Analysis of Extension Strategies for Improving Spatial Performance in an Existing Single-Family House

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Dóra Nagy

HAMK
Häme University
of Applied Sciences

Abstract

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Author	Dóra Nagy	
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Supervisors	Lauri Korhonen	

This thesis investigates extension strategies for improving the spatial performance of an existing single-family residential building constructed with masonry walls. The study is motivated by the limitations of traditional room-based layouts in older buildings, which often fail to meet contemporary requirements for open, flexible, and multifunctional living spaces.

The research is based on a case study approach, analysing an existing two-storey residential building and proposing a horizontal extension aimed at increasing capacity and improving the usability of shared living areas. The study involves the preparation of architectural and structural design proposals supported by relevant calculations and modelling tools. Three alternative extension strategies are developed and evaluated during this work. Each approach is designed as a structurally independent system and assessed in terms of structural performance, thermal behaviour, construction cost, environmental impact, and overall feasibility.

The results show that all three strategies satisfy the required structural and thermal performance criteria, while notable differences can be identified in their flexibility, cost efficiency, and environmental impact. Masonry construction provides high structural stability but limited adaptability, while timber construction offers greater flexibility and favourable environmental performance. The modular approach demonstrates the highest level of cost efficiency and construction speed, although with reduced adaptability due to its prefabricated nature.

In conclusion, the study highlights that no single extension strategy can be considered universally optimal. Instead, the selection of the most appropriate solution depends on project-specific priorities, requiring a balance between architectural, structural, economic, and environmental considerations. The findings demonstrate that well-designed extensions can significantly enhance the spatial quality and functionality of existing residential buildings.

Keywords Extension strategies, masonry, timber, modular section
Pages 55 pages and appendices 49 pages

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1 Introduction

The layout of common spaces in a residential building plays a fundamental role in shaping everyday comfort, patterns of use, and the overall quality of domestic life. These shared spaces not only accommodate daily activities but also influence social interaction within the household. (Mellen, & Short, 2023) In many older residential buildings, however, the layout of common areas was designed for earlier living patterns and spatial standards, resulting in spatial arrangements that are often inadequate by present-day standards. Over time, changes in lifestyle and family models have made many of these interiors less suitable for contemporary living.

In recent years, this problem has become more visible, as existing residential buildings are increasingly renovated and extended instead of being replaced with new ones. This trend is influenced by economic reasons, sustainability concerns, and the intention to reuse existing building structures. (Pelsmakers & Warwick, 2022) However, the internal organisation of older residential buildings often reflects the lifestyle and habits of an earlier period. This is especially clear in more compartmentalised layouts, where functions are separated into distinct rooms. In contrast, contemporary housing generally requires open-plan arrangements that enable spatial integration, flexibility, and the support of multiple activities and changing needs. (Alfirevic & Alfirevic, 2016)

Architectural extensions offer a possible solution to these functional limitations, but they also introduce complex structural design questions related to foundation systems and connections between new and existing elements. (ISO 13822, 2010) Therefore, this thesis aims to investigate the structural design and integration of residential extensions in existing masonry buildings, using the improvement of architectural and functional quality as the project context. Through the analysis of a specific design project, the work examines different extension strategies and evaluates their architectural, structural, and functional implications. In all approaches, the extension is built on a separate foundation and functions as an independent structure, while remaining physically connected to the original building. The thesis compares these strategies in terms of construction methods, sustainability aspects, and overall cost efficiency. The research focuses on an existing building constructed with ceramic masonry walls, where the enlargement of an existing opening and the addition of a new extension are required. By analysing this case study, the goal is to demonstrate how carefully designed extensions can respond to modern living requirements.

2 Scope and Limitations

The scope of the thesis focuses on examining the architectural and structural implications of extending an existing two-storey masonry house, located in Slovakia, in the district of Dunajská Streda. The study investigates three alternative extension strategies: traditional on-site construction by using masonry units and then later timber elements, and last but not least, using modular prefabricated elements. The analysis considers spatial organisation, structural integration with the original building, the potential for open and aesthetically pleasing interior layouts, as well as comparative evaluation of costs and labour requirements.

The thesis is based on an existing building project for which architectural drawings and documentation are available. The analysis and design proposals rely on these drawings as the primary source of geometric and structural information. However, no measurements, structural inspections, or geotechnical investigations were carried out as part of this work. Therefore, structural calculations are performed using standard design parameters, while foundation and excavation considerations rely on typical conditions rather than verified data.

The lack of site-specific information restricts the precision of cost and time estimates, which are intended only for comparative purposes. Furthermore, legal and regulatory factors, such as zoning permissions or the presence of underground utilities, are discussed theoretically, as these cannot be confirmed for the assumed site. Despite these limitations, the use of an existing building project allows the research to remain grounded in a realistic structural and architectural context while evaluating alternative extension strategies.

3 Methodology

The thesis is based on case study-based structural design research, using an architectural project as the analytical framework for evaluating extension solutions in an existing residential building. The research is structured into several phases, each aiming to provide a coherent and systematic development of the extension strategies.

The first phase involves preparing detailed architectural and structural drawings of the original building’s layout. These include floor plans, sections and structural details, providing a clear understanding of the existing spatial organisation and the structural system. Following this, the research develops three design options for the extension. The first explores traditional on-site construction with masonry, the second observes the same method of construction but with timber as the main building component, while the third option investigates modular prefabricated sections. All approaches are designed to ensure structural independence from the existing building, maintain an open and aesthetically appealing interior, and provide practical solutions for connecting the new structure to the original structure. The final stage is a comparative evaluation of the two strategies in terms of construction time, cost, labour requirements and design feasibility.

This analysis utilises a variety of data sources, including national building codes, cost databases and manufacturers' catalogues for the prefabricated elements. This study employs AutoCAD for structural and architectural design, ArchiCAD and Lumion for modelling the new structure's appearance, Mathcad for structural calculations, and Cenkros for construction cost estimation. RFEM is used for the structural design of the roof, enabling the determination of climatic loads in combination with the self-weight of the roof structure.

In addition to structural and architectural analysis, the study includes a thermal performance assessment of the proposed building assemblies. This evaluation is carried out using Ubakus software, which enables the analysis of multilayered building elements. For each extension strategy, the external wall, roof, and floor structures are defined, and the thermal transmittance, also referred to as U-value, of these elements is calculated to assess the energy performance of the proposed solutions.

Furthermore, ChatGPT is used to assist with the translation of selected technical terms and to provide language-related suggestions during the preparation of the work. In addition to terminology support, the tool is employed to refine the sentence structure, improve clarity, and ensure consistent use of specific vocabulary throughout the thesis.

4 Existing Building Analysis

Residential extensions cannot be effectively designed without a deep understanding of the existing building and its functional constraints. The spatial organisation, load-bearing structure, material system, and original layout of the house directly influence the feasibility, performance, and architectural quality of any intervention.

For this reason, the analysis of the original residential building plays a central role in the development process. By examining the architectural configuration, structural characteristics, and current functional performance of the house, it becomes possible to identify the key challenges that the proposed extension must address.

4.1 Location and Context

The case study building is assumed to be in a suburban residential area in the district of Dunajská Streda, Slovakia. The location is selected as a representative example of low-density residential development found in the region. For this reason, the surrounding built environment is assumed to consist of detached single-family homes with low-rise building technology – this assumption reflects common suburban housing patterns and provides a realistic contextual framework for the extension design. Therefore, the use of fictional site context allows the research to focus on architectural and structural principles rather than site-specific constraints. The plot is assumed to have a rectangular geometry, providing direct access from the street, and it also enables simple vehicular access while providing sufficient outdoor space for potential horizontal expansion of the building. The assumed orientation of the plot supports favourable daylight conditions for the main living spaces, which is an important factor when considering the transformation of the original layout.

However, it is important to note that no real site survey data, cadastral information, or official planning documentation is available for this project. Although exact environmental conditions, such as specific soil parameters, groundwater level and other data, are not available, standard regional construction assumptions are applied throughout the design process.

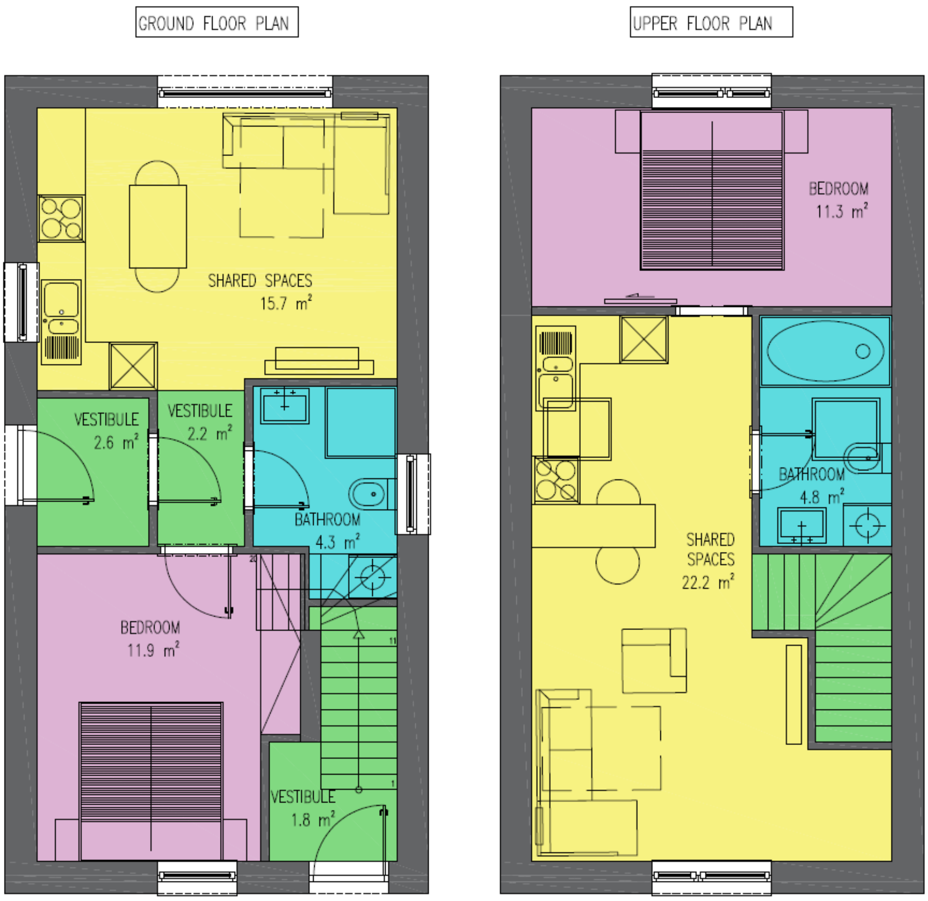
4.2 Architectural Layout of the Existing Building

The existing residential building is designed as a detached two-storey family house without a basement. The building is characterised by a compact rectangular footprint, with approximate ground floor dimensions of 5 x 9 metres, as can be seen in Appendix 1/1-6. While the simple geometry contributes to construction efficiency and structural clarity, it also limits the flexibility of internal spatial organisation.

From a spatial perspective, the building operates as a single structure containing two fully independent accommodation units arranged vertically, which are currently used as short-term rental accommodation. Each unit has its own dedicated external entrance and private access zone, allowing independent use by guests. The ground floor unit is accessed directly through a separate entrance leading straight into the interior space, while the upper floor unit is accessed through an entrance that leads into a stairwell, which belongs to the upper accommodation unit. There is no internal connection between the two levels, allowing both units to function independently within the same building envelope.

The internal layout of both accommodation units follows a traditional room-based arrangement, as can be seen in Figure 1. Different functions are separated by internal walls, which create clearly defined spaces but limit openness and flexibility. This is especially noticeable on the ground floor, where the size of the common living area affects how the space can be used and furnished.

Figure 1. The spatial layout of the ground floor and upper floor plan



4.3 Structural System of the Existing Building

The load-bearing structure of the building is supported by continuous strip foundations, as Appendix 1/1-6 shows, which transfer loads from the superstructure to the ground. The ground floor slab has an approximate thickness of 150 mm, and it is reinforced with welded steel mesh. Above the foundations, the building is constructed using a masonry wall structural system. The external load-bearing walls are built with 250 mm thick ceramic masonry units and serve as the primary vertical load path of the structure, carrying loads from the upper structures and transferring them directly to the foundations. For dividing interior spaces, non-load-bearing internal partition walls are placed with a thickness of 100 mm; these separation walls do not take part in the load-bearing system.

Above the ground floor level, the horizontal load-bearing structure consists of a 150 mm thick reinforced concrete slab, which provides sufficient load-bearing capacity for residential use. In addition to vertical load transfer, the slab contributes to the building's horizontal stiffness and improves the overall structural behaviour of the supporting system. Structural continuity and global stability of the framework are ensured by a monolithic reinforced concrete ring beam, which not only connects the wall structures but also improves the resistance against horizontal forces. This information about the structural system can be read from the details drawing in Appendix 1/1-6.

The existing building's roof structure is formed by a duo-pitched timber roof system with a slope of approximately 45°, and it is covered by lightweight roofing sheets that can be observed in Appendix 1/1-6. The timber structure is supported by wall plates anchored to the reinforced concrete ring beam, which transfers the loads from the upper structures into the vertical bearing members. Thermal insulation of the roof assembly is provided by mineral wool layers with a total thickness of approximately 210 mm, protected by a vapour barrier layer to ensure adequate thermal performance and moisture control, as Appendix 1/1-6 shows.

The building's framework in its current condition represents a closed structural system, as the existing load-bearing elements are not intended to receive additional loads. For this reason, the extension is designed as a structurally independent system with its own foundation and load-bearing skeleton. This approach minimises the manipulation of the existing property and reduces structural risks during construction.

4.4 Problems and Limitations of the Existing Layout

From a functional perspective, the main limitation of the existing house is related to the capacity of the ground floor unit. With the current floor plan layout, the ground level is only able to comfortably accommodate two to three people. Therefore, the primary objective of the project is to increase the capacity to four to five people, allowing the building to host families as well as larger groups of people. This change is expected to improve both the functional usability and economic efficiency of the cottage house.

The most significant limiting factor is the size of the shared living space on the ground floor. The current layout does not provide sufficient space for a large extendable sofa, adequate storage solutions, and a properly defined dining area that would support the needs of an increased number of guests. Consequently, due to these functional and spatial limitations, the current floor area and spatial arrangement are not suitable for any meaningful reorganisation or renovation without architectural and structural intervention. In this context, the extension does not serve purely aesthetic purposes but rather offers a direct solution to the spatial constraints of the building. Therefore, the main design goal is to create a larger, more open and flexible communal space that supports increased occupancy while also providing a pleasant and high-quality experience for the visitors in a spacious and comfortable environment.

5 Theory

Before addressing the structural calculations, comparative evaluation, and design decisions related to the proposed extension, it is necessary to understand the basic building principles that define the existing structure. This section therefore provides an overview of the loads acting on the building, the materials typically used in construction, and the key building elements that influence the overall structural behaviour.

5.1 Loads Acting on the Structure

In order to carry out the structural design of the extension, first, the loads acting on the structure must be defined. Besides that, these loads determine the dimensioning of the structural elements and the utilisation of their safety and stability, and they also have a significant impact on the structure's durability and lifetime. For that reason, the correctly defined load assumptions are essential for ensuring the strength, stability and safety for both the existing building and the new extension. The following chapters present the load assumptions used in this thesis and explain how they are determined for the analysed structural system.

In Slovakia, the equation for load calculations is typically carried out using the Ultimate Limit State (ULS) approach, which ensures that the structure can safely resist the highest expected loads. These load combination equations are calculated according to Annex 1, Table A1.2(B), Eq. 6.10 from Eurocode 1990 (SFS EN 1990, 2002, p. 52) as presented in Equation 1.

Equation 1. Design values of actions

$$1{,}35 \cdot K_{FI} \cdot G_{kj,sup} + 1 \cdot G_{kj,inf} + 1{,}5 \cdot K_{FI} \cdot Q_{k,1} + 1{,}5 \cdot K_{FI} \cdot \sum_{i>1} \psi_{0,i} \cdot Q_{k,i}$$

Where:

$G_{kj,sup}$	Characteristic upper value of the permanent action (unfavourable)
$G_{kj,inf}$	Characteristic lower value of the permanent action (favourable)
$Q_{k,1}$	Characteristic value of the leading variable action
$Q_{k,i}$	Characteristic value of the accompanying variable action
K_{FI}	Factor for actions
$\psi_{0,i}$	Combination factor for an accompanying variable action

5.1.1 Dead Load

Dead load refers to the self-weight of all permanent elements acting on the structure. This includes both structural components, such as slabs, columns and beams, but also non-structural elements, such as windows, insulation layers, and roof coverings. (Ernst, 2022) According to Eurocode, dead load is defined as a permanent action, which can be determined by calculating volume, mass, and density. (SFS EN 1991-1-1, 2002, pp. 32-42)

5.1.2 Live Load

Live loads, also known as imposed loads, represent variable actions resulting from the use and occupancy of the building. Typical examples include occupants, furniture or movable equipment. Unlike permanent loads, their magnitude and position may change over time depending on how the space is used.

Live loads can act as concentrated or distributed loads and may include dynamic effects such as vibration. For this reason, design standards specify representative load values that ensure safe structural performance under expected usage conditions. (SFS EN 1991-1-1, 2002)

5.1.3 Snow Load

Snow load refers to the load acting on the structure due to the accumulation of snow on the roof surfaces. This load is particularly relevant in regions where snowfall is frequent or heavy, as accumulated snow can significantly increase the vertical load on the roof structure. The value of the snow load is influenced by several factors, including roof geometry, as snow tends to accumulate more easily on flat or low-slope roofs, while steeper roofs allow snow to slide off more easily. (SFS EN 1991-1-3, 2003)

According to Eurocode (SFS EN 1991-1-3, 2003), snow load is classified as a variable action and it is determined based on the characteristic snow load on the ground, modified by coefficients that account for roof shape, exposure, and thermal conditions. National Annexes provide country-specific values for these parameters.

Equation 2. Snow loads on roofs for the persistent/transient design situations

$$S = \mu_i \cdot C_e \cdot C_t \cdot S_k$$

Where:

μ_i	Snow load shape coefficient
C_e	Exposure coefficient
C_t	Thermal coefficient
S_k	Characteristic value of snow load on the ground

5.1.4 Wind Load

Wind loads are the forces caused by air movement acting on the surfaces of the building. When the wind blows around the building, it creates both pressure and suction on surfaces such as walls and roofs, which must be considered in structural design. These forces can act in both horizontal and vertical directions and may significantly influence the stability of the structure. The magnitude of wind load depends on factors such as wind speed, geographical location, terrain category, building shape and exposed surface area. According to Eurocode EN 1991-1-4, wind load is classified as a variable action, and it is determined using basic wind velocity together with coefficients that account for terrain, exposure, and structural characteristics. National Annexes provide country-specific values for parameters such as the basic wind velocity. (SFS EN 1991-1-4, 2005)

5.2 Building Materials

Building materials are materials used for construction purposes. They can be made of naturally occurring materials or human-made, artificially produced substances. The right material selection is the basis for a construction, not just because of the pleasing look and shape, but because it ensures the long-term stability, strength and overall safety. In addition, the appropriate material choice can reduce the construction time and costs by minimising labour requirements and simplifying installation processes.

