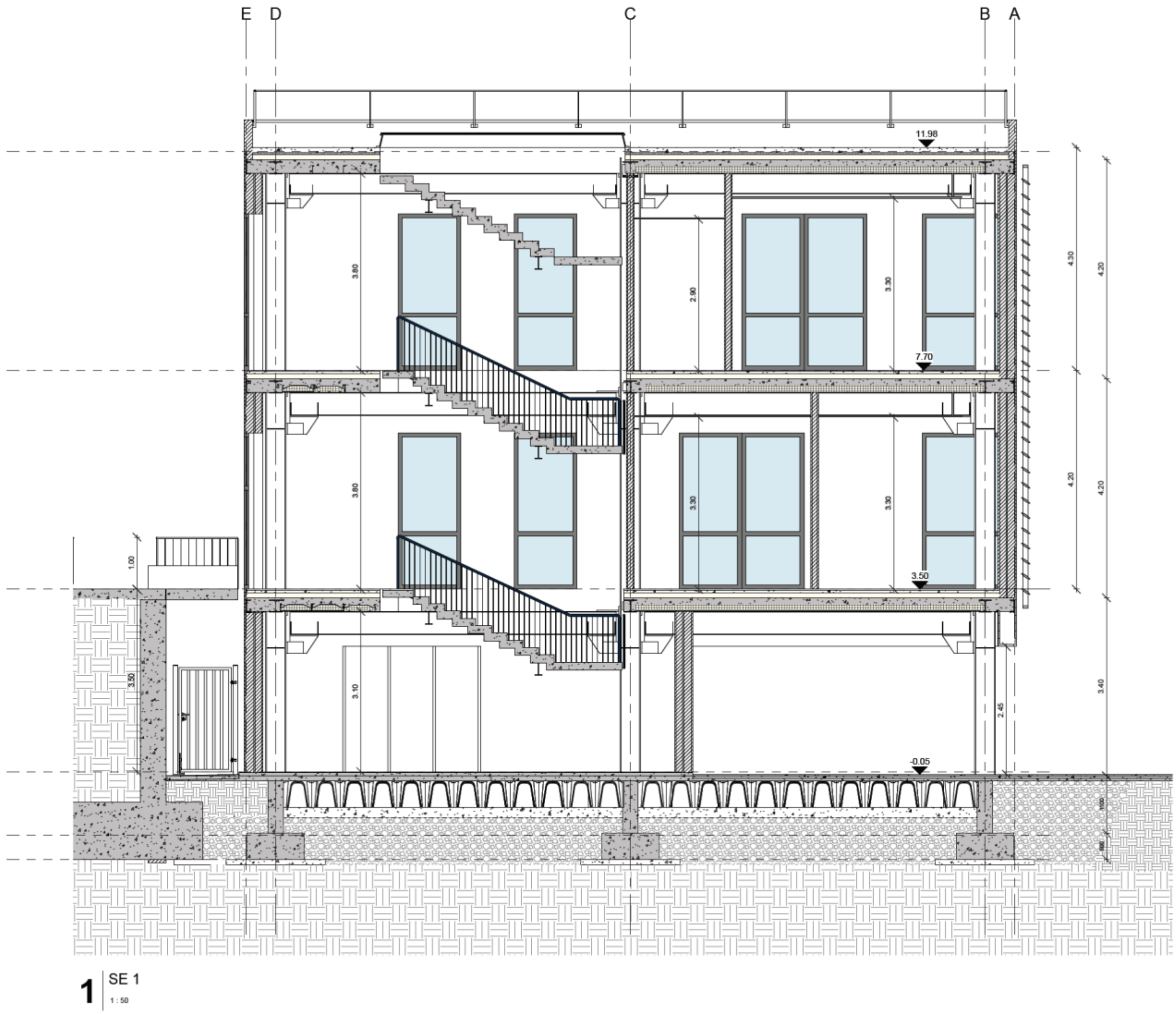


Figure 7: *Section of the building evidencing the stairs' structure.*

The stairs allows to have access to the roof of the building for all the maintenance needs. To this scope, the last ramp is covered with a movable light cover.

In Figure 8 a longitudinal section of the building is shown.

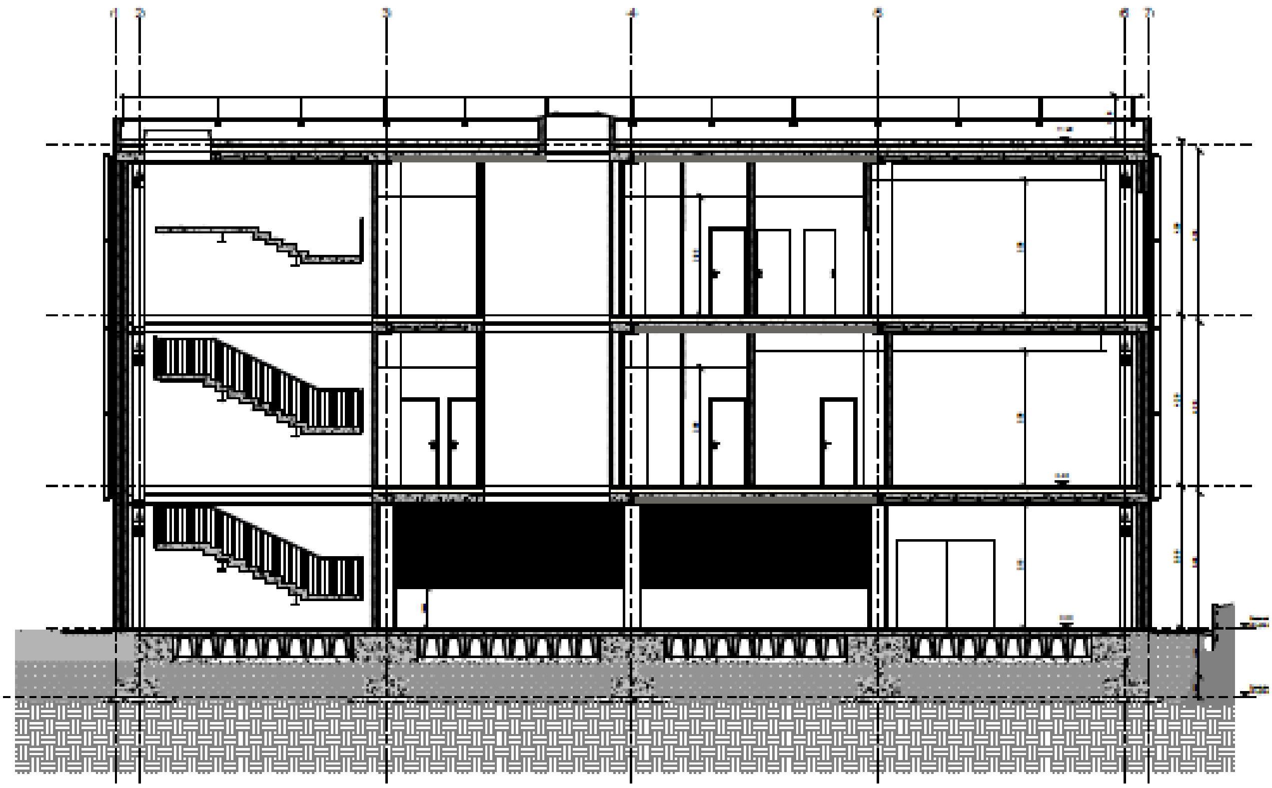


Figure 8: *Longitudinal section of the building*

4. The building facade

From the architectural point of view, the building is very simple because of its parallelepiped shape. Therefore, particular attention was devoted to the design of the façade, being the only component capable of providing the building with an architecturally attractive appearance.

For this reason, two options were investigated for the façade.

Figure 9: First option for the façade system (the adopted option)

The main feature of the first option (Figure 9), the chosen one, is the horizontal and vertical louvers system which envelops the sides of the building, acting as shading device. Each side will be covered in a different way, depending on the amount of solar irradiation. This feature, in addition to the possibility to change the angle of the louvers, adjusting the amount of solar radiation entering the building, allows to achieve a good equilibrium between daylight, electric lighting consumption and thermal comfort. The main structure is detached from the external walls and partially visible from the outside. A coating will protect the steel against environmental actions and will highlight the structural elements. The same philosophy is applied to the FREEDAM joint. Due to maintenance and monitor, the joint will be fully accessible to inspection, thanks to the recess of the suspended ceiling at the perimeter.

The second option (Figure 10) was driven by the same principles concerning the inside of the external walls: the structure would be isolated and highlighted. However, in this option, it would be more visible from the outside thanks to the presence of horizontal and vertical fixed shading devices that frame the façade but leave the glazed portion uncovered. These elements provide visual variation on each side of the building, through a standardized system. Windows have been sized to balance the required light levels for office and lab activities, whilst ensuring that solar heating loads are reduced. By placing the glazing on the inside of the boxing element, it would be possible to use the full depth of the façade for shading purposes, in conjunction with internal rolling blinds.