5.2.1 Masonry

Masonry is a building method in which modular units, such as bricks, concrete blocks, structural clay tiles, glass blocks, and natural or cast stone, are laid and bonded together with mortar to form durable and structurally efficient walls. These units include bricks, which are heat-hardened clay products, and concrete blocks, which are chemically hardened. Masonry construction provides high compressive strength, excellent fire resistance, and good thermal performance, allowing structures to store heat effectively. However, masonry has relatively low resistance to tensile and shear forces, so reinforcement is often used to improve overall strength, stability, and safety. (Ching, 2014, Section 5.14)

5.2.2 Concrete and Reinforced Concrete

Concrete is a construction material composed of cement, water and aggregates. When these components are mixed, they harden into a strong, stone-like mass through the hydration process. Chemical or mineral admixtures may also be added to improve workability, regulate curing, and enhance durability under various environmental conditions. Concrete is widely used in the construction industry because it can be poured into almost any desired shape, and its high compressive strength, together with its availability and affordability, make it an ideal construction material. However, plain concrete exhibits very low tensile strength, so it is commonly reinforced with steel bars or mesh to increase its tensile capacity and create reinforced concrete. (Asmara, 2023)

5.2.3 Timber

Timber is a wooden product from trees that are suitable for building and construction purposes. It has been used for building for thousands of years and is still important today because it has a high strength-to-weight ratio, low thermal conductivity, and a natural aesthetic appearance. Timber can refer to both raw wood from trees and processed wood used for structural elements, such as beams, floor joists, and roof trusses. It is usually classified into softwoods, which come from cone-bearing trees like pine or spruce, and hardwoods, which come from broadleaf trees such as oak or teak. The durability and performance of timber depend on factors like proper seasoning, chemical preservatives, and protective surface coatings. (Harte, 2009)

5.2.4 Insulation

In the construction field, insulation refers to a material or system used to reduce the transfer of heat between the interior and exterior environments of a building. It functions as a barrier that limits heat loss during cold conditions and heat gain during warm conditions, thus helping to maintain a stable indoor temperature. By controlling heat transfer processes such as conduction and convection, insulation improves the overall thermal performance and energy efficiency of buildings. Effective insulation also reduces the demand on heating and cooling systems, contributing to lower energy consumption and operational costs. Consequently, insulation is considered a fundamental component in building design. (Ching, 2014, Section 7.41)

5.3 Extension of an Existing Building

In Slovak construction practice, a building extension can be understood as the enlargement of an existing building through additional construction that is physically connected to the structure. Rather than being defined as a separate term, it falls under the broader category of modifications to existing buildings. In practice, this type of intervention results in an increase in the building’s floor area or volume while maintaining a functional and structural relationship with the original construction.

Building extensions can generally be categorised based on their spatial configuration. A horizontal extension expands the building footprint by adding new spaces alongside the existing structure, while a vertical extension increases the building height by adding additional storeys. The choice between these approaches depends on site conditions, structural capacity, and functional requirements. Therefore, the primary purpose of a building extension is to improve the spatial performance and usability of an existing structure. This may include adapting the building to contemporary functional needs or enhancing the flexibility of interior spaces. (Slovenská Republika, 2025)

5.4 Modular Building Section

Modular buildings are a form of construction in which building components are prefabricated off-site in the form of volumetric units or modules. These modules are manufactured in a controlled factory environment and then transported to the construction site, where they are assembled to form a complete structure. Modular construction can be applied to various structural systems and materials, rather than representing a single specific building type.

This approach offers several advantages, including improved construction quality, reduced construction time, and minimised material waste due to controlled production conditions. However, modular buildings may also present certain limitations, such as constraints related to module dimensions, transportation, and structural connections. Despite these challenges, modular construction has become increasingly relevant in residential applications, where it can provide efficient and flexible solutions for building extensions and spatial improvements. (Lacey et al., 2018)

5.5 Environmental Effects

Environmental effects in construction refer to the overall impact that construction activities have on the natural environment. These effects arise throughout the entire lifecycle of a project, from material transportation to on-site construction processes. They may be either harmful or beneficial, but in most cases, they involve resource consumption, emissions of pollutants, and the generation of construction waste. In addition, construction activities can alter natural ecosystems by causing habitat loss, soil degradation, and a reduction in biodiversity.

The extent of these effects depends on factors such as the scale and location of the project, the materials used, and the construction methods applied. External influences, including climate conditions and surrounding environmental sensitivity, may further intensify these impacts. For this reason, understanding environmental effects is essential for identifying critical issues and reducing negative impacts through more sustainable design and construction practices. (Rakennustieto, 2025)

5.6 Thermal Transmittance

Thermal performance is a key aspect of building design, as it directly influences energy efficiency, indoor comfort, and operational energy demand. One of the primary indicators used to describe the thermal behaviour of building elements is the thermal transmittance, commonly referred to as the U-value. This value represents the rate of heat transfer through a building component per unit area under steady-state conditions, driven by the temperature difference between the interior and exterior environments. It is expressed in W/m^2K and reflects the overall ability of a structure to resist heat flow. A lower U-value indicates better thermal insulation performance and reduced heat loss. The thermal transmittance of a building element depends on the thermal resistance of its individual material layers. Each layer contributes to the total thermal resistance of the assembly, and the U-value is calculated as the inverse of this total resistance. (Song, et al., 2024)

5.7 Underpinning

Underpinning is a construction technique used to strengthen and stabilise the foundations of an existing structure. It is typically applied when the original foundation is no longer capable of safely supporting the imposed loads, or when changes in soil conditions reduce the bearing capacity. In many cases, underpinning involves extending the depth or width of the existing foundation. The method is commonly required in situations such as structural damage, excessive settlement, nearby excavation works, or when additional loads are introduced due to extensions or additional storeys. Despite its advantages, underpinning is considered a technically demanding and high-risk construction process that requires careful design, sequencing and professional execution to avoid structural damage. When properly implemented, however, it can significantly extend the service life of a building and provide a cost-effective alternative to demolition and reconstruction. (Dachowski, 2020)

6 Design Proposal of Extension Strategies

Based on the theoretical principles discussed in Chapter 5 and the functional limitations identified in Chapter 4, this chapter represents the proposed extension design for the existing building. The design approaches explore different architectural and structural solutions while responding to the identified functional constraints, load-bearing principles and material characteristics of the existing structure. Three alternative extension strategies are developed and examined to evaluate their feasibility and performance under the defined theoretical, economic and practical conditions.

6.1 Design Objectives

The primary objective of the design is to improve the spatial performance of the existing building by increasing the usable floor area and creating a more open and flexible living space. The extension is intended to accommodate a higher number of occupants while maintaining comfort, functionality, and efficient manipulation within the building.

From a structural perspective, the extension is designed as an independent system with its own foundation to minimise the impact on the existing load-bearing structure. At the same time, the connection between the new and existing building must ensure functional continuity and a coherent architectural composition.

Another key objective is to evaluate different construction approaches, including traditional on-site construction with masonry units and timber elements, and modular prefabrication. The design aims to compare these methods in terms of construction time, cost efficiency, labour requirements, and structural feasibility. In addition, the project also aims to compare different construction materials used in the design approaches, with a particular focus on material selection and construction method, while supporting the functional requirements of the extension.

6.2 Initial Design Concept

The initial design concept is based on addressing the limited size and functionality of the existing ground floor layout. As previously shown in Figure 1, the original building provides only a relatively small, shared living area, which restricts the usability of the space and limits the number of hosts. To overcome this limitation, the concept proposes a horizontal extension connected to the existing layout. The extension has dimensions of 4 x 5 metres and significantly opens and enlarges the ground floor. It creates a new, spacious living area, allowing for a more flexible arrangement of furniture and supporting multiple functions such as living, dining, and social interaction within a single open space, and it can be seen in Figure 2.

The layout is designed to ensure a clear and direct connection between the existing structure and the new building part, forming a continuous interior environment. However, structurally, the extension is considered an independent system with its own foundation, as introduced earlier in the design objectives. This approach minimises intervention in the existing load-bearing structure and reduces structural risks during construction, while still allowing for a physical and functional connection between the two parts of the building.

For the purpose of ensuring a consistent comparison between the different extension approaches, certain design parameters are kept identical. In all design requests, the foundation system and roof structure remain the same, while the primary difference lies in the choice of wall material. Therefore, by limiting the number of changing parameters, the comparison focuses specifically on the impact of material selection and construction method on structural behaviour, construction efficiency, and overall stability. Furthermore, the evaluation can focus on a more transparent and objective comparison between the different strategies.

Figure 2. The spatial layout of the proposed design

6.3 Extension Strategy with Traditional Construction Method Using Masonry Elements

The first extension strategy applies a traditional on-site construction method using masonry elements as the primary load-bearing system. For simplicity, this approach follows the structural logic of the existing building, ensuring compatibility in terms of material selection, construction techniques, and architectural appearance. The extension is designed as a structurally independent unit with its own foundation system. This configuration reduces construction complexity and ensures that the extension integrates effectively with the existing building. Despite that some materials were kept identical, for the roof structure, an independent design had to be carried out to ensure that the extended area's height would not exceed the allowed limitations.

A separation, so-called dilation gap of approximately 20 mm, is introduced between the new and the existing building, as shown in the detail drawing in Appendix 2/1-5. This detail allows independent structural behaviour of the extension and accommodates potential differential settlement and movement between the new and existing structure.

6.3.1 The Roof Structure of the Extended Room with Masonry Elements

The roof of the proposed extension is designed as a mono-pitched timber structure with an approximate slope of 9°, inclining in the longitudinal direction of the building, as shown in the roof plan in Appendix 2/1-5. The relatively low slope allows control over the overall height of the extension and ensures compatibility with the existing building, particularly with respect to the upper-floor window, as presented in Appendix 2/1-5, while still enabling controlled drainage of rainwater. The geometry of the roof is defined by the rectangular plan dimensions of approximately 5 x 4.35 metres, which correspond to the footprint of the extension.

From a structural perspective, the roof is formed by C24 timber rafters, arranged at a regular spacing of approximately 0.7 metres. These rafters span between wall plates along the longitudinal edges of the structure, forming a simple and clear load path. Therefore, the loads acting on the roof, including self-weight, snow load, and wind load, are transferred through the rafters to the wall plates and further to the vertical load-bearing elements of the extension.

The outer covering consists of ceramic roof tiles installed on timber battens and counter battens, creating a continuous ventilation gap beneath the covering. This ventilation layer is essential for moisture control and prevents the accumulation of condensation within the roof structure. A waterproofing membrane is positioned beneath the battens to ensure additional protection against water penetration.

As can be seen in Appendix 2/1-5, the ceiling structure below the rafters is thermally insulated using mineral wool, with a total thickness of 300 mm. A vapour barrier is installed on the warm side to control vapour diffusion and prevent condensation. Internally, the structure is stabilised by a double layer of OSB sheeting and finished with a suspended gypsum board layer.

Due to the height constraints imposed by the existing building, particularly the requirement to remain below the upper-floor window, the available wall height was insufficient to accommodate a standard door opening. As a result, a window was introduced instead of a door at this location. Consequently, the integration of a terrace connection was not feasible within this approach, which means that this design decision represents a limitation of the masonry-based approach, as it restricts the functional flexibility of the extension.

From a structural analysis perspective, the timber roof structure was designed as a lightweight mono-pitched system, selected to provide an efficient load-bearing solution while minimising structural weight and reducing loads transferred to the foundation. The use of timber elements allows for a simple structural arrangement and ease of construction, making it suitable for the proposed extension.

The structural design was carried out using the Dlubal RFEM software in accordance with Eurocode standards and the Slovak National Annex. The determination of loads, including permanent, variable, and environmental actions, was based on Eurocode 1991-1-1 (SFS EN 1991-1-1, 2002) and its Slovak National Annex. The use of these standards ensured a clear and systematic definition of load values, making it straightforward to establish realistic loading conditions for the structure. Therefore, the obtained load values and coefficients were implemented into the RFEM model, where load cases and combinations were automatically generated using Eurocode 1990 (SFS EN 1990-1-1, 2002). This approach allowed for efficient identification of the most unfavourable load combinations, ensuring that the structure was assessed under critical design scenarios.

The structural analysis was based on timber material properties corresponding to strength class C24, which provides a balanced combination of strength and stiffness for residential roof structures. The characteristic values for bending, compression, and shear, together with the elastic and shear modulus, were used to present the mechanical behaviour of the material accurately. (Swedish Wood, 2022) According to Eurocode (SFS EN 1995-1-1, 2004), the service class and modification factor were applied to reflect the expected environmental conditions, ensuring that the design realistically accounts for moisture influence and long-term performance.

The composition of the roof structure, as previously discussed, consists of timber rafters with a cross-section of 100 x 200 mm, supported by wall plates. The structural analysis, which can be seen in Appendix 2/1-5, focused on the verification of the main load-bearing elements under ultimate limit state conditions. The most unfavourable internal forces, shear forces, and bending moments, were obtained from the RFEM simulation. Therefore, the rafters were checked for compression, shear and bending resistance, as well as for combined loading and lateral torsional buckling. More specifically, the utilisation ratios for the rafter are approximately 0.75% for compression, 2.79% for shear, and 2.8% for bending, indicating that the member is significantly under its design capacity. Afterwards, similarly, the wall plate was verified for shear and bending resistance in accordance with the standards that were used before, with a maximum utilisation ratio of approximately 21.5%, which also satisfies the design requirements. No critical instability or failure modes were identified.

It should be noted that, due to the relatively small scale of the structure, the use of smaller cross-sections or lower strength timber classes could be considered sufficient from a purely structural perspective. However, in this case, standardised dimensions and material properties were intentionally adopted to ensure simplicity in design and construction, as well as compliance with commonly used building practices. As a result, the utilisation ratios remain relatively low and well within the allowable design limits.

6.3.2 The Wall Structure of the Extended Room with Masonry Elements

The structural system of the proposed extension is based on load-bearing masonry walls with a thickness of 250 mm and are constructed using Porotherm Profi masonry units, which provide sufficient compressive strength for low-rise residential construction. Furthermore, this material is selected due to its structural reliability, dimensional accuracy, and compatibility with the existing building, allowing for a consistent load-bearing system and simplified construction process.

To achieve the required thermal performance, the external walls are insulated with an external thermal insulation system, finished with an exterior plaster layer. This configuration improves the overall energy performance of the building envelope while maintaining the structural efficiency of the masonry core. Following this, the internal surface of the wall is finished with a plaster layer. In addition, all monolithic structural elements are externally insulated, as can be observed in the detail drawings in Appendix 2/1-5.

The load-bearing system of the proposed extension consists of ceramic masonry walls designed to transfer vertical and horizontal loads from the roof structure to the foundation. The structural design calculation was carried out in accordance with Eurocode 1996 (SFS EN 1996-1-1, 2024) and the Slovak National Annex, ensuring compliance with the relevant design requirements.

The analysis was based on masonry-constructed ceramic blocks with a thickness of 250 mm and a maximum wall height of 2.5 meters. The material properties were defined using manufacturer data and European standard provisions, resulting in a characteristic compressive strength of approximately 4.39 MPa and a design compressive strength of 2.2

MPa. Meanwhile, the loading conditions included vertical loads from the roof structure, ring beam, and self-weight of the masonry, as well as horizontal loads due to wind action. These loads were combined according to ultimate limit state requirements. The analysis considered the combined effect of axial compression and bending caused by load eccentricities, which were evaluated at the top, middle, and bottom sections of the wall. Consequently, the results show that all verification criteria are satisfied. More specifically, the utilisation ratios are approximately 2.53% at the top, 2.36% at mid-height, and 3.12% at the base of the wall, indicating that the structure remains stable within the allowable design limits.

To support the accuracy of the calculations, a design tool provided by Porotherm Slovakia was used as a reference for verification purposes. Although the tool is available only in Slovak language, it served as a guideline for checking the consistency of the manually performed calculations, which were carried out in accordance with Eurocode 1996. This approach ensured both transparency and reliability of the structural design process, as it can be observed in Appendix 2/1-5.

6.3.3 Foundation Design

The extension is supported by a strip foundation system, which is selected due to its suitability for load-bearing masonry structures and its simplicity in construction. This type of foundation provides a continuous load transfer from the vertical structural elements to the ground, ensuring stable and uniform distribution of loads.

The foundation is constructed using cat-in-place concrete and it is placed on a prepared gravel bedding layer, which improves load distribution and reduces the risk of differential settlement. In addition, a drainage system is incorporated to prevent water accumulation around the foundation, while above the foundation level, the floor structure is designed as a layered system. The reinforced concrete slab acts as the primary horizontal load-bearing element, while the additional layers provide thermal insulation, moisture protection, and support for the underfloor heating system. Moreover, to protect the structure against ground moisture, pressure water, and radon, a waterproofing membrane is applied above the base concrete layer. This layer ensures the continuity of moisture protection and contributes to the durability and indoor environmental quality of the building.

The design assumes that the groundwater level does not reach the foundation level. Therefore, standard soil conditions are considered, and the foundation system is designed accordingly. In cases where the foundation depth does not reach the frost-free level, additional gravel filling is applied to prevent frost-related damage. The dimensions and detailed systems used are shown in the foundation and detail drawings, in Appendix 2/1-5.

A verification that is based on Eurocode 1997 was carried out regarding the bearing capacity of the subsoil under the applied loads. The combined effect of loads from the superstructure, masonry walls, plinth elements, and the footing resulted in a total design line load of approximately 26.82 kN/m acting on the soil, as the calculation shows in Appendix 2/1-5. The design bearing resistance of the soil was taken as 150 kPa, based on data obtained from the existing project documentation, as stated in Appendix 2/1-5. As a result of the calculations, the allowable soil bearing capacity shows a utilisation ratio of approximately 29.8%, indicating that the load remains satisfying within the design limits. Therefore, the low utilisation ratio reflects the relatively small structural demand and confirms that the selected foundation dimensions are adequate for the given conditions.

6.3.4 Connection of the Masonry Elements to the Existing Structure

The connection between the existing building and the extension is resolved through a detailed junction design, with particular attention to the continuity of the building envelope. At the interface of the two structures, the alignment of thermal insulation layers is ensured to minimise thermal bridging and maintain consistent thermal performance across the connection. Waterproofing is achieved by extending the membrane layers across the junction, preventing moisture penetration at the connection point, while airtightness is maintained through the application of flexible sealing layers capable of accommodating minor deformations without compromising the integrity of the envelope.

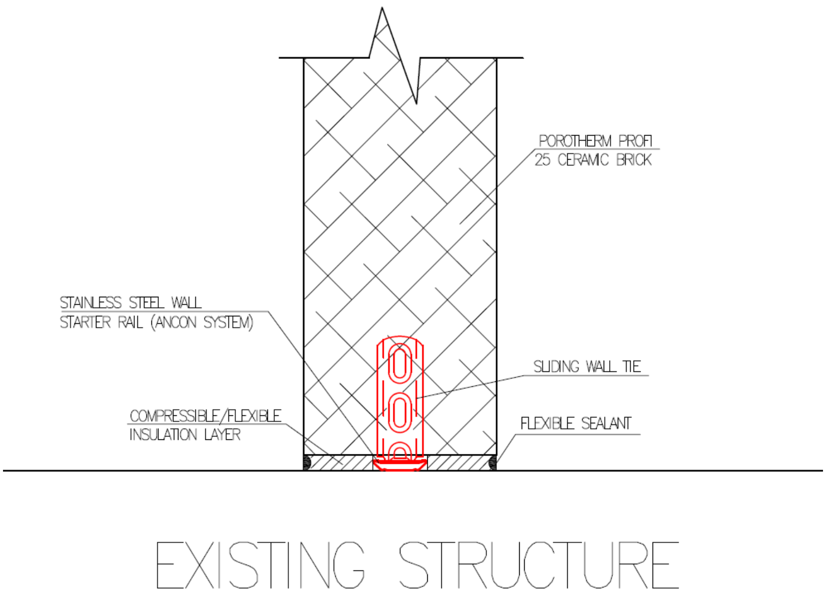
From a structural perspective, the extension is designed as an independent load-bearing system with its own foundation, and therefore, it does not rely on the existing building for vertical load transfer. Consequently, a rigid structural connection between the existing and the new masonry walls is intentionally avoided. Instead, a movement joint of approximately 20 mm is introduced between the two interfaces, allowing for differential settlement and thermal expansion. This separation is essential to prevent the accumulation of stresses at the interface, which could otherwise lead to cracking and long-term structural damage in the masonry elements.

To ensure the lateral stability of the extension while still maintaining the structural independence, sleeved wall ties, which can be seen in Figure 3, are applied across the joint. These elements provide resistance to horizontal actions, such as wind loads, while allowing relative movement between the connected walls. This approach is consistent with established masonry design principles, where sleeved ties are used across movement joints to provide stability without creating a rigid connection between adjacent structures. (Morton, 2012, p. 74)

Figure 3. Sleeve wall ties – 36/8 Wall Extension System (Ancon, n.d.)

The joint is filled with a compressible backing material and sealed with a flexible sealant, ensuring watertightness and airtightness while accommodating movement. The detailed drawing of the connection design is illustrated in Figure 4, where the layer configuration and transitions between materials are presented in more detail.