Figure 10: Second option for the façade system

Therefore, the first option was selected because adjusting the amount of solar radiation entering the building, it allows to achieve a better equilibrium between daylight, electric lighting consumption and thermal comfort.

Because of the selected option, the architectural aspect and aesthetic rendering of the building are shown in the **Figure 11** through a rendering that frames the building in the intervention area. In the background, you can see the university residences.

Figure 11: *Selected option for the façade with rendering of the building*

The external walls of the building consist of a highly insulated, double-framed dry panel system provided by KNAUF. As an alternative option, almost full-height glazing is utilized. A prominent feature of this chosen design is the integration of horizontal and vertical louver systems along the sides of the building, serving as shading devices (Figure 12).

Figure 12: *North-west, south-west views*

Each side of the building will be covered in a distinct manner, taking into account the level of solar radiation it receives. This feature, coupled with the ability to adjust the angle of the louvers, enables the regulation of solar heat gain and ensures a balance between natural daylight, electricity consumption for lighting, and thermal comfort.

5. Non-structural components

The non structural components and their connections with the structural part have been the subject of deep analysis. The details of the facades are provided by TS which has interacted with KNAUF to ensure the full feasibility of the solution since KNAUF supplies the external claddings. Several details of the interconnections between the structural and non-structural parts have been reported in the executive design. Some examples of typological details are reported in Figure 13 and in Figure 14.