Figure 4. Connection of the new masonry frame to the existing masonry structure



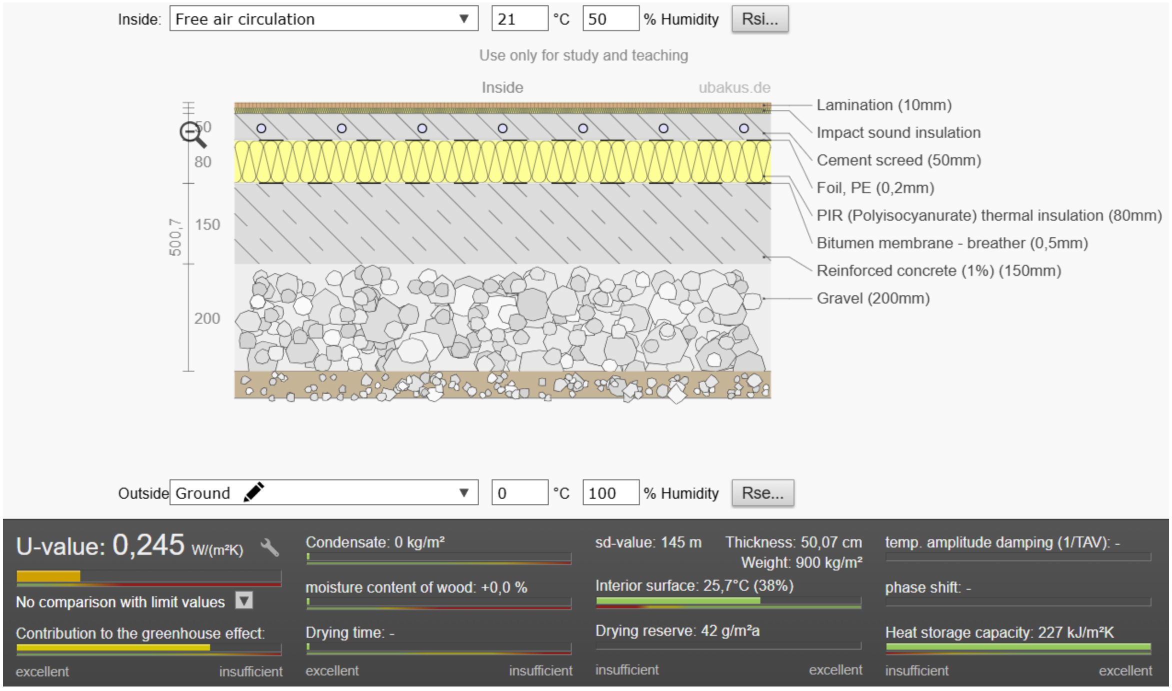
Although the extension is designed as a structurally independent system, the wall tie at the interface introduces a minor load transfer to the existing building. However, the magnitude of this load is negligible compared to the load-bearing capacity of the existing building and therefore does not significantly influence its structural behaviour. For this reason, no further structural reinforcement or detailed analysis of the existing building was required in this context. The verification of these load effects, including the evaluation of the pressure zone and the corresponding load values, is presented in Appendix 5/1-5.

6.3.5 Thermal Analysis of the Masonry Construction Approach

The thermal performance of the building envelope was analysed based on a detailed assessment of thermal transmittance across its individual layers. This approach allowed for a better understanding of how each component contributes to the overall behaviour of the structure. In addition to the U-value calculation, the distribution of temperature and relative humidity within the layers was examined. Attention was given to moisture protection and the potential occurrence of interstitial condensation, as these factors play a key role in the long-term performance and durability of the construction. The building envelope is composed of multiple layers, each serving a distinct purpose, such as structural support, insulation, or moisture control, while the thicknesses of selected materials were adjusted to achieve the required thermal performance. These requirements are defined by national regulations, which specify the acceptable limits for thermal transmittance. In Slovakia, the relevant limits are set out in STN 73 0540-2 (2012). The evaluation focuses on the masonry-based construction approach, considering the external wall, roof, and the ground-supported floor assemblies.

The ground-supported floor, which can be seen in Figure 5, is composed of a reinforced concrete slab with integrated thermal insulation and waterproofing layers, forming a multilayer system that ensures adequate load-bearing capacity while reducing heat loss to the ground and preventing moisture ingress. The structure includes a gravel base layer, a reinforced concrete slab, a bitumen membrane, PIR thermal insulation, and finishing layers above, as shown previously. The calculated U-value of the floor is 0.245 W/m²K, which, according to STN 73 0540-2 (2012) complies with the Slovak thermal transmittance limit for floors in contact with the ground. In addition, no interstitial condensation was observed within the structure, indicating appropriate moisture behaviour and sufficient durability of the designed floor assembly.

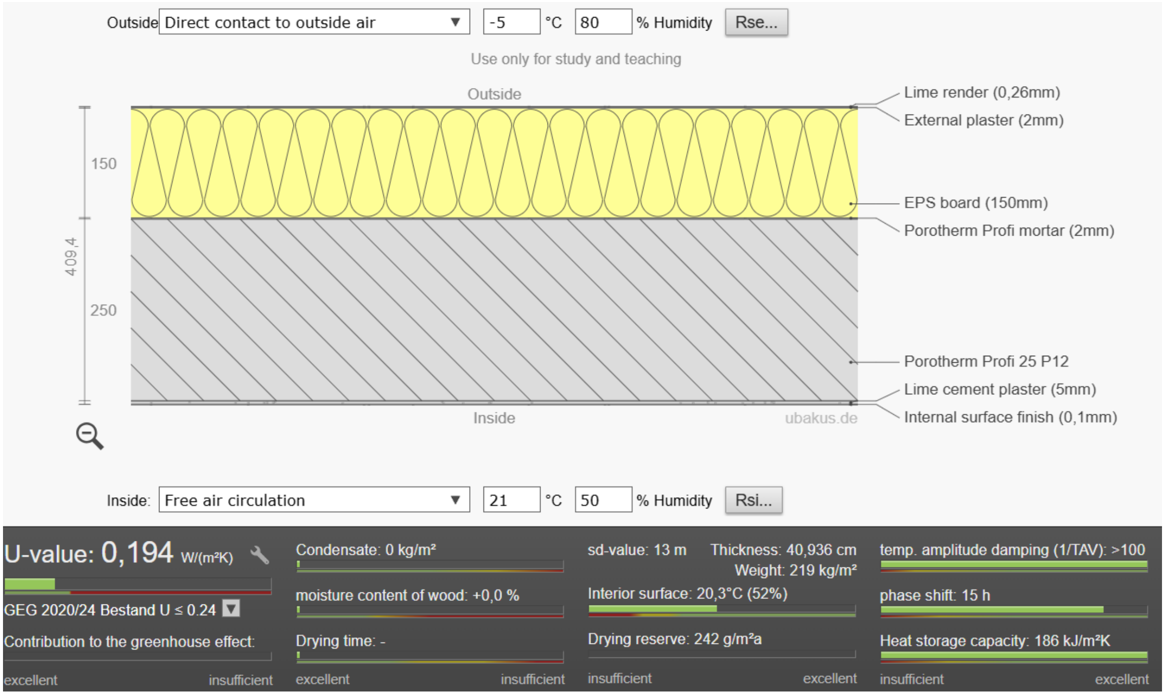
Figure 5. Ground floor structure for masonry and timber-based extension construction approach



The external wall structure is designed to ensure structural stability, effective thermal insulation, and protection against external environmental conditions. Thermal bridges are minimised through the use of insulated lintels, careful corner detailing, and a consistent insulation layer across the entire façade. In addition, the connection between the existing building and the new extension is sufficiently insulated to prevent heat loss and reduce the risk of thermal bridging at the junction. The detailing also ensures a high level of airtightness, particularly around window and door openings, where continuous insulation is maintained.

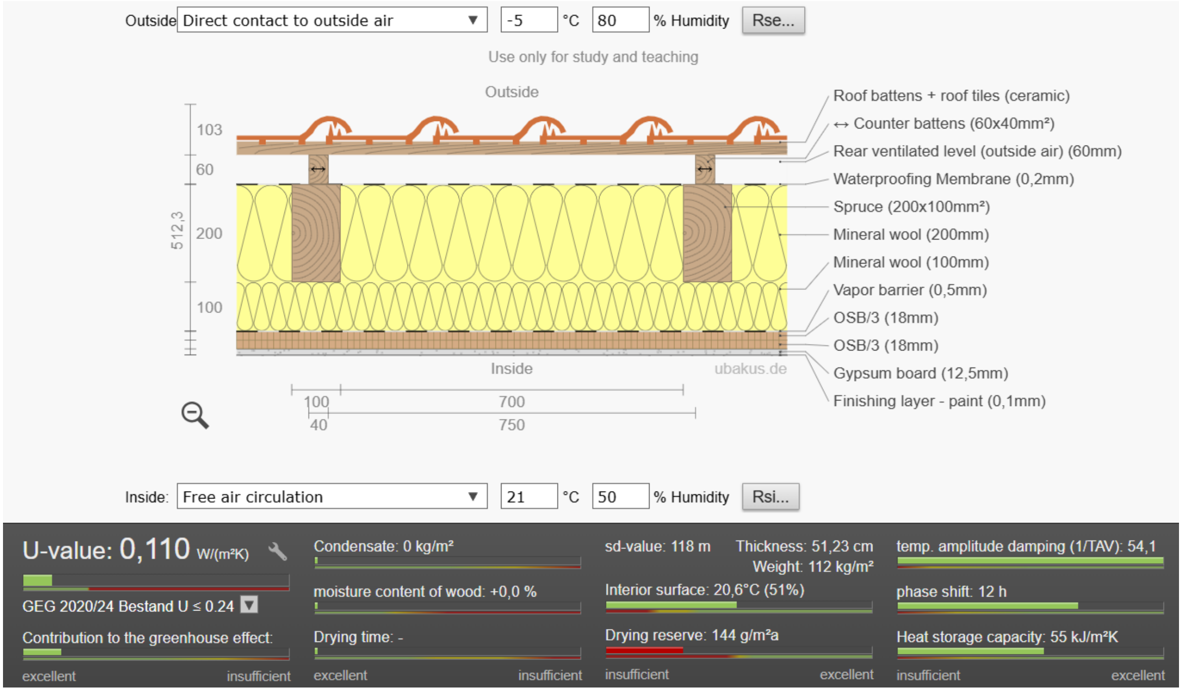
The wall, shown in Figure 6, is composed of 250 mm thick load-bearing Porotherm masonry units combined with a 150 mm external EPS thermal insulation layer, in the same way as it was used previously in the existing building. This multilayer configuration provides both structural stability and effective thermal insulation. The calculated U-value of the wall is 0.194 W/m²K, which complies with the values provided by the Slovak thermal performance requirements. Furthermore, no internal condensation was observed, confirming appropriate moisture behaviour and supporting the long-term durability of the wall assembly.

Figure 6. Wall structure for masonry extension construction approach



The roof structure follows the configuration described in Chapter 6.3.1, consisting of a mono-pitched timber system with a ventilated air layer, mineral wool insulation, and appropriate moisture protection layers, as it is presented in Figure 7. The ventilated cavity improves moisture control and contributes to the long-term durability of the structure. With the calculated U-value of 0.110 W/m²K, the roof structure meets the Slovak thermal performance criteria. The analysis also shows no occurrence of internal condensation, demonstrating adequate moisture behaviour of the structure.

Figure 7. Roof structure of the proposed design



6.3.6 Environmental Effects of Masonry Components

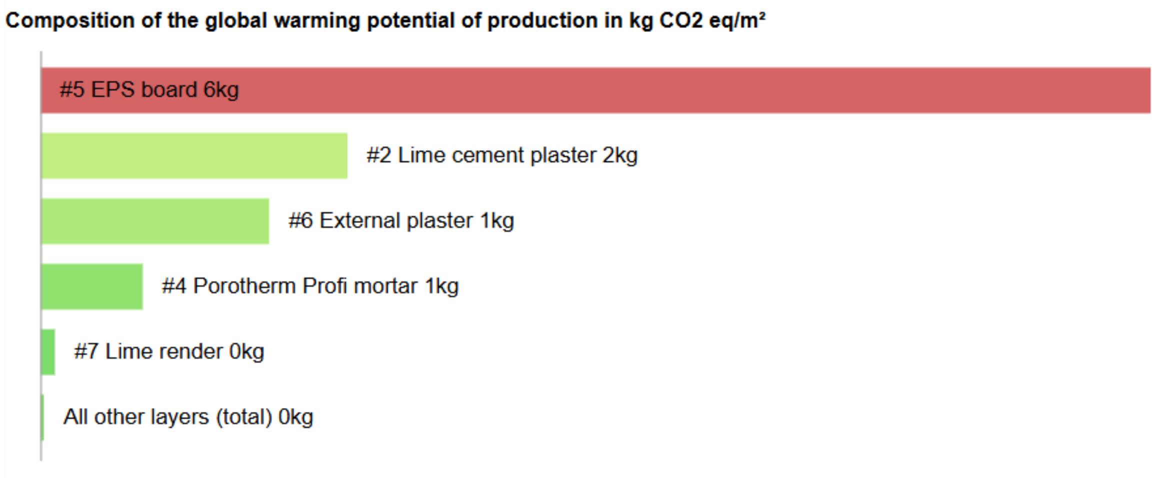
The environmental impact of the masonry construction approach is assessed based on the material characteristics and construction process of the proposed extension. Masonry materials, such as ceramic bricks and mortar, are widely used in residential construction due to their durability, availability, and long service life. (Mineral Products Association, 2024) However, their production involves energy-intensive processes, particularly during the firing of ceramic units, which contributes to increased carbon emissions and overall environmental burden. (Alves et al., 2025)

A more detailed understanding of the environmental performance can be obtained by analysing the contribution of individual layers to the global warming potential. According to the analysed layer composition, obtained from Ubakus software, shown in Figure 8, the environmental impact of the wall assembly is not dominated by the masonry units themselves, but by the thermal insulation layer, particularly EPS boards, which contribute the largest share.

From a lifecycle perspective, this observation highlights that, although masonry is often associated with high embodied energy, auxiliary materials used in the building envelope may have even greater environmental impact in certain configurations. (Estokova & Fabianova, 2024) Nevertheless, masonry structures offer advantages in terms of durability and low maintenance requirements. The long lifespan of masonry elements reduces the need for frequent replacement, which can partially offset the initial environmental impact associated with material production. In addition, masonry materials are non-combustible and provide good thermal mass, which can contribute to improved energy efficiency during the operational phase of the building by stabilising indoor temperature fluctuations. (Fangrat, 2016)

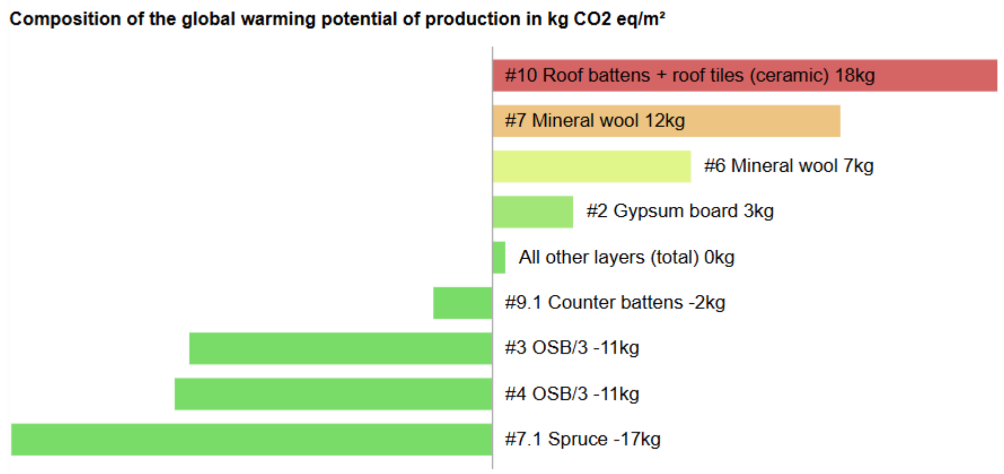
On the other hand, the construction process of masonry systems is typically labour-intensive and involves wet processes, such as mortar application and plastering. These processes require significant water consumption and extend construction time, which may increase further the environmental impact. Furthermore, waste generation is another relevant factor in the environmental assessment. Although masonry units can be cut and adjusted on-site, this often results in material waste. While some masonry waste can be recycled or reused as aggregate, the recycling process is not always efficient or widely implemented. (Abbas, 2025)

Figure 8. Composition of the global warming potential of the masonry structure



According to the analysed layer composition, as shown in Figure 9, the overall environmental impact is mainly influenced by the roofing covering and insulation materials, rather than a single dominant component. The largest contribution is associated with the ceramic roof tiles and supporting battens, which can be explained by the energy-intensive production processes of ceramic materials, particularly high-temperature firing, as discussed before. In addition, insulation materials, such as mineral wool, also represent a significant share of the environmental impact due to their embodied energy. In contrast, timber-based components, such as spruce elements, may have a negative contribution to global warming potential due to their capacity to store biogenic carbon. (Hurmekoski et al. 2022) As a result, the environmental performance of the roof structure reflects a balance between high-impact industrial materials and carbon-storing natural materials. From a lifecycle perspective, this indicates that the environmental impact of roof assemblies is strongly dependent on material selection and the combination of components.

Figure 9. Composition of the global warming potential of the roof structure



6.3.7 Cost Analysis of the Masonry Construction Approach

The cost analysis of the masonry construction approach was carried out based on detailed calculations using Cenkros software, considering both material and labour costs for the individual construction elements.

The total cost of the masonry extension is approximately €22 942, excluding VAT, with foundation works representing the largest share, as it can be seen in Figure 10. Other significant cost components include all major construction works such as structural elements, thermal insulation, surface finishes, carpentry works and roof construction. The masonry construction method requires a considerable amount of on-site labour, particularly for wall construction, plastering and concrete works. This results in increased labour intensity and longer construction time compared to other solutions. Furthermore, wet construction processes contribute to extended project duration and additional costs related to curing and installation time.

Figure 10. Cost analysis for masonry extension approach (Obtained from Cenkros software)

Thesis - masonry	22,941.89
Assemblies and Supplies PCW	12,087.89
Earthworks	179.59
Foundation works	5,997.68
Vertical structures	1,837.59
Horizontal structures	844.43
Surface finishes, flooring, and installation	3,093.56
Other structures and works – demolition	135.04
Assemblies and Supplies SCW	10,854.00
Protection against water and moisture	332.18
Thermal insulation	2,294.32
Soundproofing and vibration protection measures	494.07
Roof insulation and membrane coverings	156.78
Carpentry structures	2,500.56
Timber structures	709.53
Hard coverings	2,320.61
Timber coverings	1,322.69
Strip and parquet flooring	420.74
Coatings	64.86
Paint finishes	237.66

6.4 Extension Strategy with Traditional Construction Method Using Timber Elements

The second extension strategy applies a traditional on-site construction method using timber elements as the primary load-bearing system. This approach differs from the existing building in terms of material selection, introducing a lightweight structural system that offers greater flexibility and reduced structural load.

The extension strategy that uses timber elements is designed as a structurally independent unit with its own foundation system, as defined in the design objectives. This ensures that no additional loads are transferred to the existing building, while allowing a clear structural separation between the two systems. The use of timber elements enables a more adaptable structural design, particularly in relation to height limitations and opening configurations. From an architectural perspective, the structural system allows for the incorporation of a door opening, making the integration of a terrace connection possible. However, to maintain consistency between the different extension strategies and ensure a more objective comparison, the terrace is not included in the final design of the timber-based extension strategy.

Furthermore, a separation gap of 20 mm is introduced between the new and the old structure in this approach, just as was done previously with the masonry method, as shown in the detail drawing in Appendix 3/1-4.

6.4.1 The Roof Structure of the Extended Room with Timber Elements

The roof structure of the timber extension follows the same design principles as described in Chapter 6.3.1. The mono-pitched roof geometry, structural arrangement, and material composition are maintained to ensure consistency with the previously defined solution. The roof is formed by timber rafters spanning between wall plates, with loads transferred through the structural system in the same manner as in the masonry-based approach.

In addition, the layer configuration, including thermal insulation, vapour barrier, and internal finishing, remains unchanged, ensuring comparable thermal performance and construction detailing across the different extension strategies.

6.4.2 The Wall Structure of the Extended Room with Timber Elements

The external wall of the timber construction approach is designed as a lightweight framed structure, providing both load-bearing capacity and thermal insulation. The wall consists of a timber stud frame filled with insulation, combined with internal and external sheeting layers to ensure structural stability and resistance to environmental loads.

On the exterior side, the wall is protected by timber cladding and weather-resistant layers, which protect against moisture and external conditions. The interior side includes a vapour control layer and finishing materials, ensuring proper moisture regulation and airtightness of the structure. The layered composition allows for efficient integration of insulation within the wall thickness while maintaining a relatively low structural weight. However, special attention is given to the construction detailing in order to minimise thermal bridges, particularly at junctions. The connection between the old load-bearing system and the new timber extension is also designed carefully and insulated to reduce heat loss and ensure continuity of the building envelope. Furthermore, the timber wall system offers a light and more flexible solution, allowing faster construction and reduced loads coming to the footings.