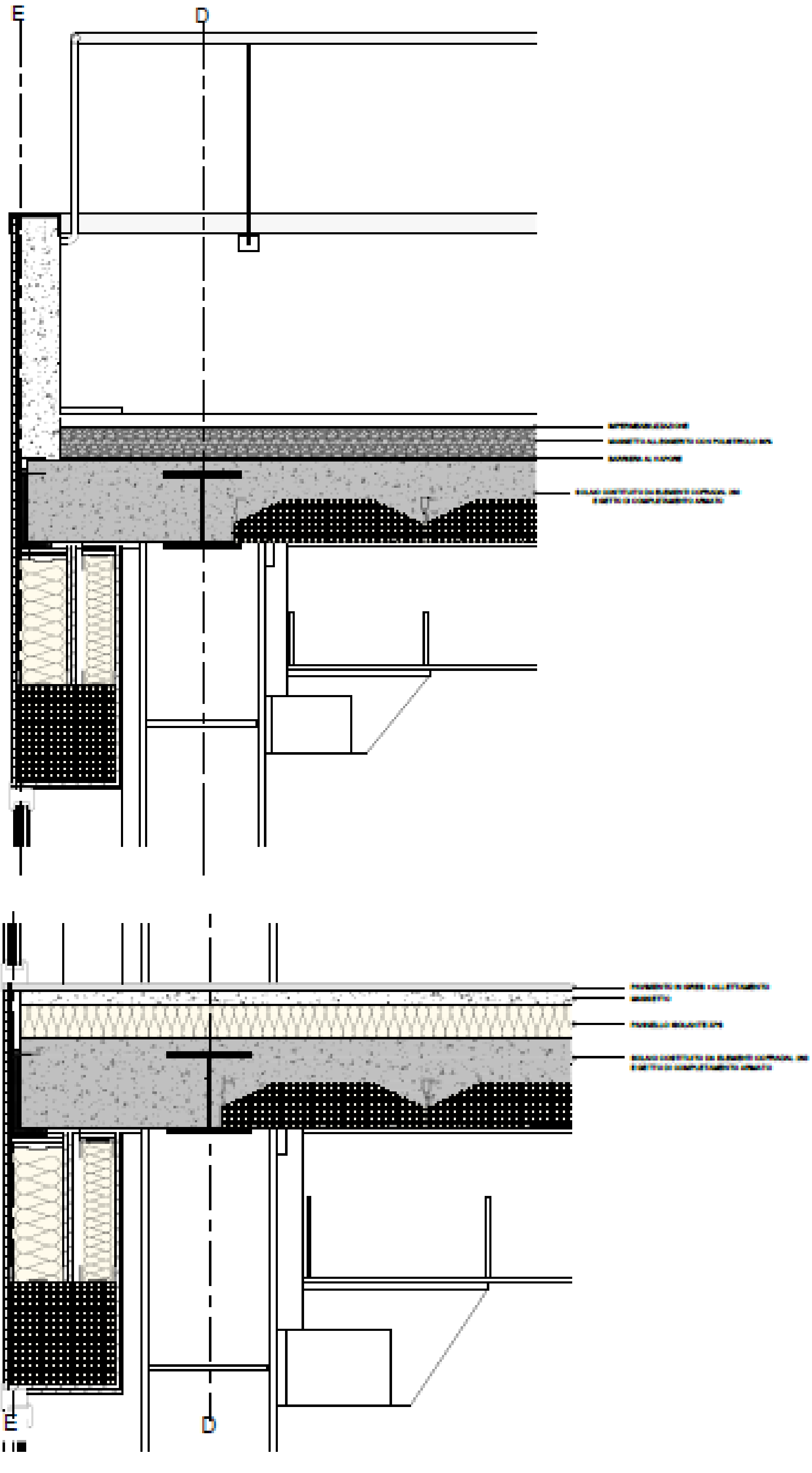


Figure 13: *Typological details (1/2)*

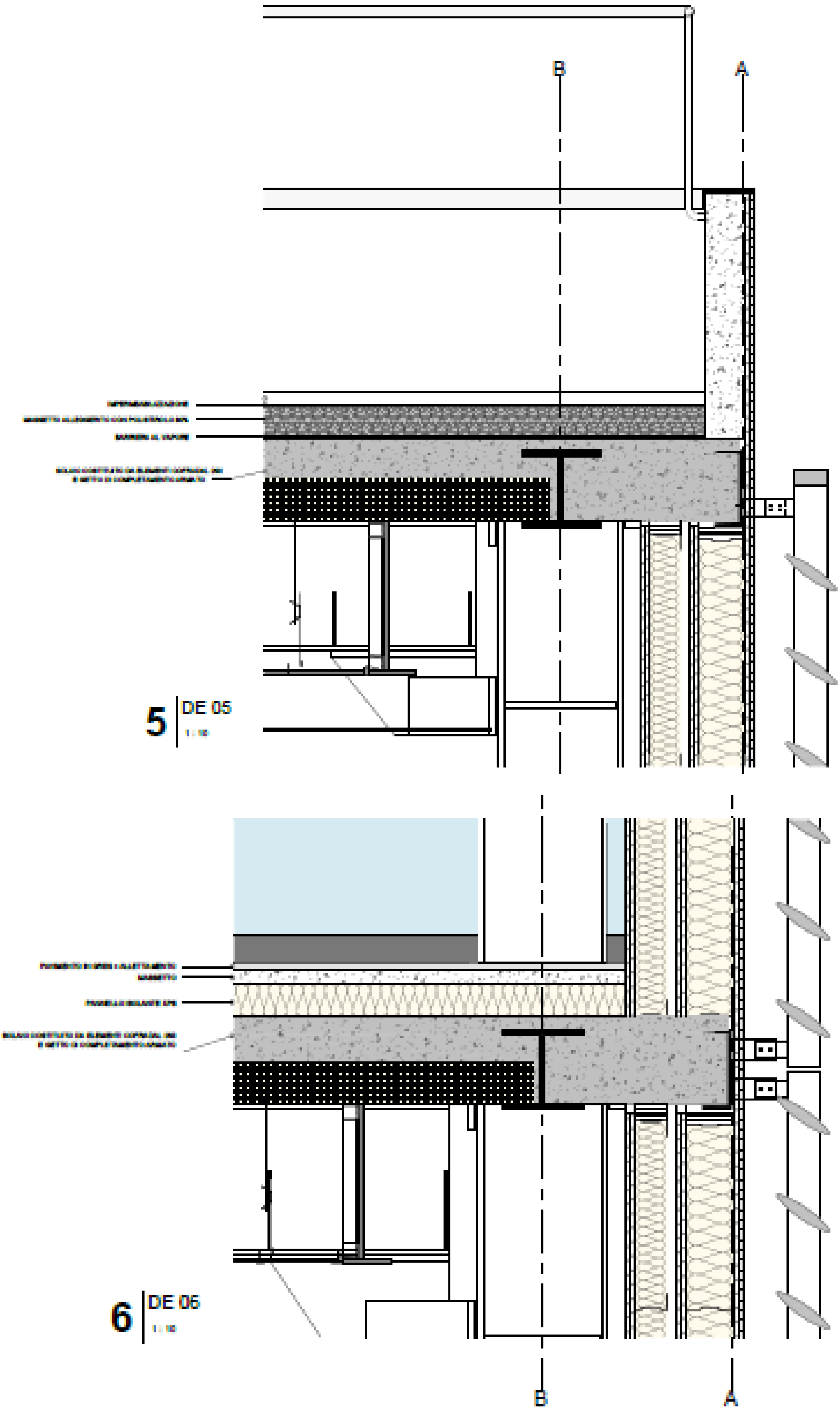
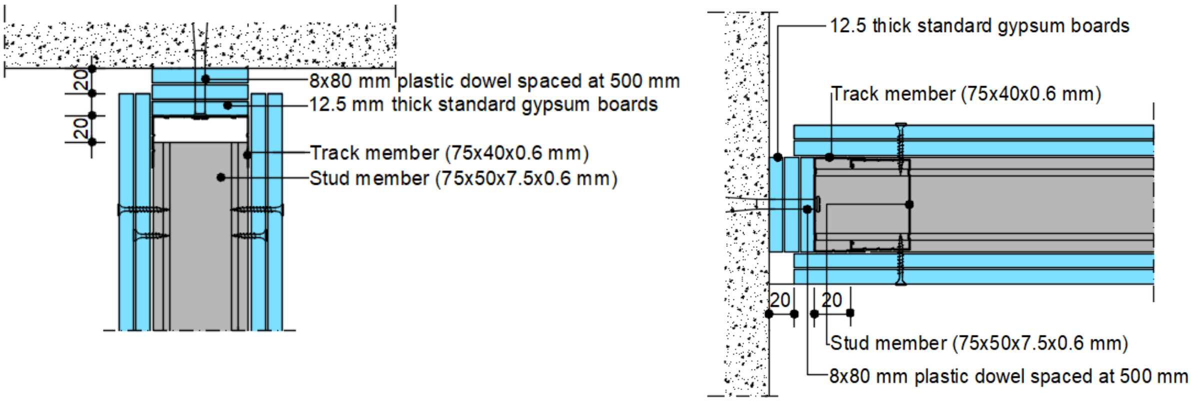