From a structural aspect, the load-bearing system of the timber wall consists of vertical timber studs designed to transfer vertical loads from the roof structure to the foundation while also resisting horizontal wind loads. The structural analysis was carried out in accordance with Eurocode 1995-1-1 and the Slovak National Annex. The wall structure is composed of timber studs with a cross-section of 50 x 160 mm, spaced at 600 mm intervals, as Appendix 3/1-4 presents. The material properties correspond to strength class C24, and the design parameters were defined using European standards. The analysis considered the combined effects of axial compression from vertical loads and bending caused by wind action. The maximum axial force in a stud was approximately 4.56 kN, while the corresponding bending moment was 0.134 kNm. These values were used to evaluate the structural performance under ultimate limit state conditions. The verification results show that all design criteria are satisfied. More specifically, the utilisation ratios are approximately 3.92% for compression and 3.77% for bending, with combined loading conditions also meeting the required interaction criteria. In addition, buckling verification was performed, confirming that the stability requirements are fulfilled in both principal directions.

It should be noted that in this case, the utilisation ratios are also relatively low, reflecting the modest load demand of the structure. From a structural perspective, smaller cross-sections or lower-strength timber classes could be reasonable to use. However, the selected configuration follows standard construction practices and ensures simplicity and compatibility with typical timber frame systems.

6.4.3 Foundation Design

The foundation design of the timber extension corresponds to the solution previously described in Chapter 6.3.3. The same strip foundation system is used, with identical material composition, dimensions, and structural configuration, ensuring a consistent design approach across the different extension strategies.

6.4.4 Connection of the Timber Elements to the Existing Structure

The timber extension is connected to the existing building using the same general principle as the masonry extension: the new structure remains fully independent, and no vertical loads are transferred to the existing building. A movement joint is maintained at the junction to accommodate differential settlement, moisture-related timber movement, and thermal expansion between the old and new structures.

In this case, the connection is formed by mechanical steel fixing elements, which can be seen in Figure 11 and 12, that provide positional stability and lateral restraint, while still allowing limited relative movement between the structures. The joint is therefore not designed as a rigid structural connection, but as a controlled interface between two independent systems. The separation gap is filled with a compressible mineral wool strip, which provides thermal insulation while allowing movement within the joint. Therefore, the joint is not sealed by flexible sealant alone, as the sealant may deteriorate over time due to environmental exposure and movement. On the interior side, the joint is covered by the internal wall build-up, including finishing layers, which ensure airtightness and visual continuity. On the exterior side, the connection is protected by the timber cladding system, which acts as a weather-resistant layer and shields the joint from direct environmental exposure.

Figure 11. The first alternative of the movement joint connected to the timber wall

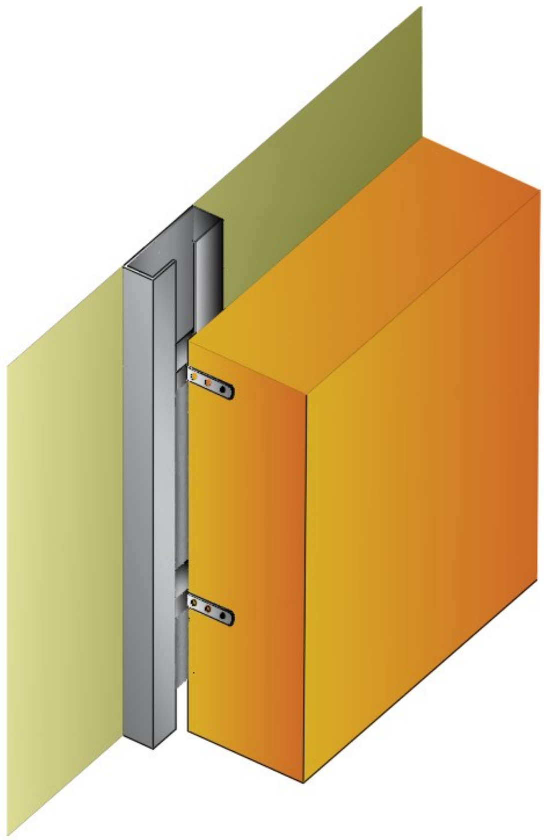
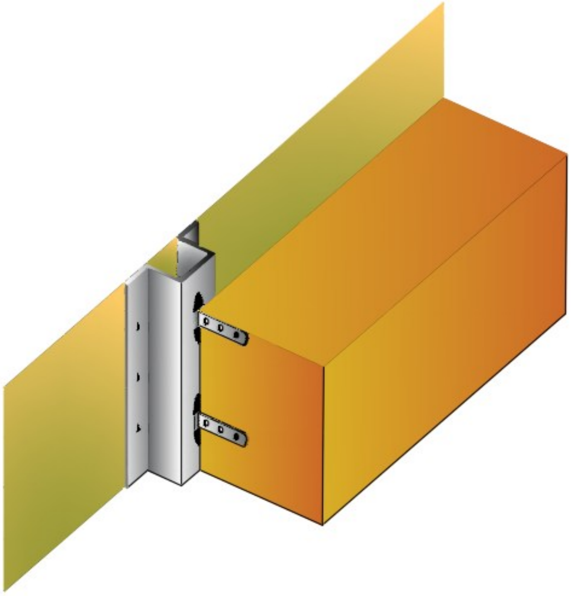


Figure 12. The second alternative of the movement joint connected to the timber wall

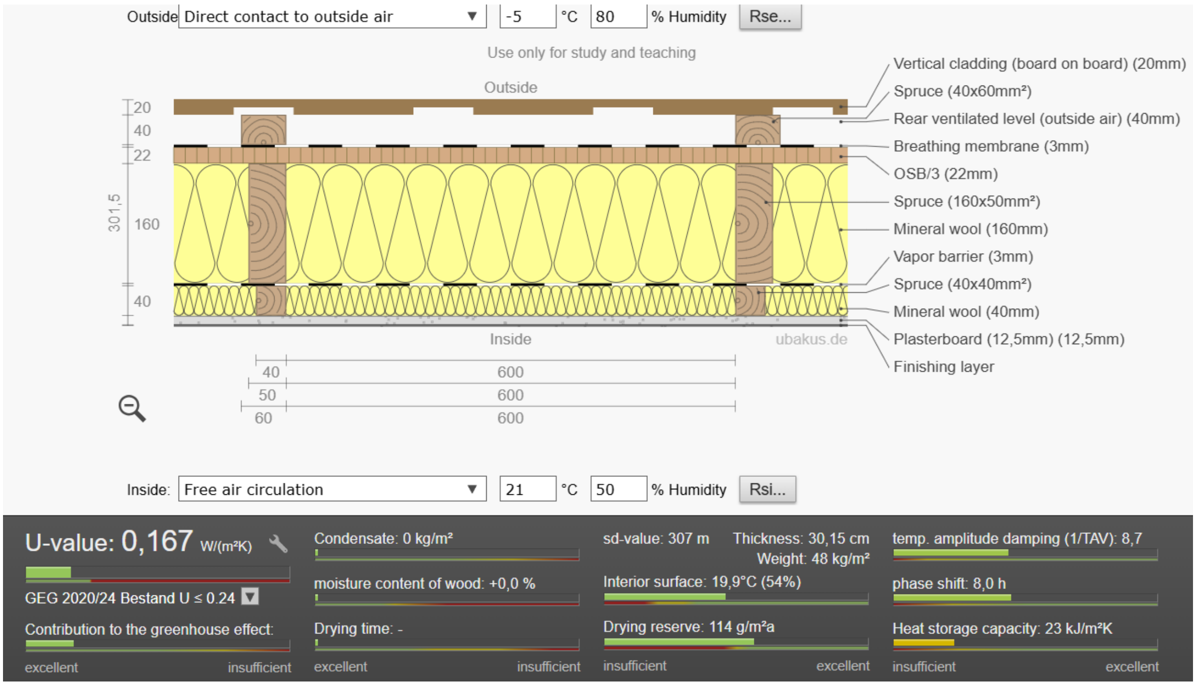


6.4.5 Thermal Analysis of the Timber Construction Approach

Since the roof and ground-supported floor assemblies are identical to those used in the masonry construction approach, their thermal performance is not described separately in this section and can be found in Chapter 6.3.5.

However, the thermal performance of the timber wall was evaluated based on a layer-by-layer analysis of the assembly. The calculated U-value is 0.167 W/m²K, which satisfies the Slovak thermal performance requirements and indicates a good level of thermal insulation. In addition, no interstitial condensation was observed within the structure, confirming that the wall assembly provides appropriate moisture behaviour under the given boundary conditions. The presence of a ventilated cavity on the exterior side further contributes to moisture control by allowing air circulation and reducing the risk of moisture accumulation within the structure. The results, which are presented in Figure 13, therefore, demonstrate that the combination of mineral wool insulation within the timber frame and additional internal insulation layers provides an effective thermal solution. Due to the relatively low thermal mass of the timber structure, the wall is expected to respond more quickly to changes in external temperature compared to heavier constructions. This characteristic may influence indoor thermal stability but contributes to efficient heating performance.

Figure 13. Wall structure for the timber construction approach

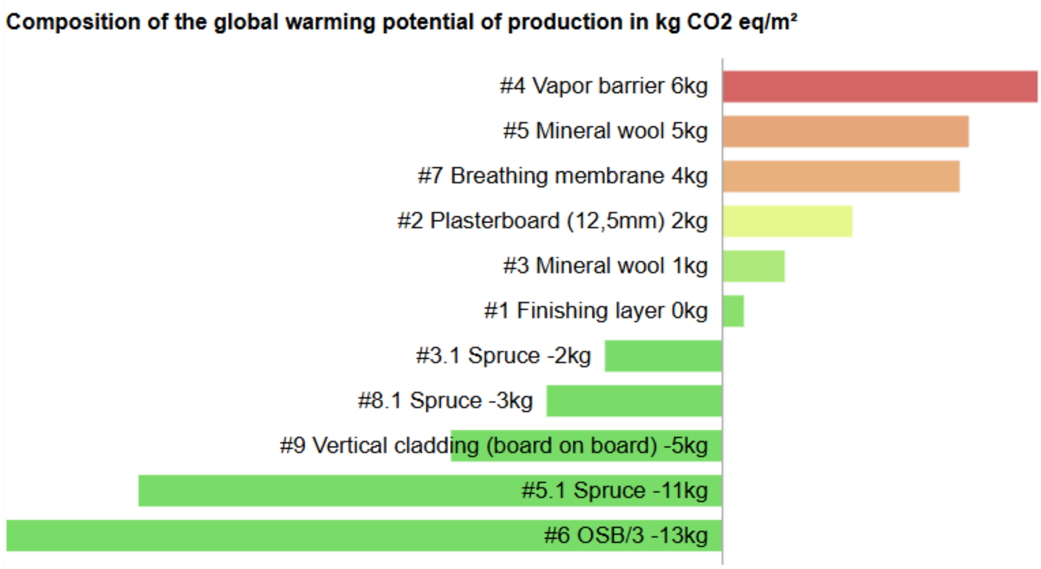


6.4.6 Environmental Effects of Timber Components

As shown in Figure 14, the environmental performance of the wall is influenced by the combined contribution of different materials. The highest positive contributions are associated with non-structural layers, such as the vapour barrier, mineral wool and breather membrane, which exhibit notable embodied carbon due to their industrial production process. In contrast, timber-based elements, including spruce components and OSB boards, show negative contributions to the global warming potential. This is primarily due to their capacity to store biogenic carbon, effectively acting as temporary carbon sinks within the building structure. (Hurmekoski et al., 2022) Consequently, the overall performance of the timber wall represents a balance between carbon-intensive industrial materials and carbon-storing natural components. From a lifecycle perspective, this underlines the potential of timber construction to reduce the environmental impact of building envelopes, provided that material selection and composition are carefully optimised.

It should be noted that the roof structure applied in this construction approach is identical to that used in the masonry case. Therefore, the global warming potential is associated with the roof assembly remaining unchanged and is not influenced by the change in the wall construction system.

Figure 14. Composition of the global warming potential of timber frame walls



6.4.7 Cost Analysis of the Timber Construction Approach

The total construction cost of the timber extension method resulted in a final sum of approximately €25 000, excluding VAT, as it can be observed in Figure 15, from which the largest contribution is associated with the foundation works. This highlights that, despite the lightweight nature of timber superstructures, the foundation still represents a significant portion of the total cost. Other notable cost components include thermal insulation, surface finishes and carpentry works, all of which contribute substantially to the final budget. In contrast, the cost of the primary vertical and horizontal timber structural elements remains relatively low compared to the overall budget. This indicates that the structural system itself is not the dominant cost driver, and that auxiliary systems and finishing layers have a greater financial impact.

Figure 15. Cost analysis for the timber construction approach (Obtained from Cenkros software)

Description	Total price
Thesis - timber	25,007.75
Assemblies and Supplies PCW	9,930.88
Earthworks	179.59
Foundation works	6,024.81
Vertical structures	1,174.09
Horizontal structures	379.80
Surface Finishes, Flooring, and installation	2,037.55
Other structures and works – demolition	135.04
Assemblies and Supplies SCW	15,076.87
Protection against water and moisture	1,100.43
Thermal insulation	3,100.68
Soundproofing and vibration protection measures	494.07
Roof insulation and membrane coverings	156.78
Carpentry structures	2,500.56
Timber structures	709.53
Hard coverings	2,320.61
Timber coverings	1,846.76
Strip and parquet flooring	420.74
Coatings	64.86
Painting finishes	102.01
Wall cladding	2,259.84

6.5 Extension Strategy with Modular Sections

The third extension strategy investigates the application of modular construction using prefabricated building sections. In contrast to the previously described masonry and timber approaches, which rely on traditional on-site construction methods, this solution is based on factory-produced volumetric units that are transported to the site and assembled to form the final structure. These modules are designed as integrated systems, in which structural elements, insulation layers, and internal finishes are combined into a single unit. (Staib et. al, 2008, p. 43)

In this approach, modular units function as complete structural entities, often described as closed systems, where individual components are pre-designed and assembled into fully functional building sections. As a result, each module can carry its own loads through its internal structural configuration, forming a self-supporting unit within the overall building system. (Lacey et al., 2018)

For the purpose of this study, the modular system is developed based on solutions provided by the company Modulix and HCT s.r.o., allowing the design to reflect realistic construction practices and currently available technologies. In addition, consultation was carried out with these companies regarding the composition of wall assemblies, connection details, and other relevant design aspects. During this process, practical considerations related to prefabrication, assembly, and material selection were also discussed. The input received was used to support the development of the proposed modular solution and to ensure that the design remains consistent with current industry practices.

6.5.1 Modular Section Analysis

The modular extension is designed as a prefabricated volumetric unit with approximate plan dimensions of 4 x 5 m, as it can be observed in Appendix 4/1-5, which is attached to the building while maintaining structural independence. The module acts as a self-supporting structural system, transferring loads through its walls and floor structure to the foundations. The load-bearing system is based on an integrated structural framework, where the walls, floor, and roof elements form a unified system. Due to this configuration, loads are distributed within the module and transferred to the footings at defined support zones along the perimeter.

Unlike traditional construction, where structural elements are assembled on-site, the modular unit is prefabricated off-site under controlled conditions, which ensures consistent material quality and precise assembly. Although a detailed structural calculation of the module was not carried out within this work, the system is based on standard prefabricated construction principles, where structural performance is ensured through manufacturer design and compliance with relevant structural codes.

However, the wall assembly of the modular unit is composed of multiple layers arranged from exterior to interior, forming an integrated system that fulfils structural, thermal and moisture control functions. Starting from the exterior, the assembly includes an external cladding layer and a ventilated air cavity, which together protect against environmental exposure and facilitate moisture dissipation. This is followed by a breathable, vapour membrane and a structural sheeting layer, typically consisting of OSB boards. Meanwhile, the primary load-bearing function is ensured by a timber structural frame, within which mineral wool insulation is installed to enhance the thermal performance of the wall. On the interior side, a vapour barrier is applied to maintain airtightness and to limit moisture diffusion into the structure. Finally, the assembly is completed with internal layers, such as plasterboard, and a finishing layer, providing the required interior surface quality.

6.5.2 Foundation Design

In contrast to the previously analysed construction approaches, the foundation design of the modular extension differs in terms of load distribution and structural support conditions. While the previously mentioned strategies required foundation support along only three sides due to the arrangement of load-bearing elements, the modular unit is designed as a fully closed structural system with load-bearing walls along all four sides. Consequently, the loads are transferred continuously along the entire perimeter of the module, which necessitates a strip foundation system on all four sides. Therefore, this configuration ensures a more uniform distribution of loads to the subsoil.

The foundation system consists of reinforced concrete strip footings with typical dimensions of approximately 600 x 600 mm, as shown in Appendix 4/1-5. The strip footings are connected to a reinforced concrete slab, which distributes loads within the footprint of the modular unit. Furthermore, as indicated in the existing foundation documentation, the soil conditions correspond to a design bearing capacity of 150 kPa, just like previously mentioned in Chapter 6.4.3.

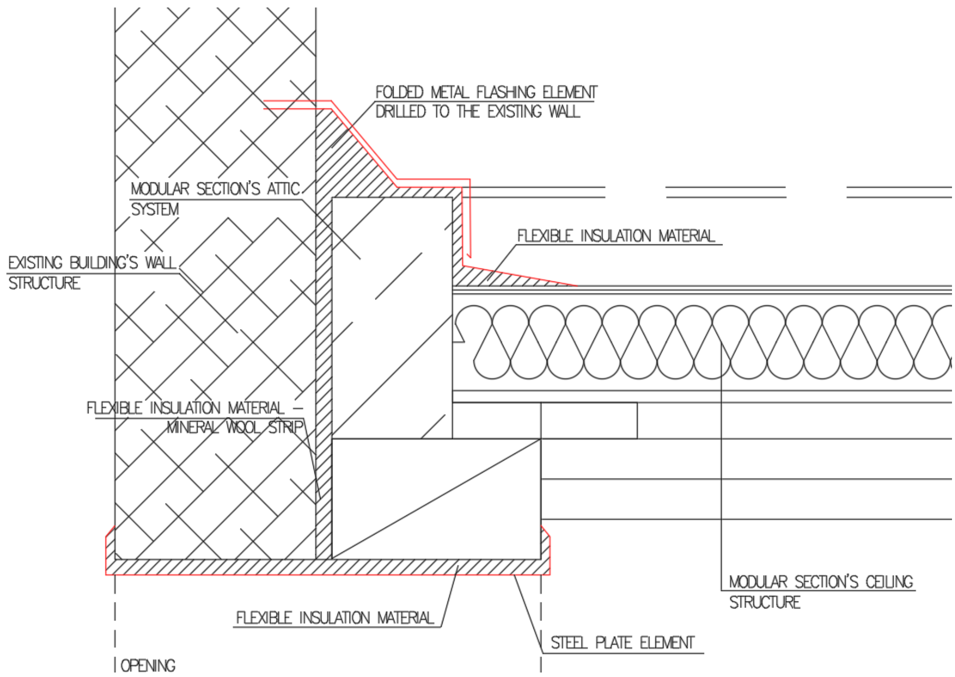
The loading conditions for the modular foundation were determined based on permanent, variable, and environmental conditions. According to the calculations, the total design load acting on the soil is approximately 37.79 kN/m² under ultimate limit state conditions. This value includes the self-weight of the modular unit, the reinforced concrete slab, the strip footing, and additional loads such as snow, wind, and live loads. Therefore, the bearing capacity verification shows a utilisation ratio of approximately 25.19%, as Appendix 4/1-5 shows, which confirms that the applied loads remain well within the allowable limits of the subsoil.

6.5.3 Connection of the Modular Section to the Existing Structure

The connection between the modular extension and the existing building is designed to ensure both structural stability and functional independence, while accommodating differential movement between the two systems. From a structural perspective, the modular unit is stabilised laterally by anchoring its steel frame to the foundation using steel anchor bolts. This solution ensures sufficient resistance against horizontal forces, such as wind loads, while maintaining the overall stability of the module. Furthermore, since the modular unit is designed as a closed structural system with load-bearing elements on four sides, its global stiffness provides sufficient overall stability without relying on the existing building. This differs from the previously analysed masonry and timber extension approaches, where additional measures were required to ensure lateral stability due to the more open structural configuration.