Figure 14: *Typological details (2/2)*

Additional details can be found in the complete design documentation given as Annexes to this deliverable and available on the project website (www.dreamersproject.eu).

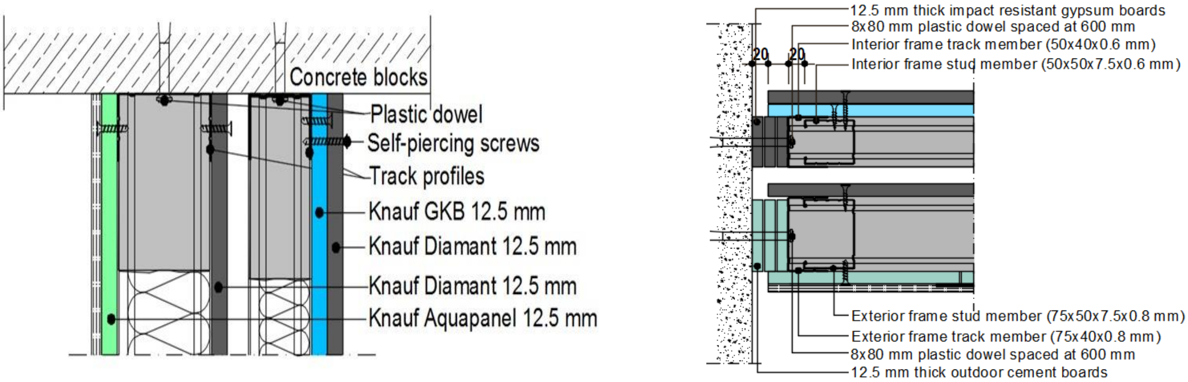
The selection of LWS drywall products for optimal seismic response, with respect to damage limit states, is based on previous research funded by Knauf and summarized in the relevant deliverable of the project. Anti-seismic enhanced solutions have been chosen for non-load bearing partitions (Figure 15), façades (Figure 16), and suspended ceilings (Figure 17).



Horizontal enhanced (sliding) connection ***Vertical enhanced (sliding) connection***

***Figure 15**: Anti-seismic enhanced connection details for partitions.*

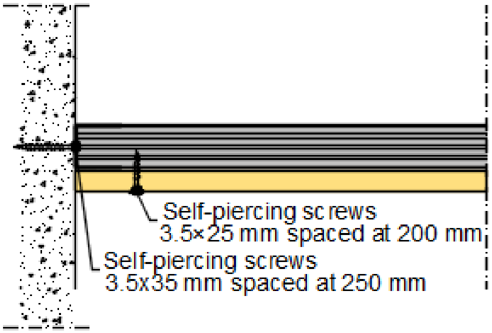
Figure 15 illustrates the details of anti-seismic enhanced connections for partitions, including horizontal enhanced (sliding) connections and vertical enhanced (sliding) connections. Figure 16 showcases the anti-seismic enhanced connection for façades, featuring horizontal basic (fixed) connections and vertical enhanced (sliding) connections. Figure 17 displays the anti-seismic enhanced connection details adopted in ceilings, specifically the connection between furring channels and the wall, and the connection between carrying channels and the wall.