At the interface between the modular unit and the existing building, a separation gap of approximately 20 mm is introduced. This gap allows for differential movement between the structures and reduces the risk of stress accumulation at the connection. The joint is filled with a flexible insulation material, such as compressible mineral wool strips, which ensures airtightness and prevents thermal bridging. In the upper area of the opening in the intersection of the connected areas, as it can be seen in Figure 16, the connection is stabilised using steel plate elements, which provide not only local stability but also ensure proper load transfer around the opening. Meanwhile, the connection at roof level, as also stated in Figure 11, is detailed using folded metal flashing elements, which ensure effective water drainage and prevent moisture penetration at the junction between the two structures.

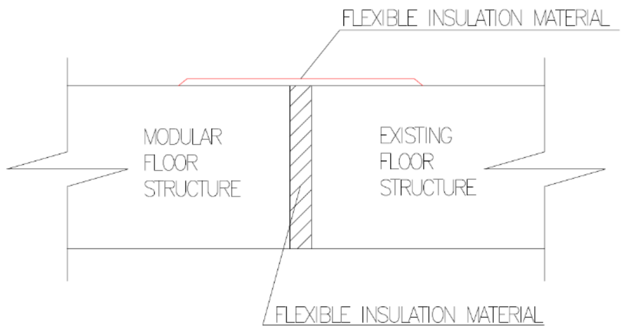
Figure 16. Connection at roof level and above the opening



At floor level, the connection between the existing and the new structure is resolved using a timber transition strip, which provides a continuous and visually coherent floor surface.

Alternatively, an expansion joint may be applied using a metal cover element, shown in Figure 17, which allows the joint to remain functionally effective.

Figure 17. Connection of the floor structure between the new and the existing structure

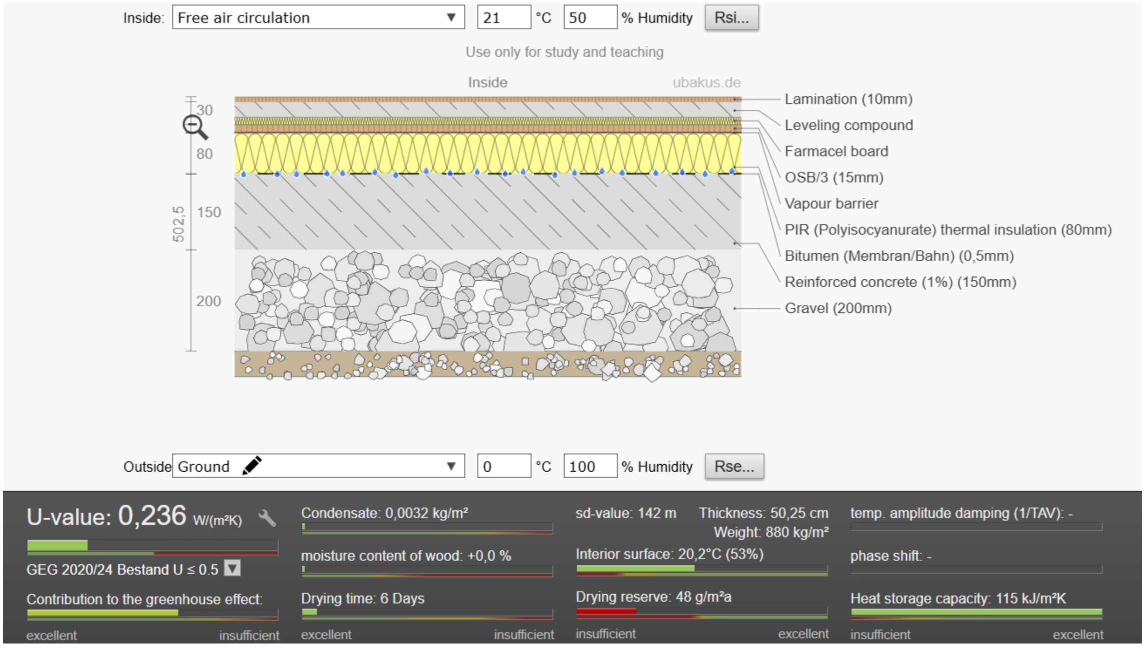


6.5.4 Thermal Analysis of the Modular Section

The thermal performance of the modular extension is analysed based on the individual building envelope components, namely the ground-supported floor, external walls, and roof structure. Unlike the previous construction strategies, the modular system is composed of prefabricated elements, where each structural component is designed as a multilayer assembly with integrated thermal insulation and moisture control. Therefore, the following sections evaluate the thermal behaviour of each structural component separately, focusing on their layer composition and thermal transmittance.

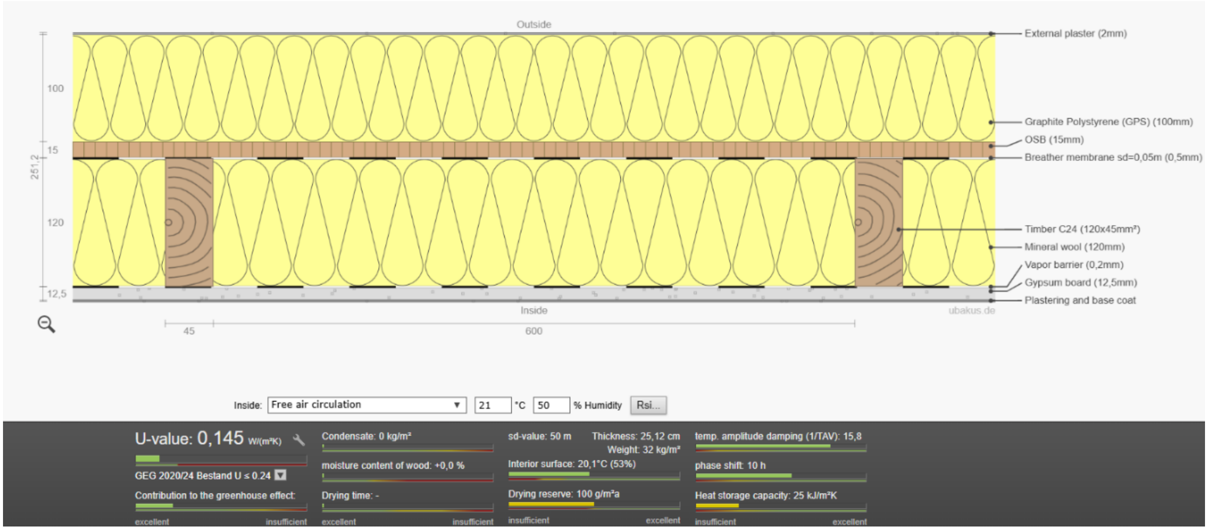
The ground-supported floor of the modular unit is designed as a multilayer system, combining structural, thermal, and moisture protection functions, as Figure 18 shows. The assembly consists of interior finishing layers, structural boards, a vapour barrier, PIR thermal insulation, a bituminous waterproofing membrane, reinforced concrete slab, and a compacted gravel layer. The main thermal insulation is provided by an 80 mm thick PIR layer, which ensures efficient thermal resistance within a relatively small thickness, while moisture protection is achieved through the combination of a vapour barrier and waterproofing membrane, reducing the risk of condensation. Therefore, the calculated thermal transmittance of the floor is approximately 0.236 W/m²K, which complies with the requirements of the national annex and confirms adequate thermal performance.

Figure 18. Floor structure of the modular section



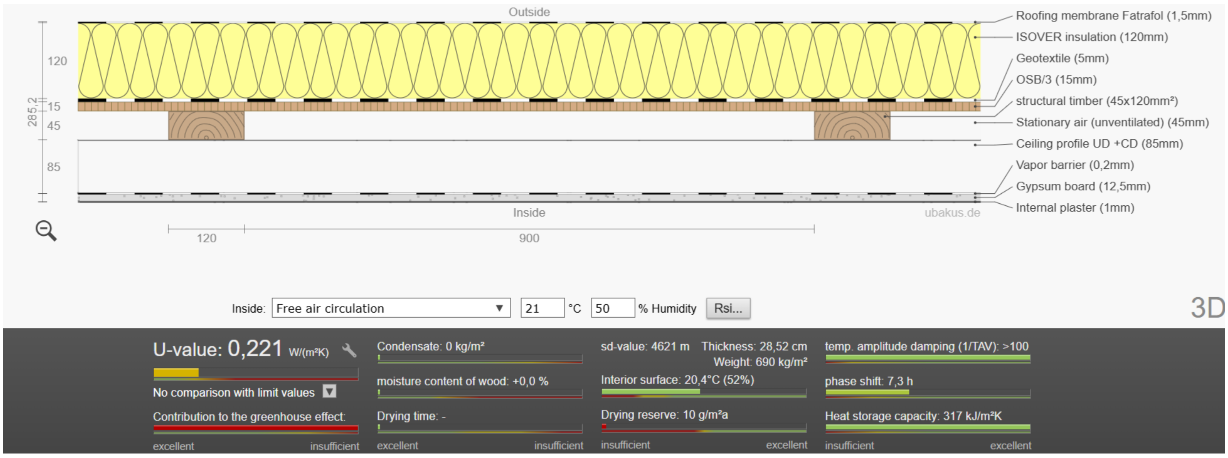
The external wall of the modular section is designed as a multilayer system consisting of a primary steel structural frame, while the enclosure is formed by timber stud infill panels with integrated insulation. The wall build-up includes external plaster, graphite polystyrene (EPS) insulation, OSB sheeting with a breather membrane, stud framing filled with mineral wool insulation, a vapour barrier, and internal gypsum board finishing, as Figure 19 shows. Meanwhile, thermal insulation is achieved through the combination of external EPS insulation and mineral wool within the stud cavity, ensuring a continuous insulation layer. This configuration helps to mitigate potential thermal bridging effects associated with the steel frame. The calculated thermal transmittance of the wall is approximately 0.145 W/m²K, which fell below the required limit.

Figure 19. Wall structure of the modular section



The roof structure of the modular unit consists of thermal insulation, structural support, and moisture protection. More precisely, it is built up of roofing membrane, insulation layer, geotextile, OSB sheeting, structural timber beams, a ventilated cavity, a vapour barrier, and internal gypsum board finishing, as Figure 20 shows. The calculated thermal transmittance of the roof is approximately 0.221 W/m²K, which satisfies the requirements, although it is close to the maximum allowable limit.

Figure 20. Roof structure of the modular section

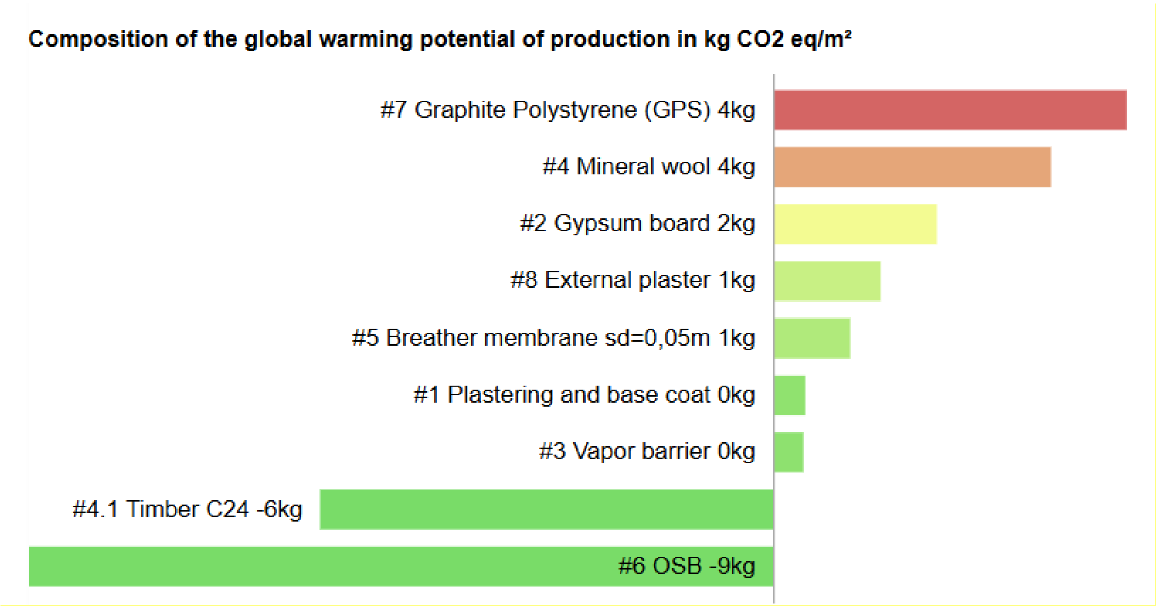


6.5.5 Environmental Effects of the Use of Modular Sections

The environmental impact of the modular wall system is assessed based on the contribution of individual layers to the global warming potential. As shown in Figure 21, the environmental performance of the wall is influenced by multiple materials, with both positive and negative contributions. Therefore, the highest contribution is associated with insulation materials, just like in the previously described cases. In this particular case, graphite polystyrene (GPS), followed by mineral wool and gypsum board. These materials exhibit relatively high embodied carbon due to their energy-intensive manufacturing processes. Additional components, such as external plaster and breather membranes, also contribute to the overall environmental impact, although to a lesser extent. In contrast, timber-based structural elements, including timber studs and OSB boards, show negative contributions to the global warming potential, as discussed before in the previous approaches.

It should be noted that the primary structural system of the modular unit is based on a steel frame, which contributes significantly to the overall environmental impact due to its high embodied energy. However, an additional advantage of the modular approach from a lifecycle assessment's perspective is related to the modular section's disassembly potential. As strong adhesive bonding is not applied in the connections, the wall elements can be dismantled and reused in other applications after the end of their service life. This contributes to improved resource efficiency and supports circular construction principles, and it distinguishes modular systems from conventional construction methods, where permanent bonding often limits reuse potential.

Figure 21. Composition of the global warming potential of the modular wall section



6.5.6 Cost Analysis of the Modular Section Approach

It is important to note that all costs were calculated without value-added tax (VAT), while the summary includes VAT to present the total construction expenses. In Slovakia, the standard VAT rate is 23%, and the reduced rate is 5% (Finančná správa, n.d.).

The cost of the modular extension approach is based on an estimation of construction and prefabrication costs, resulting in a total cost of approximately €18 300, excluding VAT. The largest cost component is the prefabricated module itself, accounting for approximately €10 000, excluding VAT, which can be observed in Figure 22, representing more than half of the total construction cost. As no specific supplier quotation was available, this value was estimated based on the average market price of a basic modular unit. It should be noted, however, that the actual cost of modular units can vary significantly depending on factors such as level of prefabrication, material quality, included technical systems and transportation methods. This indicates that a significant portion of the total cost is concentrated in a single prefabricated element, reflecting the integrated nature of the modular construction system. As a result, the number of on-site construction processes is reduced, leading to a more streamlined construction approach.

Figure 22. Cost analysis of the modular construction approach (Obtained from Cenkros software)

Description	Total price
Thesis - modul	18,272.52
Assemblies and Supplies PCW	17,708.21
Earthworks	216.63
Foundation works	7,291.58
Module	10,200.00
Assemblies and Supplies SCW	564.31
Protection against water and moisture	299.40
Thermal insulation	264.91

7 Comparative Analysis of the Extension Approaches

This chapter represents a comparative analysis of the three proposed extension strategies, namely masonry construction, timber construction, and modular prefabrication. The objective of this comparison is to evaluate the performance of each approach based on key criteria relevant to residential extension design. These criteria include structural performance and flexibility, thermal behaviour, construction cost, and construction time. By analysing these aspects, the study aims to highlight the advantages and limitations of each solution under comparable design conditions. Therefore, the comparison is based on the previously developed design proposals and calculated results.

7.1 Structural Performance Comparison

From a structural design perspective, all three extension strategies provide sufficient load-bearing capacity for the given application. Nevertheless, notable differences can be identified in terms of structural behaviour and flexibility, which are shown in Table 4.

The masonry construction approach represents the most rigid system. Its high compressive strength ensures excellent stability and durability, but at the same time, it also limits the potential for architectural modifications. The creation of larger openings or future alterations requires significant structural intervention, which reduces the overall flexibility of the system. However, compared to timber and modular systems, masonry performs very well under vertical loads due to its compressive behaviour, but is less capable of handling tension and deformation. The results show that the structural elements are far below their maximum capacity, which indicates that the system is safe and stable. However, because masonry is a stiff and brittle material, it does not tolerate movement. This is why movement joints are required between the existing building and the extension to prevent cracking. As a result, masonry provides the highest level of structural stability, but it offers the lowest level of flexibility.

In contrast, the timber construction approach behaves differently as a lightweight and more flexible system. Compared to masonry, the loads acting on the structure are significantly lower, which reduces the demand on the foundation and improves the overall efficiency. Timber elements can carry both compression and bending, and the frame structure allows a clear and simple load transfer. Similar to masonry, the utilisation ratios are low, meaning that the structure has sufficient capacity. However, unlike masonry, timber is able to accommodate deformation more effectively, which makes it easier to modify or introduce openings without major structural changes. At the same time, compared to modular construction, timber provides greater adaptability, although its lower stiffness may result in increased sensitivity to deformation, which needs to be controlled through proper design.

The modular construction approach follows a different structural principle, where the extension acts as a self-supporting unit. In comparison to both timber and masonry, the walls, floor, and roof work together as one system. This results in an efficient load distribution and stable structural behaviour. The loads are transferred along the full perimeter of the module, which leads to a uniform distribution on the foundation and low utilisation of the soil capacity. Similar to timber, the system is lightweight, which contributes to structural efficiency. However, unlike timber, the modular system is less flexible, because the structural configuration is fixed during manufacturing, and any changes after installation are difficult to carry out.

Therefore, the differences between the three systems are not primarily related to their load-bearing capacity, but rather to their structural behaviour and level of flexibility. While the masonry construction approach provides the highest level of stability due to its rigid existence, this comes at the expense of limited adaptability. In contrast, the timber construction approach offers a more flexible system, where the lightweight frame structure allows easier adjustments and a more efficient distribution of loads. The modular construction approach, on the other hand, achieves a high level of structural efficiency and precision through its integrated, prefabricated system, although the same characteristics restrict the possibility of post-construction modifications due to its fixed structural configurations.

Table 1. Comparison of utilisation ratios for soil bearing capacity

Comparison of Utilisation Ratios for Soil Bearing Capacity		
Masonry Construction	Timber Construction	Modular Construction
29.8%	25.39%	25.19%

7.2 Thermal Performance Comparison

From a thermal performance perspective, all three extension strategies meet the required limits. However, clear differences can be observed in their thermal behaviour, which are mainly related to the material properties, layer composition, and structural systems used in each approach, as it can be seen in Table 2.

The masonry construction approach provides stable thermal behaviour due to its relatively high thermal mass, which allows heat to be stored and released gradually. In comparison to timber and modular systems, this results in more stable indoor temperatures and reduced fluctuations over time. However, this advantage comes at the cost of higher material demand and thicker wall assemblies, as additional insulation is required to achieve the necessary U-values. In contrast, the timber construction approach achieves better insulation performance than masonry, particularly due to the integration of insulation within the structural frame, which allows a more efficient use of wall thickness. Compared to masonry, timber provides lower U-values and therefore reduces heat loss more effectively. However, unlike masonry, the low thermal mass of timber results in faster thermal response, meaning that indoor conditions are more sensitive to external temperature changes.

A similar trend can be observed in the modular construction approach, where the prefabricated system achieves the lowest U-value among the three solutions, indicating the highest level of insulation efficiency. Compared to both masonry and timber, the controlled manufacturing process reduces thermal bridging and ensures a consistent performance. At the same time, similarly to timber, the lightweight structure provides limited thermal mass, which reduces its ability to stabilise indoor temperature compared to the masonry approach.

Table 2. Thermal performance comparison

Thermal Performance Comparison – U-value (W/m²K)			
	Masonry Approach	Timber Approach	Modular Approach
Floor structure	0.245	0.245	0.236
Wall structure	0.194	0.167	0.145
Roof structure	0.110	0.110	0.221

7.3 Cost Comparison

From a cost perspective, the three extension strategies show more significant differences than in the case of structural or thermal performance. While all systems satisfy the technical requirements, the overall cost is strongly influenced by construction method, labour demand, and level of prefabrication.

The masonry construction approach represents a mid-range solution in terms of cost. Compared to timber and modular systems, masonry requires more on-site labour due to wet construction processes such as wall laying, concrete works, and plastering. This increases both construction time and labour costs. In addition, the heavier structure and thicker wall assemblies result in higher material usage. Although the material costs themselves are relatively standard, the overall cost is increased by the labour-intensive nature of the construction process. As a result, masonry is less cost-efficient than modular construction, but generally more economical than timber.

In contrast, as it can be seen in Table 3, the timber construction approach results in the highest overall cost among the three systems. Compared to masonry, the structural elements are lighter and faster to assemble. However, the system requires multiple additional layers, including insulation, cladding, and protective elements. Furthermore, while construction is faster, the prefabricated components and specialised detailing contribute to higher overall expenses. Compared to modular construction, timber offers greater flexibility, but at the same time also higher cost.

The modular construction approach provides the most cost-effective solution. Compared to both methods, the prefabrication process reduces on-site labour and shortens construction time. A large portion of the total cost is concentrated in the prefabricated module itself, but this is offset by the reduced need for labour and faster installation. In addition, the controlled manufacturing process minimises material waste and improves efficiency. However, unlike timber, the system offers limited flexibility, and unlike masonry, it depends more on transportation and supplier conditions.

Table 3. Cost comparison between the three construction approaches

Cost Comparison Between the Three Construction Approaches		
Masonry Approach	Timber Approach	Modular Approach
€22 941.89	€25 007.75	€18 272.52

7.4 Environmental Effect Comparison

The environmental performance of the three extension strategies shows notable differences, primarily influenced by material selection, construction method, and lifecycle considerations. The masonry construction approach demonstrates relatively high environmental impact, mainly due to the high energy requirement to produce the ceramic materials. The firing process of brick manufacturing significantly contributes to carbon emissions. In addition, the use of EPS insulation further increases the global warming potential, as identified in the layer-based analysis. However, masonry offers advantages in terms of durability and long service life, which can partially offset its initial environmental burden over time.

In contrast, the timber construction approach presents a more favourable environmental profile. Timber elements act as carbon storage materials, contributing negatively to the global warming potential. This results in lower overall environmental impact compared to masonry. Nevertheless, the presence of industrial materials such as mineral wool, vapour barriers, and membranes still contributes significantly to embodied carbon, meaning that the system is not entirely low impact.

The modular construction approach provides a balanced environmental performance. The system is based on a hybrid structural solution, where the primary load-bearing frame is formed by steel elements, while enclosing walls are composed of prefabricated sandwich-type panels with timber-based infill. This combination results in both positive and negative environmental contributions. The steel structural frame has relatively high embodied carbon due to energy-intensive production processes, whereas the timber components contribute negatively to the global warming potential. At the same time, the prefabrication process reduces material waste and improves production efficiency. Additionally, a major advantage of the modular system is its potential for disassembly and reuse, which supports circular construction principles.

8 Discussion

The purpose of the thesis was to investigate and compare different extension strategies for improving the spatial performance of an existing masonry residential building. The three analysed approaches, masonry construction, timber construction, and modular prefabrication, were evaluated based on structural behaviour, construction process, thermal performance, cost efficiency, and overall feasibility, with the intention of identifying the most suitable solution under realistic design conditions.

From a structural perspective, all three extension strategies were found to provide adequate performance for the given application, as the calculated utilisation ratios of the structural elements remained significantly below their maximum capacity in each case. This result can be explained by the relatively small scale of the extension, the short structural spans, and the moderate load conditions typical for residential buildings. Based on the obtained results, it can be stated that significantly smaller cross-sections and lower-strength material classes could have been applied while still satisfying the structural requirements. However, the use of standardised structural elements was an intentional design decision, aiming to ensure simplicity, ease of construction, and compatibility with common building practices. Although a more optimised design could potentially reduce material consumption and improve cost efficiency, structural optimisation was not the primary objective of this study, as the main focus was placed on the comparative evaluation of different extension strategies rather than achieving maximum material efficiency.

From an architectural perspective, the proposed extension successfully improves the spatial quality and functionality of the ground floor. However, it also introduces new challenges, particularly in relation to natural daylight conditions. Due to the addition of the new volume, the existing kitchen and dining areas lose a significant portion of their direct light sources, which may negatively affect the overall indoor environment and user comfort. A potential architectural response to this issue would be the introduction of larger window openings in the existing building. While this solution would be fully justified in terms of spatial quality and daylight improvement, it would require substantial intervention in the existing load-bearing masonry walls. Such modifications would significantly increase structural risks, as the removal of wall sections may weaken the load-bearing system and require additional reinforcement measures, including the installation of lintels and temporary support structures during construction. In addition, these interventions would lead to a considerable increase in construction cost and complexity. Therefore, this situation represents a clear design trade-off, where architectural improvement must be carefully balanced against structural safety and economic feasibility.

Another important aspect relates to the execution phase, particularly the construction of the foundation system. The design assumptions are based on typical conditions, but in real-life scenarios, the actual ground properties may differ from place to place within a single construction zone. (SFS-EN 1997-1, 2004) If the soil bearing capacity is insufficient or the ground is unstable, the excavation required for the new foundation may compromise the stability of the existing structure. In such cases, underpinning techniques may be required to stabilise the existing foundations and prevent unwanted settlement or displacement during the manipulation phase. While underpinning provides an effective solution for maintaining structural stability, it also introduces additional technical complexity, increases construction time, and results in high additional costs. Consequently, ground conditions represent a critical risk factor that must be carefully evaluated before construction, and the conditions must be carefully prepared beforehand. (Dachowski, 2020) For example, the improvement of the existing conditions beneath the foundation. Techniques such as soil compaction, replacement with granular material, or injection methods can increase the bearing capacity of the subsoil without modifying the original foundation. (SFS-EN 1997-1, 2004) This approach reduces the need for deep excavation and minimises structural intervention in the existing building. However, its effectiveness strongly depends on the existing soil conditions and requires careful geotechnical analysis.

An additional practical consideration related to the modular construction approach is the limitation imposed by transportation and handling requirements. Although the proposed design assumes a single volumetric unit with dimensions of approximately 4 x 5 metres, in practice, transporting such a module as one piece may not be efficient or feasible due to size restrictions, transportation regulations, or handling constraints. (Lacey et al., 2018) As a result, it would be more practical to divide the module into two smaller units, which can be transported separately and assembled on-site. While this approach allows the project to be more compact and manageable, it also provides greater flexibility during construction, as the final floor layers can be adapted to site-specific conditions and requirements. Despite that, it may reduce some of the advantages typically associated with fully prefabricated modular construction, in terms of speed of assembly.

In addition to foundation-related risks, the connection between the new extension and the existing structure plays a crucial role in the overall performance of the system. The requirement to maintain structural independence while ensuring adequate lateral stability, airtightness, and thermal continuity leads to the need for carefully designed connection details. Improper execution of this interface may result in issues such as cracking due to differential movement, air leakage, or thermal bridging, all of which can negatively affect both structural behaviour and indoor comfort. (ISO 13822, 2010) Therefore, the connection between the existing building and the extension should be considered a critical design element.

During the design development of the modular extension, the insulation layer was reduced to simplify the wall build-up and align with typical prefabricated module dimensions. However, this modification was not strictly necessary from a technical perspective. The original insulation thickness could have been maintained without compromising the structural or functional performance of the module, but this configuration's drawback would have been an unreasonably thick wall thickness, even if it would have reduced the construction time and costs. Therefore, the reduction of insulation should be considered a design simplification rather than a technical requirement.

9 Conclusion

The results of this study highlight that the design of building extensions involves a series of interconnected decisions, where improvements in one aspect may lead to compromises in another. While structural systems can be designed to safely resist the applied load with relatively low utilisation, architectural requirements such as daylight, spatial openness, and functional flexibility may introduce additional complexity and risk. Similarly, construction-related factors, including soil conditions, connection detailing, execution methods, material availability and transportation management, can significantly influence both the feasibility and the final cost of the project.

Overall, the findings demonstrate that no single extension strategy can be considered universally optimal, as each approach involves specific advantages and limitations. The selection of the most appropriate solution, therefore, depends on the priorities of the project, including structural performance, cost effectiveness, environmental impact, and the required level of flexibility. Among the analysed approaches, modular construction offers the highest level of cost efficiency and construction speed, while timber construction provides greater flexibility and favourable environmental performance. In contrast, masonry construction ensures high structural stability and durability, although with reduced adaptability and higher environmental impact.

In conclusion, the study confirms that carefully designed extensions can significantly improve the spatial performance and usability of existing residential buildings. At the same time, it emphasises the importance of balancing architectural, structural, and practical considerations to achieve a solution that is both technically feasible and functionally effective.

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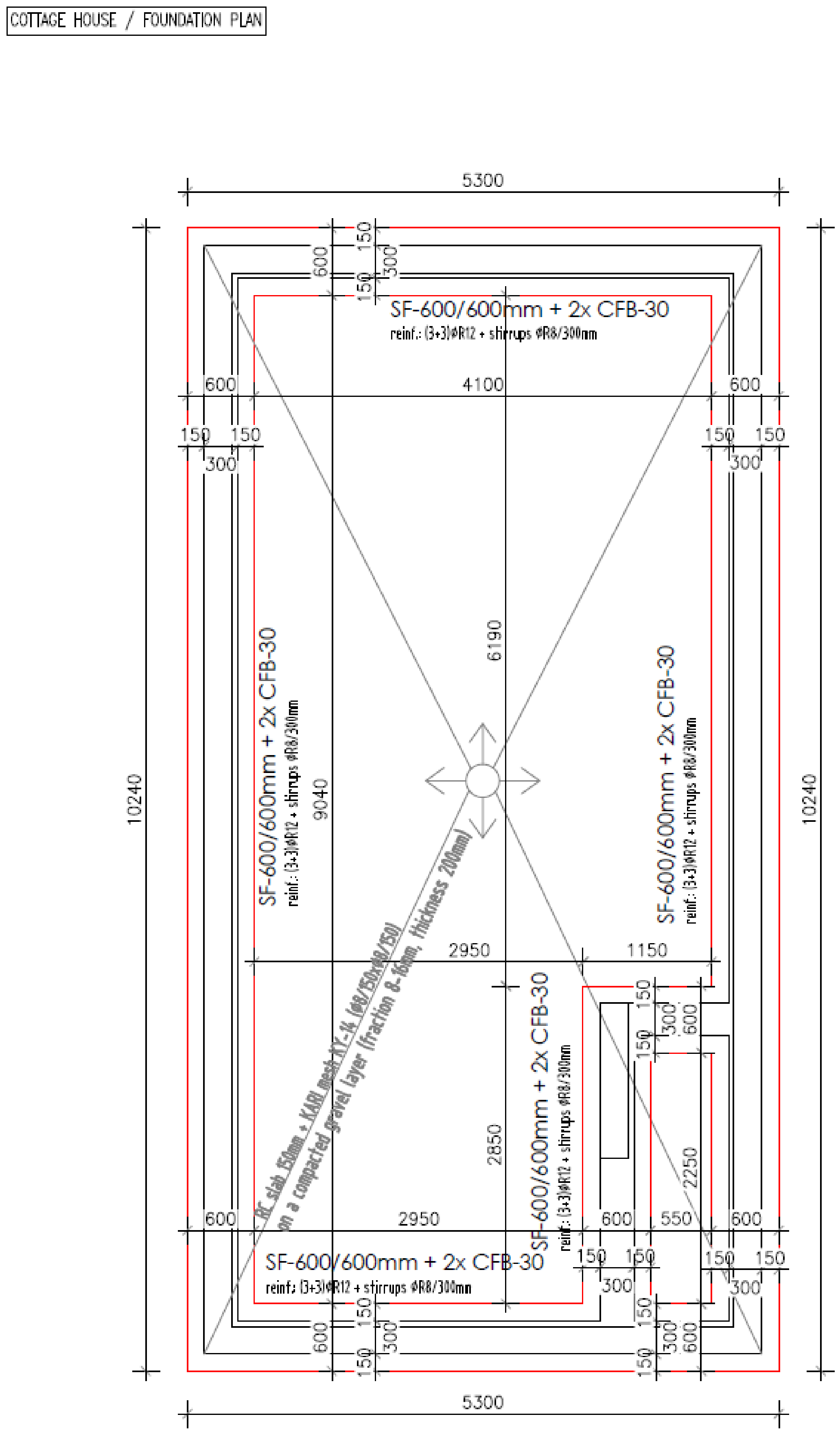
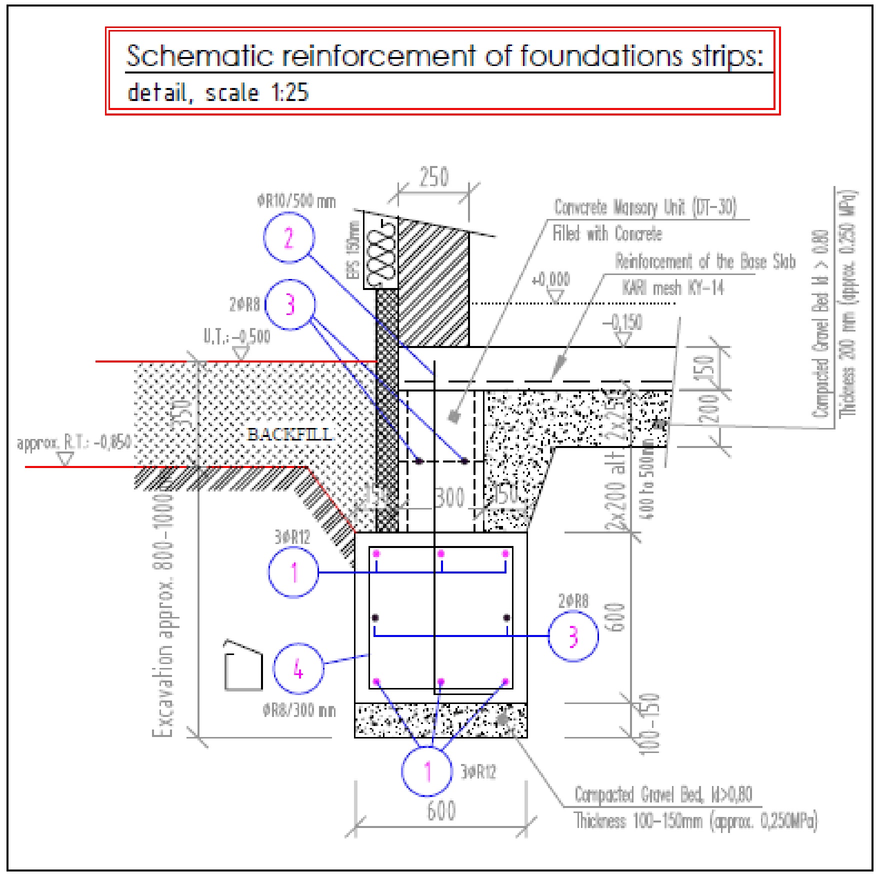
Appendix 1. Existing Building Drawings





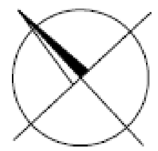
Concrete: C 20/25
Reinf. steel: B-500B (O 10505-R)
Concrete cover: 50mm - strip footing, 30mm - slab

Foundation slab reinforcement:
(blinding concrete)
- welded mesh rein. at the bottom surface, type KY-14
(KY-14 = Ø8/150 x Ø8/150 -2400x6000mm)
- lap splice length of welded mesh: 450mm
(3 mesh openings in both directions)

NOTES

Before starting foundation concreting, it is necessary to mark locations and leave openings for the passage of sewer pipelines through the foundation structure.
Compacted sub-base layer bearing capacity: 0.25 MPa.
Before casting the blinding concrete layer, underground sewer pipelines must be installed in accordance with the design documentation (sanitary engineering section). After installation of strip foundations, place gravel backfill, thickness 200 mm.
Verification of foundation soil conditions at foundation trench level and determination of groundwater presence in the subsoil must be carried out prior to casting blinding concrete. If conditions differ from the design assumptions, it is necessary to adjust foundation dimensions accordingly.
Quantity of crushed gravel bedding (fraction 0/32) for area approx. 59.70 m^2: approx. 12.00 m^3.
Concrete volume for strip foundations, thickness 115.4 m^3: approx. 11.54 m^3.
Concrete volume for foundation slab, thickness 150 mm, area 49.70 m^2: approx. 7.50 m^3.
Other concreting works: footings, foundation strip edges, lintel supports, reinforced slabs, stairs.
Concrete grade: STN EN 206 – C 20/25 – XC2 (SK) – Cl 0.4 – Dmax 16 – S2.
Reinforcement steel: B500B (STN 10505–R).
Concrete cover: 50 mm for strip foundations, 30 mm for foundation slab.

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

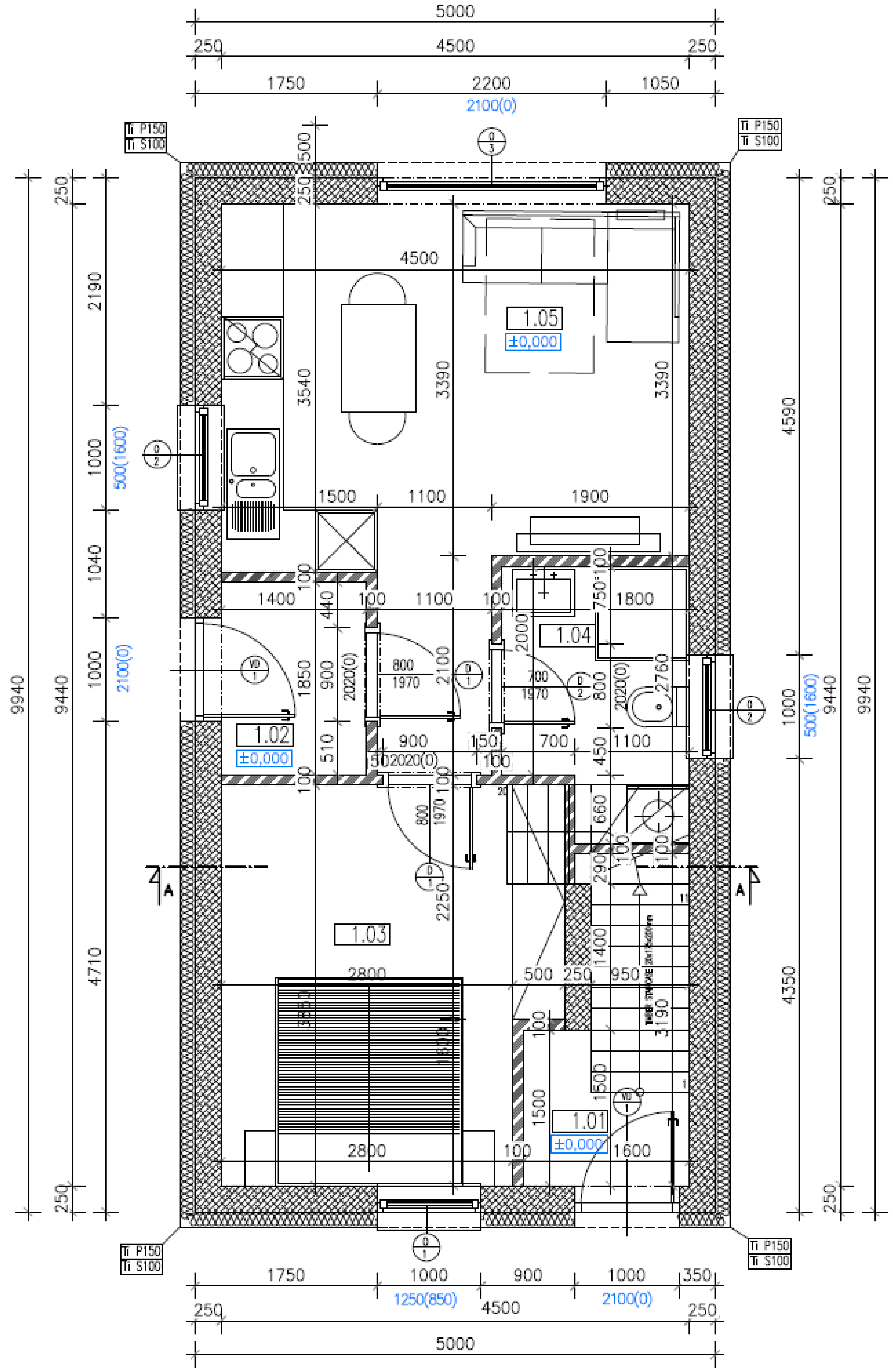


DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 2xA4	DRAWING NO.: A1
DRAWING: FOUNDATION PLAN	SCALE: 1:50	
	DATE: 08/2025	

COTTAGE HOUSE / GROUND FLOOR PLAN



LEGENDS OF MATERIALS

- EXTERIOR AND LOAD-BEARING MASONRY POROTHERM PROFI 25 (P12), thickness 250mm, with thin-layer full-surface adhesive POROTHERM PROFI, WITH EXTERNAL INSULATION SYSTEM BAUMIT EPS-F thickness 150mm AND INTERNAL PLASTER
- PARTITION WALLS PORFIX thickness 150mm with thin-layer full-surface adhesive, WITH INTERNAL PLASTER
- CONCRETE FORM BLOCKS (CFB) DT-30 – thickness 300mm
- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL EMBANKMENT – DANUBE GRAVEL, FRACTION ø20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION ø20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