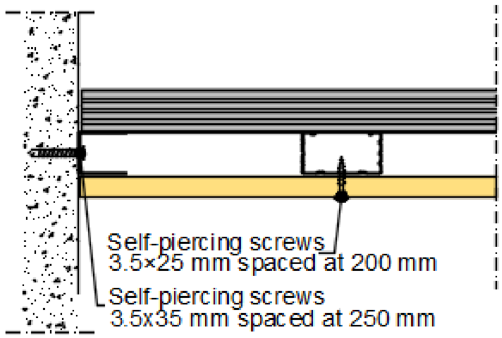
Horizontal basic (fixed) connections ***Vertical enhanced (sliding) connections***

***Figure 16:** Anti-seismic enhanced connection for façades.*

Based on test results from past research activities funded by Knauf, seismic fragility curves are available for selected partitions and façades.



Connection between furring channels and wall



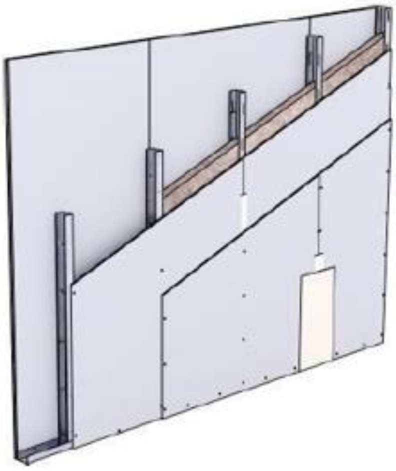
Connection between carrying channels and wall

***Figure 17**: Anti-seismic enhanced connection details adopted in ceilings*

The technical specifications for non-structural components (Knauf drywall system for partition, external wall and modular ceiling) are specified hereinafter.

Partition Wall – Single metal stud frame – Fire rating 120

Knauf metal stud partition W112: single metal stud frame with a double-layer cladding on each side with a double layer of Knauf Diamant board and sound insulation panels in the gap (Figure 18).



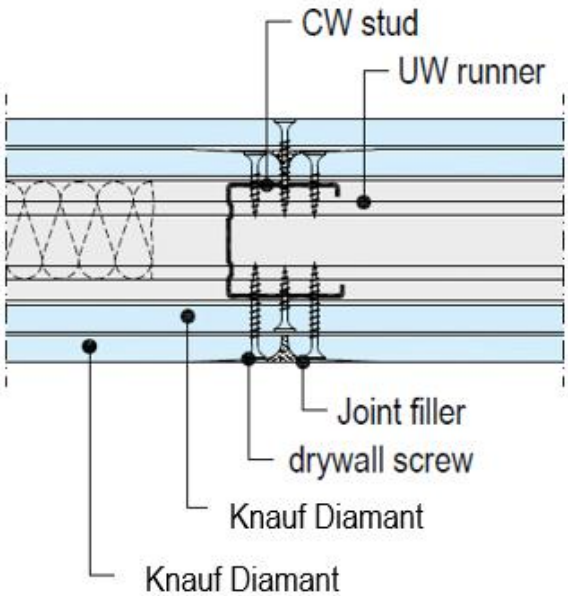


***Figure 18**: The Knauf metal stud partition W112: Axonometry and horizontal section*

The delivery and installation of a non-load-bearing single-stud interior wall with metal framework, cladded with a double layer of Knauf Diamant on each side will occur during the construction according to the following features:

- Wall thickness: 125 mm Wall height: 4,00 m
- Sound Insulation rating = 63 dB

The solution consists of:

- A single metal frame with Knauf profiles made up of steel DX51D+Z-N-A-C with a thickness of 0,6 mm, CE marked according to EN 14195 – 2005, composed of:

➢ U runners: U profile 40/100/40 mm;
➢ C studs: single C profile 50/100/50 (*) mm, maximum spacing 600 mm.
➢ One layer of glass mineral wool, conforming EN 13162 - R2F A1
➢ Knauf Diamant (DFH2IR) board as inside and outside layer of the cladding, CE marked according to EN 520, fixed to the C studs with drywall screws.

Exterior Wall – Knauf Aquapanel Exterior partition

The delivery and installation of Knauf Exterior Wall as double stud system, installed between floors with intermediate board (Figure 19), will occur during the construction.