PX FLOORS

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P2
- PORCELAIN STONEWARE TILES (GRES) 600*600MM, thickness 10mm
- TILE ADHESIVE, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P3
- PORCELAIN TILE FLOORING 600 * 600 MM OR WOOD PARQUET FLOORING, thickness 10 mm
- ADHESIVE LAYER, thickness 15 mm / IMPACT SOUND INSULATION LAYER
- CEMENT SCREED, thickness 45 mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30 mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 20 mm
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 210 mm

LEGEND OF DESCRIPTIONS

- D/X – WOODEN CASED (LINED) DOORS
- VD/X – ENTRANCE DOOR
- O/X – WINDOW / GLAZED WALL
- VM – VENTILATION GRILLE 150x150mm
- KV – SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM – THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- TI NX – THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- TI PX – THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- TI SX – THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

STRX CEILINGS

STR1
- WALKING SURFACE – OSB BOARD, thickness 18 mm
- CAVITY INFILL BETWEEN JOISTS WITH MINERAL WOOL, thickness 180 mm
- TIMBER JOISTS / BEAMS (ACCORDING TO STRUCTURAL CALCULATION)
- THERMAL INSULATION – MINERAL WOOL, thickness 100 mm
- VAPOUR-PERMEABLE MEMBRANE
- 2 * OSB BOARDS, thickness 18 mm
- SUSPENDED GYPSUM BOARD CEILING, thickness 12.5 mm

STR2
- REINFORCED CONCRETE SLAB

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND

ROOM NO.	ROOM NAME	FLOORS	WALLS	CEILING TYPE	AREA /m²
1.01	VESTIBULE	P2	GYPSUM PLASTER (S.O.)	STR2	2.40
1.02	VESTIBULE	P2	GYPSUM PLASTER (S.O.)	STR2	2.60
1.03	ROOM	P1	GYPSUM PLASTER (S.O.)	STR2	12.00
1.04	BATHROOM	P2	PORCELAIN TILE CL. (S.O.)	STR2	4.30
1.05	HALL + KITCHEN	P1,P2	GYPSUM PLASTER (S.O.)	STR2	18.00
TOTAL USABLE FLOOR AREA					39.30

NOTES:
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DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

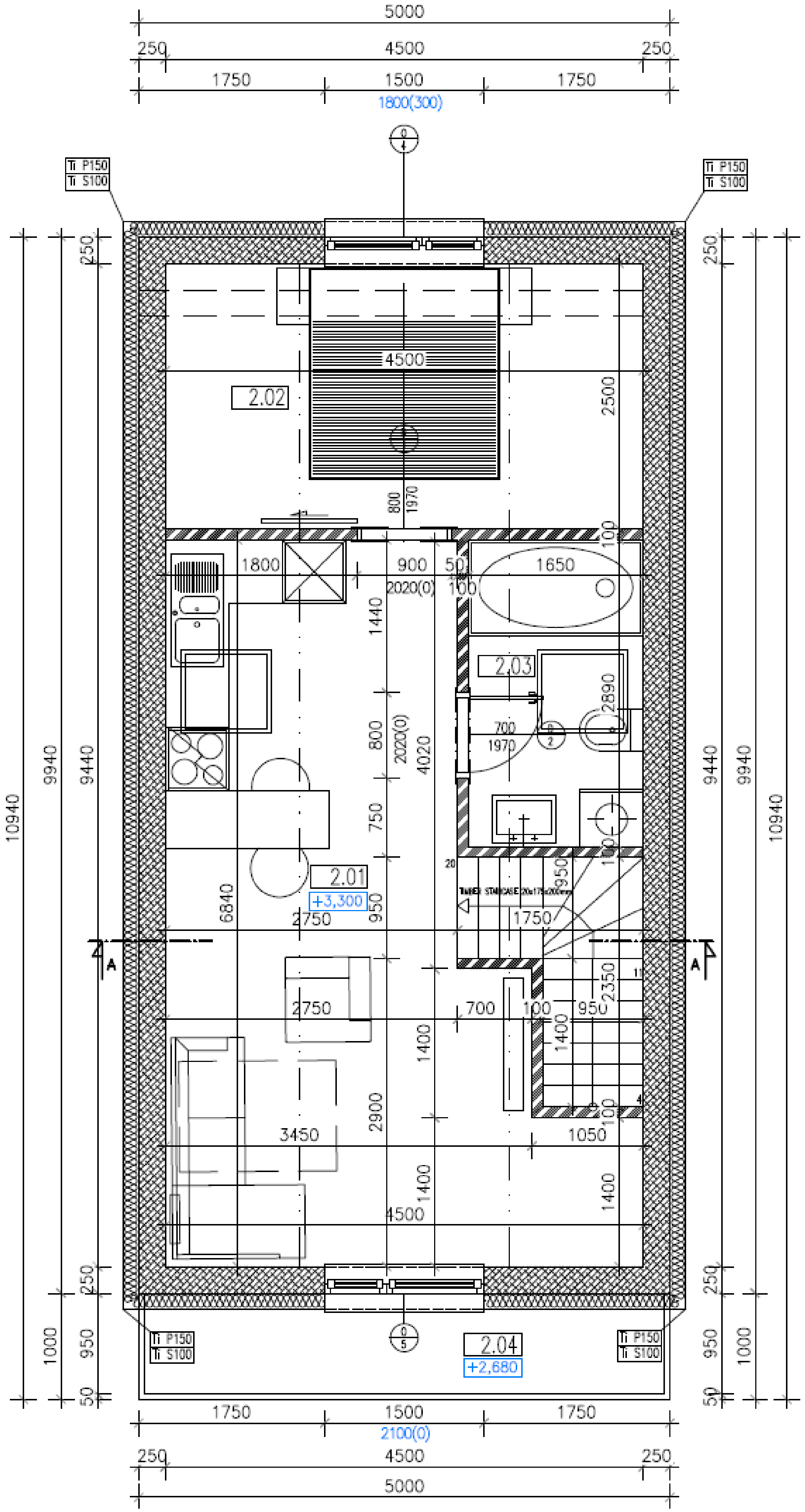
TITLE: COTTAGE HOUSE

PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY: DISTRICT:

INVESTOR:

STRUCTURE: COTTAGE HOUSE — SHEET SIZE: 2xA4 — SCALE: 1:50
DRAWING: GROUND FLOOR PLAN — DATE: 08/2025 — DRAWING NO.: A2

COTTAGE HOUSE / UPPER FLOOR PLAN



LEGENDS OF MATERIALS

- EXTERIOR AND LOAD-BEARING MASONRY POROTHERM PROFI 25 (P12), thickness 250mm, with thin-layer full-surface adhesive POROTHERM PROFI, WITH EXTERNAL INSULATION SYSTEM BAUMIT EPS-F thickness 150mm AND INTERNAL PLASTER
- PARTITION WALLS PORFIX thickness 150mm with thin-layer full-surface adhesive, WITH INTERNAL PLASTER
- CONCRETE FORM BLOCKS (CFB) DT-30 – thickness 300mm
- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL EMBANKMENT – DANUBE GRAVEL, FRACTION ø20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION ø20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

LEGEND OF DESCRIPTIONS

- D/X – WOODEN CASED (LINED) DOORS
- VD/X – ENTRANCE DOOR
- O/X – WINDOW / GLAZED WALL
- VM – VENTILATION GRILLE 150x150mm
- KV – SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM – THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- Ti NX – THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- Ti PX – THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- Ti SX – THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

PX FLOORS

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P2
- PORCELAIN STONEWARE TILES (GRES) 600*600MM, thickness 10mm
- TILE ADHESIVE, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P3
- PORCELAIN TILE FLOORING 600 * 600 MM OR WOOD PARQUET FLOORING, thickness 10 mm
- ADHESIVE LAYER, thickness 15 mm / IMPACT SOUND INSULATION LAYER
- CEMENT SCREED, thickness 45 mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30 mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 20 mm
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 210 mm

STRX CEILINGS

STR1
- WALKING SURFACE – OSB BOARD, thickness 18 mm
- CAVITY INFILL BETWEEN JOISTS WITH MINERAL WOOL, thickness 180 mm
- TIMBER JOISTS / BEAMS (ACCORDING TO STRUCTURAL CALCULATION)
- THERMAL INSULATION – MINERAL WOOL, thickness 100 mm
- VAPOUR-PERMEABLE MEMBRANE
- 2 * OSB BOARDS, thickness 18 mm
- SUSPENDED GYPSUM BOARD CEILING, thickness 12.5 mm

STR2
- REINFORCED CONCRETE SLAB

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND

ROOM NO.	ROOM NAME	FLOORS	WALLS	CEILING TYPE	AREA /m²
2.01	HALL + KITCHEN	P3	GYPSUM PLASTER(S.O.)	STR2	22.24
2.02	ROOM	P3	GYPSUM PLASTER (S.O.)	STR2	13.50
2.03	BATHROOM	P3	PORCELAIN TILE CLAD. (S.O.)	STR2	4.75
TOTAL USABLE AREA					40.49
2.04	BALCONY	FROST-RES. TILES			5.00

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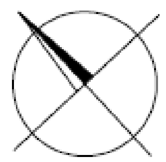
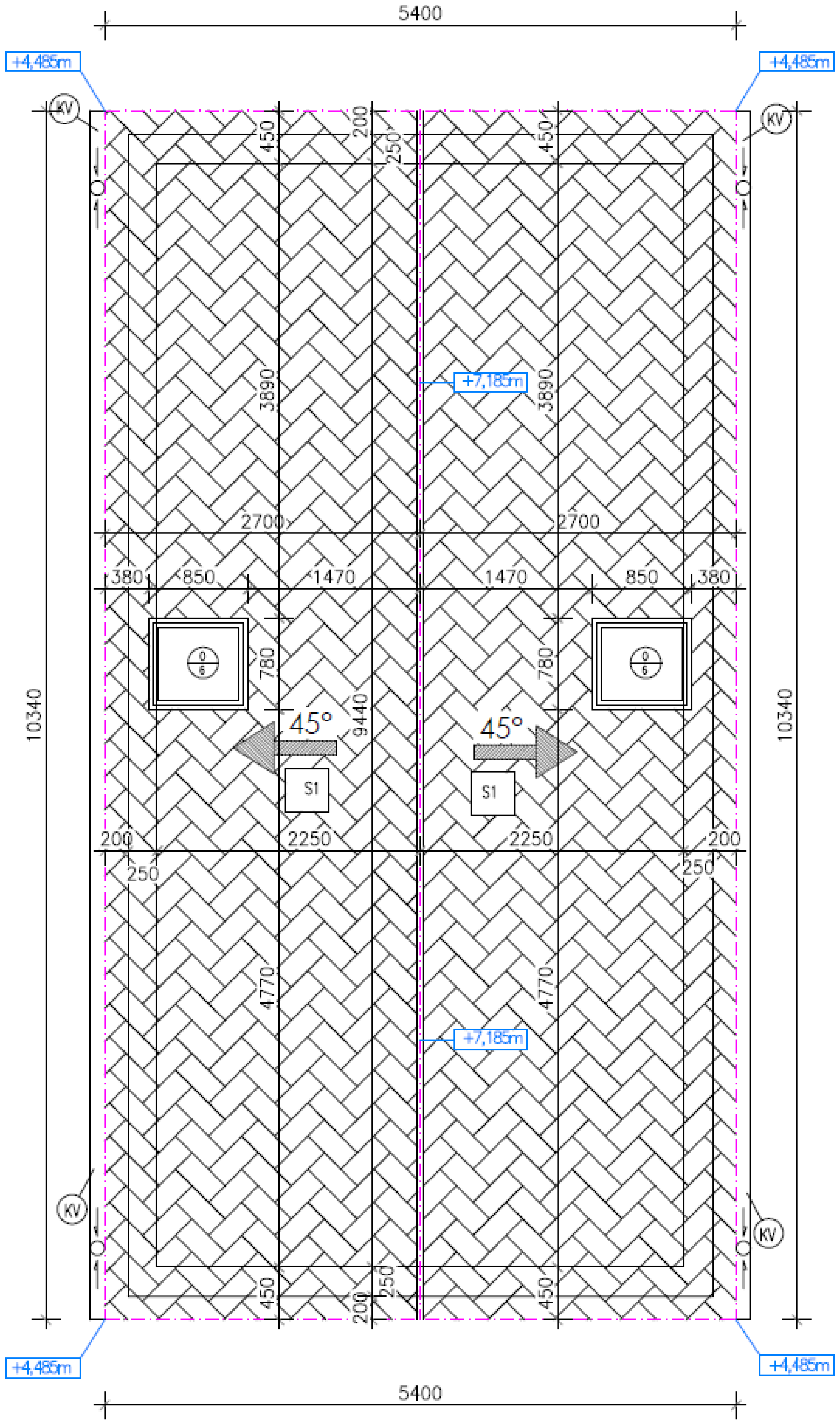


DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 2xA4 / SCALE: 1:50	DRAWING NO.: A3
DRAWING: UPPER FLOOR PLAN	DATE: 08/2025	

COTTAGE HOUSE / ROOF PLAN



LEGEND OF DESCRIPTIONS

- D/X — WOODEN CASED (LINED) DOORS
- VD/X — ENTRANCE DOOR
- O/X — WINDOW / GLAZED WALL
- VM — VENTILATION GRILLE 150x150mm
- KV — SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM — THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI

- Ti NX — THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- Ti PX — THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- Ti SX — THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 55,84m².
SLOPE OF THE ROOF 45,0°

NOTES:

INSTALLATION AND APPLICATION OF THE ROOF COVERING MUST BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S TECHNICAL SPECIFICATIONS!

THE GUTTER SYSTEM MUST BE EQUIPPED WITH PROTECTIVE MESH.
THE ROOFING SYSTEM MUST BE EQUIPPED WITH ACCESSORIES (SNOW GUARDS, BIRD PROTECTION MESH).

EAVES/ROOF EDGE COMPONENTS:
EAVES GUTTER ø125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
DOWNPIPE ø125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
ROOF FLASHING AT WALL JUNCTIONS
FACADE CHIMNEY FLASHING
VENT PIPE FLASHING

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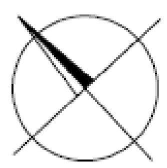
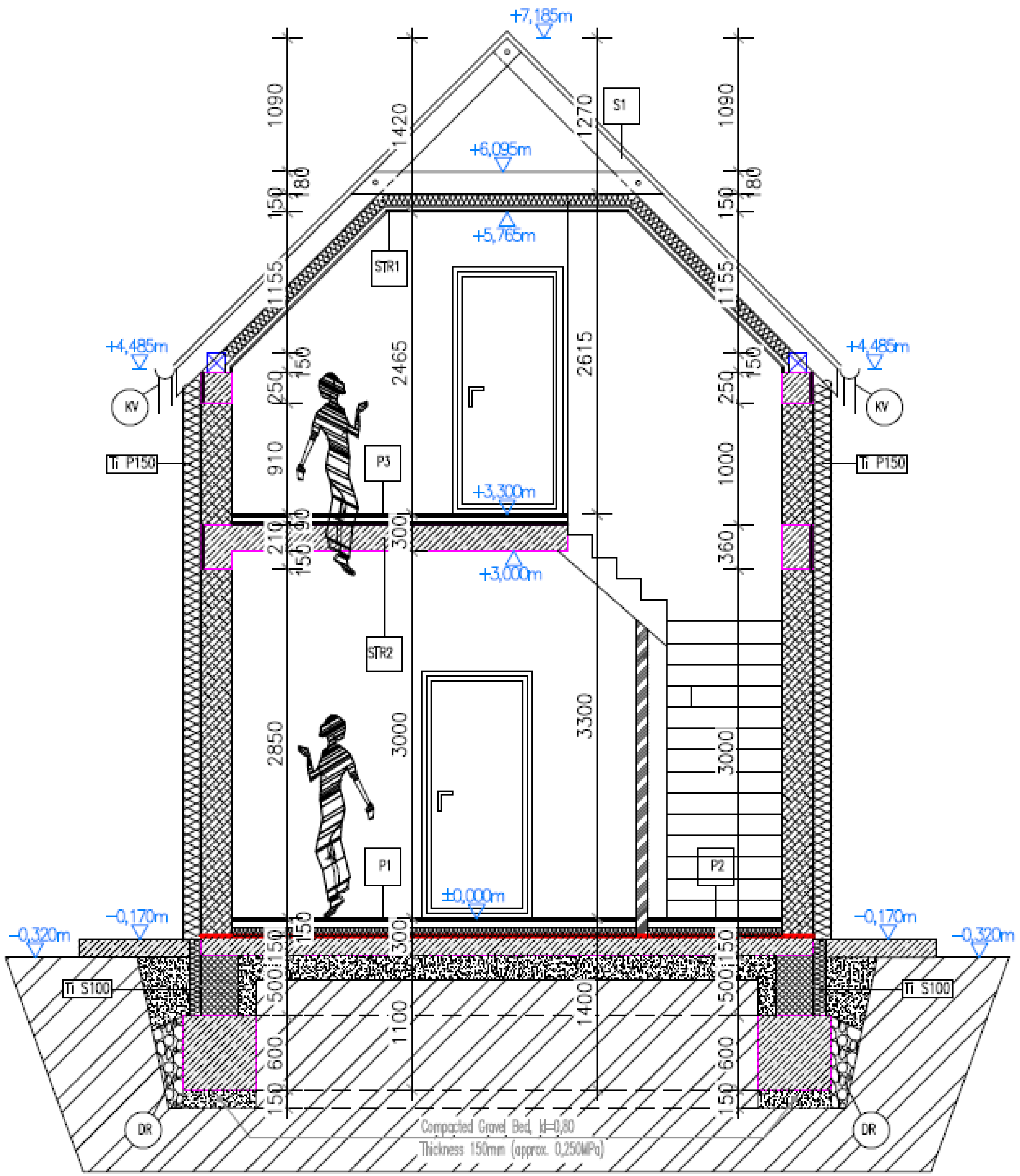


DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 2xA4	DRAWING NO.: A4
	SCALE: 1:50	
DRAWING: ROOF PLAN	DATE: 08/2025	

COTTAGE HOUSE / SECTION A–A'



LEGENDS OF MATERIALS

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- PARTITION WALLS PORFIX thickness 150mm with thin–layer full–surface adhesive, WITH INTERNAL PLASTER
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- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL EMBANKMENT – DANUBE GRAVEL, FRACTION ø20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION ø20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

LEGEND OF DESCRIPTIONS

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- KOM – THREE–COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- Ti NX – THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- Ti PX – THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- Ti SX – THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI–SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE–FORMAT DECKING BOARDS (WPC–WOOD PLASTIC COMPOSITE), thickness 150 mm

PX FLOORS

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD–BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P2
- PORCELAIN STONEWARE TILES (GRES) 600*600MM, thickness 10mm
- TILE ADHESIVE, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD–BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

P3
- PORCELAIN TILE FLOORING 600 * 600 MM OR WOOD PARQUET FLOORING, thickness 10 mm
- ADHESIVE LAYER, thickness 15 mm / IMPACT SOUND INSULATION LAYER
- CEMENT SCREED, thickness 45 mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30 mm
- THERMAL INSULATION – EPS POLYSTYRENE, thickness 20 mm
- LOAD–BEARING REINFORCED CONCRETE SLAB, thickness 210 mm

STRX CEILINGS

STR1
- WALKING SURFACE – OSB BOARD, thickness 18 mm
- CAVITY INFILL BETWEEN JOISTS WITH MINERAL WOOL, thickness 180 mm
- TIMBER JOISTS / BEAMS (ACCORDING TO STRUCTURAL CALCULATION)
- THERMAL INSULATION – MINERAL WOOL, thickness 100 mm
- VAPOUR–PERMEABLE MEMBRANE
- 2 * OSB BOARDS, thickness 18 mm
- SUSPENDED GYPSUM BOARD CEILING, thickness 12.5 mm