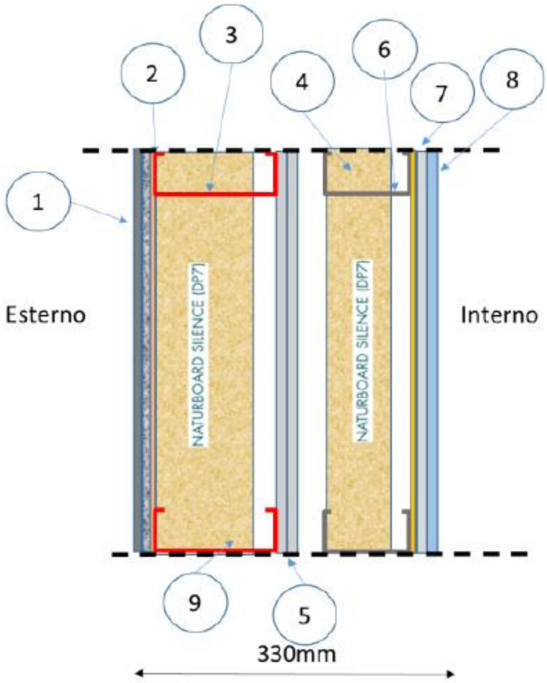


Figure 19: *Knauf exterior wall horizontal section*

The solution consists of:

- Exterior metal frame with Knauf profiles MgZ made up of steel DX51D+Z-N-A-C with additional Zinc-Magnesium coating, profile thickness of 0,6 mm, CE marked according to EN 14195 – 2005, composed of:
  ➢ U runners: MgZ U profile 40/150/40 mm;
  ➢ C studs: single MgZ C profile 50/150/50 (*) mm, maximum spacing 400 mm.
- Interior metal frame with Knauf profiles made up of steel DX51D+Z-N-A-C with profile thickness of 0,6 mm, CE marked according to EN 14195 – 2005, composed of:
  ➢ U runners: U profile 40/100/40 mm;
  ➢ C studs: single C profile 50/100/50 (*) mm, maximum spacing 400 mm.

Thermal and sound insulation materials between studs:

- Single layer of rockwoll Knauf Insulation Naturboard Silence, conforming EN 13162 produced with Ecose Technology, placed in the gap of the external metal framework. Technical data: dimensions 600x1000 mm, thickness 120 mm, density 70 kg/m3, λD: 0,034 W/mK, firereaction class A1 (EN 13501-1), vapor resistance µ = 1. Knauf products are endowed with the Euceb brand to ensure bio-solubility and compliance with note Q of European Directive 97/69 / EC.

- Single layer of rockwoll Knauf Insulation Naturboard Silence, conforming EN 13162 produced with Ecose Technology, placed in the gap of the internal metal framework. Technical data: dimensions 600x1000 mm, thickness 80 mm, density 70 kg/m3, λD: 0,034 W/mK, firereaction class A1 (EN 13501-1), vapor resistance µ = 1. Knauf products are endowed with the Euceb brand to ensure bio-solubility and compliance with note Q of European Directive 97/69 / EC.
- Cladding of the exterior side with Knauf Aquapanel Outdoor board, CE marked according to EN 12467 and ETA, fixed to the external MgZ C studs with Aquapanel Maxi Screws SB 25

<u>*Modular Ceiling witk Knauf Topiq Efficient Pro board*</u>

The delivery and installation of demountable gypsum ceiling in exposed T-grid system (Figure 20) will occur during the construction.

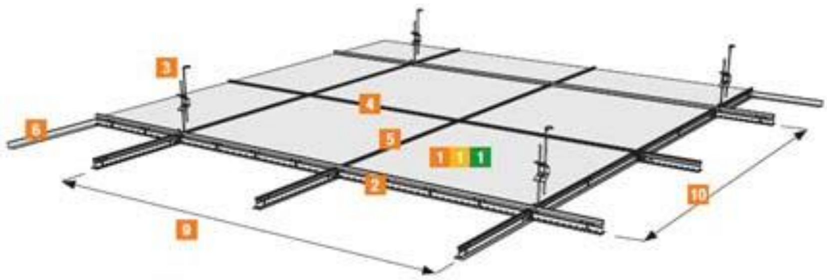


***Figure 20**: Modular Ceiling witk Knauf Topiq Efficient Pro board*

Products and materials:
Board: KCS Topiq Efficient Pro

Main runner
Type: T-profile
Material: 0.4mm galvanized steel Colour: White
Dimensions: Width < 15 or 24 mm > | Height 38 mm

Cross-tees
Type: T-profile
Material: 0.4mm galvanized steel Colour: White
Dimensions: Width < 15 or 24mm > | Height 38mm

Wall connection
Type: < L-profile or Shadow line trim> Material: 0.5mm galvanized steel Colour: White
Dimension: < 24x20mm or 15x15x8x25mm >

Suspension
Type: Adjustable hanger Dimension: < xxx - xxx mm >

Installation

- Screw spacing for attachment of wall connections max. 300mm c/c and in relation to the required ceiling height < xxx mm > (min. 120mm)

- Distance from wall to first hanger in direction of load-bearing (main runner) section ≤ 400 mm.
- Distance between hangers ≤ 1200 mm.
- Distance from wall to first load-bearing (main runner) section ≤ 600 mm.
- Distance between load-bearing (main runner) sections ≤ 1200 mm.
- Subdivision made with cross-tees length 1200 and 600 mm.
- Units of up to 3.0kg can be integrated directly into the ceiling tiles.

In the case of heavier units, the unit must be installed independently without any load on the ceiling tile. For loads above 3kg/m², additional hangers must be used.

6. List of complete design documentation

As already stated, according to the Grant Agreement all the design documentation is due in Italian language, because it has to fulfil the Italian Code provisions and has to be delivered to the National local authorities to obtain the relevant authorizations. The detailed design documentation is listed in the following Tables and fully delivered (in Italian) on the project website (www.dreamersproject.eu).

Table 1. *Executive Architectural Design Reports*

R 01	Relazione Generale	General Report
R 02	Quadro economico	Economic framework
R 03	Disciplinare tecnico opere edili	Technical specifications for construction works
R 22	Studio di Fattibilità Ambientale	Environmental Feasibility Study
R 23	Piano di Sicurezza e Coordinamento con Allegati	Security and Coordination Plan with Attachments
R 24	Relazione sulla Gestione delle Materie	Material Management Report
R 25	Relazione sulle interferenze	Interference report
R 26	Piano di Manutenzione dell’opera e delle sue parti	Maintenance plan for the work and its parts
R 27	Progetto acustico ante-operam ai sensi del Piano d’Azione allegato al D.M. 11/10/2017	Pre-construction acoustic project pursuant to the Action Plan attached to the Ministerial Decree. 11/10/2017
R 28	Schema di contratto e capitolato speciale	Contract outline and special specifications
R 29	Cronoprogramma dei lavori	Work timetable
R 30	Relazione sui Criteri Ambientali Minimi (CAM) - DM 23/06/2022	Report on Minimum Environmental Criteria (CAM) - Ministerial Decree 06/23/2022
AP 02	Analisi Prezzi Opere Edili	Analysis of Building Works Prices
AP07	Analisi prezzi Oneri della sicurezza	Price analysis for security charges
EP 01	Elenco Prezzi Opere Edili	List of Building Works Prices
EP 07	Elenco Prezzi Oneri della sicurezza	Price List for Security Charges
CM 01	Computo Metrico Estimativo Opere Edili	Estimated Metric Computation for Building Works
CM 07	Computo Metrico Estimativo Oneri della sicurezza	Estimated Metric Computation of safety costs

Table 2. *Executive Architectural Design Drawings*

A 01	Stralcio P.R.G. del Comune di Fisciano	Excerpt from the General Town Plan of the Municipality of Fisciano
A 02	Planimetria di Inserimento urbanistico - P.U.A.	Urban insertion plan
A 03	Planimetria Catastale	Cadastral plan
A 04	Planimetria Generale stato di fatto con profili terreno	General state-of-the-art plan with land profiles
A 05	Planimetria Generale di Progetto con profili terreno	General Project Plan with terrain profiles
A 06	Piante delle sistemazioni esterne	Plans of the external arrangements
A 07	Pianta Livello 0.0	Plant Level 0.0
A 08	Pianta Livello 3.50	Plant Level 3.50
A 09	Pianta Livello 7.70	Plant Level 7.70
A 10	Pianta Copertura	Roofing plant
A 11	Piante dei controsoffitti	Ceiling plans
A 12	Sezioni trasversali	Building cross sections
A 13	Sezioni longitudinali	Building longitudinal sections
A 14	Prospetti (1/2)	Prospectuses (1/2)
A 15	Prospetti (2/2)	Prospectuses (2/2)
A 16	Dettagli tipologici	Typological details
A 17	Vano scala e ascensore	Stairwell and elevator
A 18	Abaco dei serramenti	Abacus of windows and doors
A 19	Sistema di ombreggiamento	Shading system