STR2
- REINFORCED CONCRETE SLAB

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
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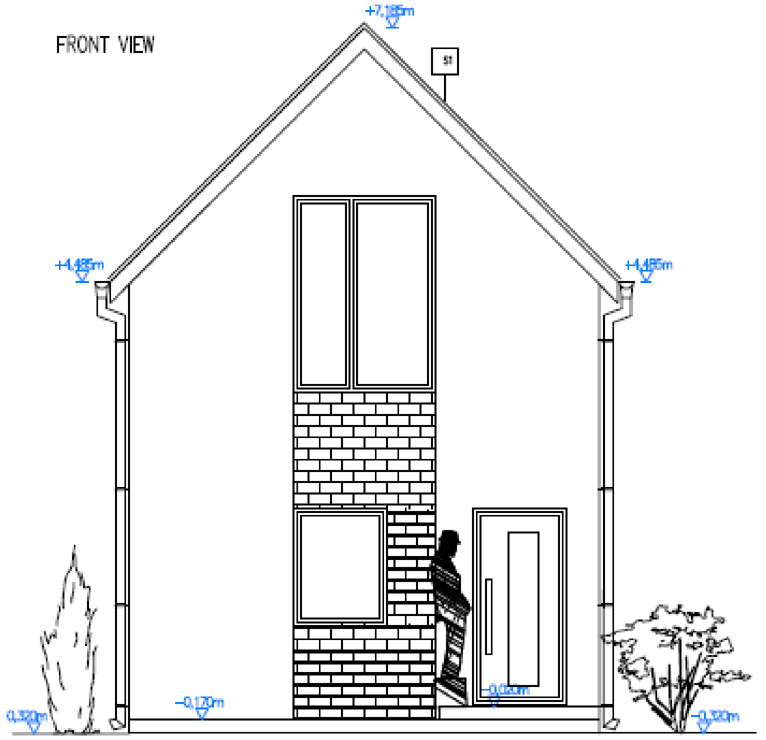
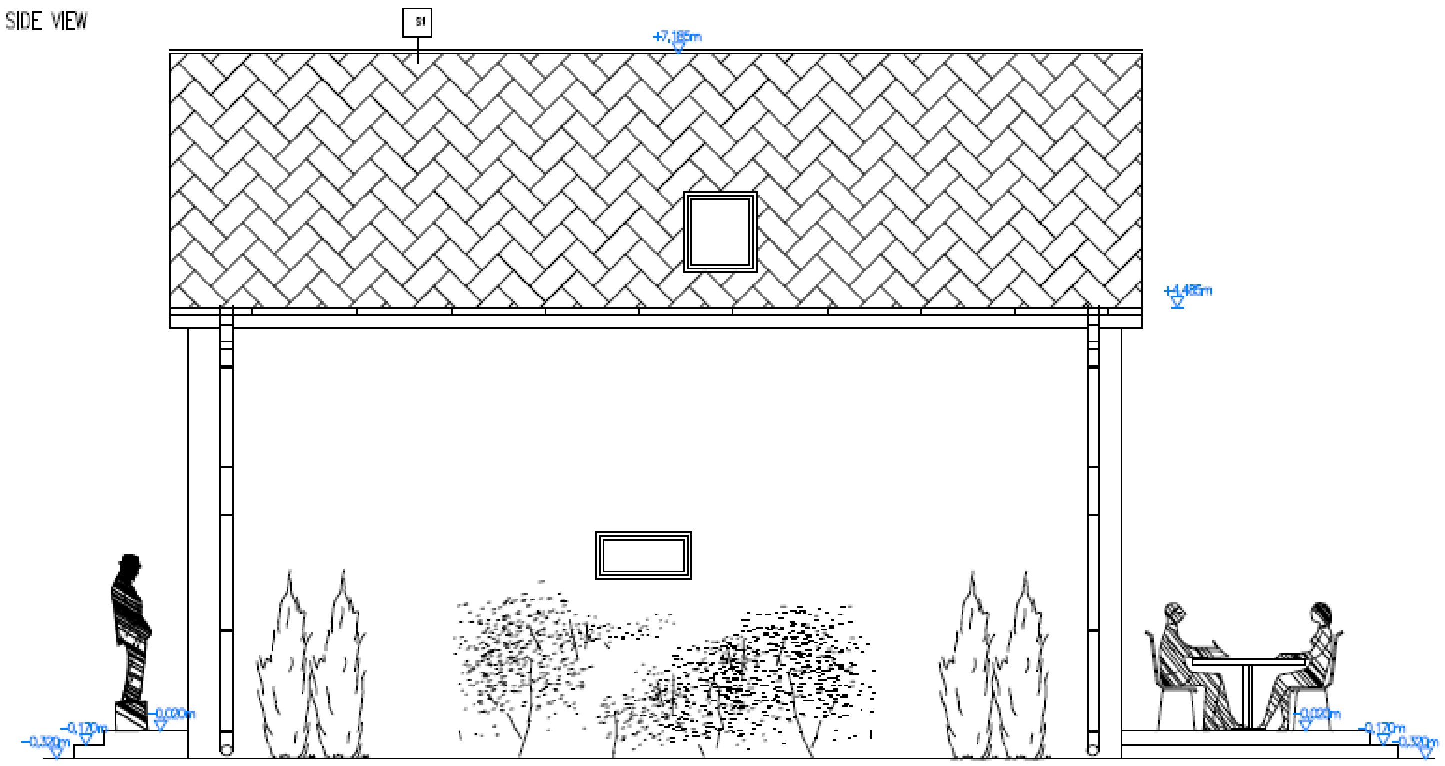
DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:

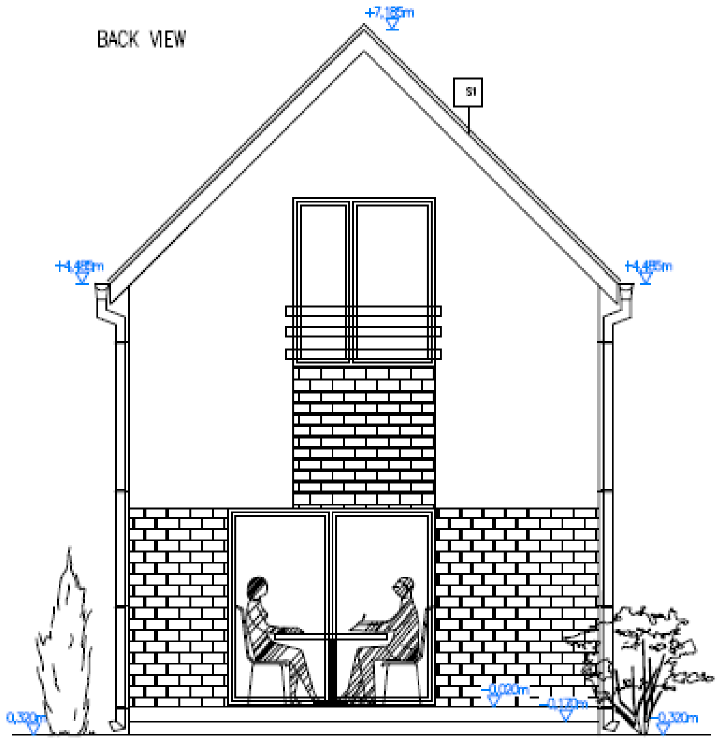
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

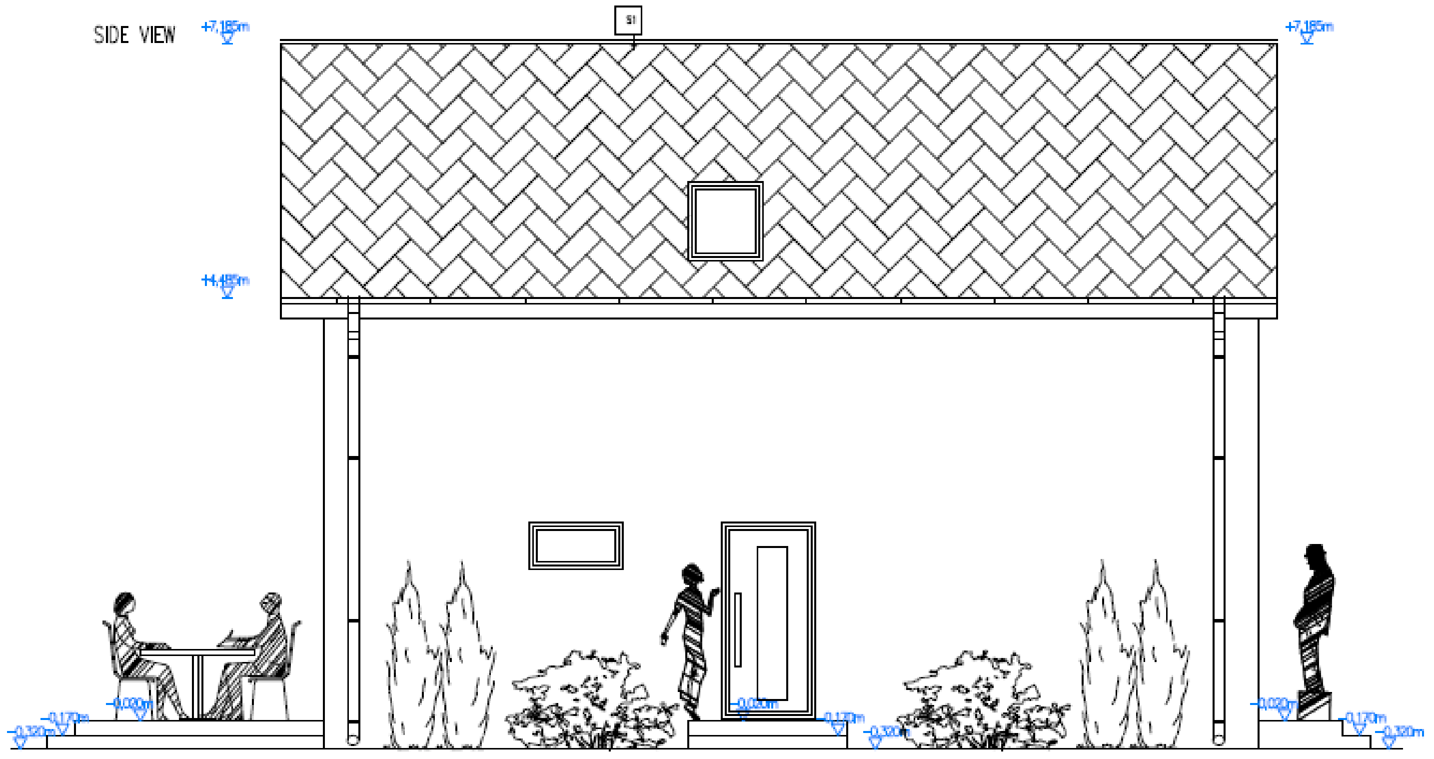
TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 2xA4	DRAWING NO.: A5
	SCALE: 1:50	
DRAWING: SECTION A–A'	DATE: 08/2025	

COTTAGE HOUSE / ELEVATIONS









LEGEND OF DESCRIPTIONS

- D/X — WOODEN CASED (UNBO) DOORS
- VD/X — ENTRANCE DOOR
- O/X — WINDOW / GLAZED WALL
- VM — VENTILATION GRILLE 150x150mm
- KV — SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM — THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 30, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 55,84m².
SLOPE OF THE ROOF 45,0°

FX FACADES

F1
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) – STO THERM CLASSIC 1
- FINISH COAT: STO COLOR LOTUSAN, WHITE COLOR (ALTERNATIVE COLOR OPTION)
- DECORATIVE PLASTER: STOLIT K / MP / R
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASEGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F – THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

F2
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) – STO THERM CLASSIC 1
- FACE BRICKS / BRICK TILES, NATURAL COLOR OR ANTHRACITE (ALTERNATIVE OPTION)
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASERGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F – THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

NOTES:

INSTALLATION AND APPLICATION OF THE ROOF COVERING MUST BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S TECHNICAL SPECIFICATIONS!

THE GUTTER SYSTEM MUST BE EQUIPPED WITH PROTECTIVE MESH.
THE ROOFING SYSTEM MUST BE EQUIPPED WITH ACCESSORIES (SNOW GUARDS, BIRD PROTECTION MESH).

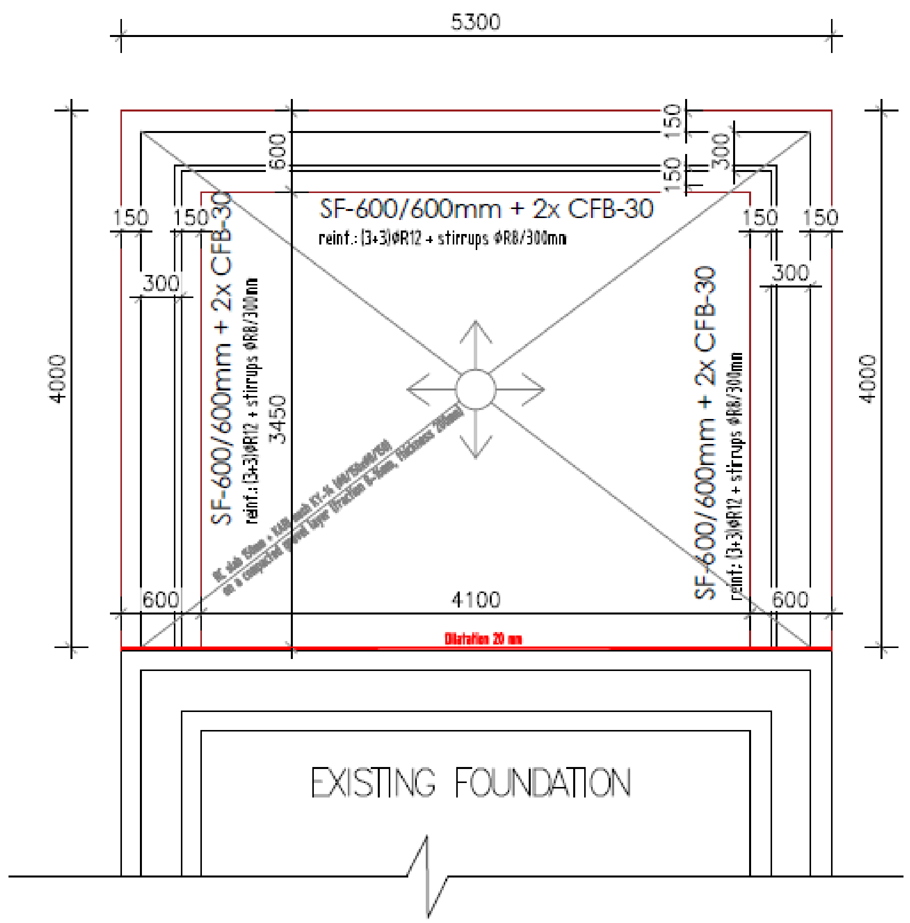
EAVES/ROOF EDGE COMPONENTS:
EAVES GUTTER ø125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
DOWNPIPE ø125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
ROOF FLASHING AT WALL JUNCTIONS
FACADE CHIMNEY FLASHING
VENT PIPE FLASHING

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4 / SCALE: 1:50 / DATE: 08/2025	DRAWING NO.: A6
DRAWING: ELEVATIONS		

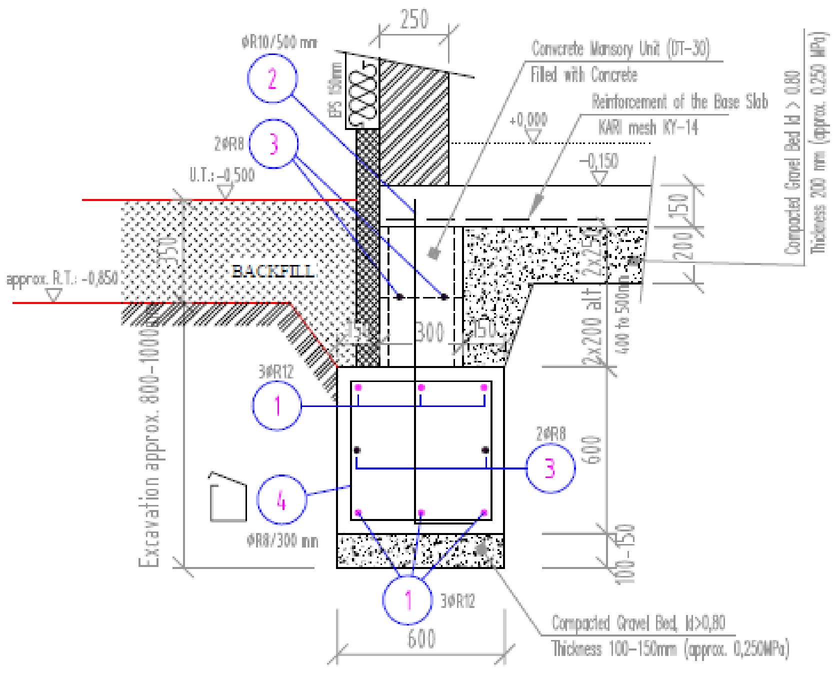
Appendix 2. Masonry-based extension proposal drawings

EXTENSION / FOUNDATION PLAN



Schematic reinforcement of foundations strips:

detail, scale 1:25



NOTES – GEOLOGY:

- Foundations are designed without an engineering-geological survey (IGP), based on the ASSUMED bearing capacity of the subsoil of 150 kPa (according to the principles of the 1st geo. category). However, before construction, it is necessary to verify that the actual soil in the foundation base corresponds to the design assumptions! A DETAILED ENGINEERING-GEOLOGICAL SURVEY IS STRONGLY RECOMMENDED!!!
- In the foundation base, standard soil conditions (estimated) are assumed, with fine-grained medium dense sandy to clayey soils of stiff consistency, medium plasticity, and a tabular bearing capacity Rdt = 150 kpa (without the influence of groundwater level).
- In the event that the actual foundation soils differ from the design assumptions, the proposed foundation method (dimensions, shape, reinforcement) must be reassessed and individually adjusted, or the foundation structures must be adapted to the actual soil conditions. If this is not done, the responsible author of the assessment does not take responsibility for any defects caused by incorrect foundation, faulty structures, or any resulting issues.

IMPORTANT WARNINGS:

- In the area where the family house is to be built, I strongly warn about the possible presence of fill materials, highly plastic fine-grained soils, loose to liquid sands/gravels in the foundation subsoil (low bearing capacity, compressibility, volume instability, and sensitivity to water). their consistency and compaction state are influenced by moisture or groundwater. therefore, I strongly RECOMMEND carrying out a detailed geotechnical survey to determine the actual soil conditions in the foundation trench.

- During excavation work or after exposing the foundation trench, it is recommended to invite a responsible geologist and structural engineer to ensure that the identified conditions (geotechnical parameters and classification of foundation soils) are in accordance with the project documentation (to verify design assumptions), and, if necessary, to carry out essential modifications.
- During foundation works, it is necessary to prevent potential moisture increase – such as from roof drainage, rain, utility network failures – and to protect the foundation trench from weather conditions (to avoid degradation of the foundation soil), as these factors may cause changes in the consistency of cohesive soils and a subsequent reduction in their bearing capacity (due to altered properties of the foundation soils compared to the initial design assumptions)!
- Uncovering of the foundation trench is recommended to be carried out immediately before concreting works (to minimize the risk of damage to the trench due to weather or mechanical influences). excavation work should be done during dry periods, and the foundation trench must be protected from soaking, freezing, and flooding – therefore, the last 100 mm of the covering soil layer should be removed just before concreting, and the bottom of the trench should be cleaned manually! immediately after excavation, create a layer of compacted gravel bedding / blinding concrete to protect the foundation trench, and FOUNDATIONS MAY ONLY BE BUILT ON UNDISTURBED FOUNDATION TRENCHES!

Before starting excavation work, it is absolutely necessary to mark all underground utilities and service lines located on the subject plot!

Before starting the concreting of foundations, it is necessary to mark and leave openings for the passage of pipes / cables through the foundation structures.

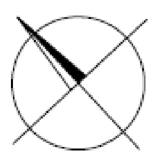
Concrete: C 20/25
Reinf. steel: B-500B (O 10505-R)
Concrete cover: 50mm - strip footing, 30mm - slab

Foundation slab reinforcement:
(blinding concrete)
- welded mesh rein. at the bottom surface, type KY-14 (KY-14 = Ø8/150 x Ø8/150 -2400x6000mm)
- lap splice length of welded mesh: 450mm (3 mesh openings in both directions)

NOTES

Before starting foundation concreting, it is necessary to mark locations and leave openings for the passage of sewer pipelines through the foundation structure.
Compacted sub-base layer bearing capacity: 0.25 MPa.
Before casting the blinding concrete layer, underground sewer pipelines must be installed in accordance with the design documentation (sanitary engineering section). After installation of strip foundations, place gravel backfill, thickness 200 mm.
Verification of foundation soil conditions at foundation trench level and determination of groundwater presence in the subsoil must be carried out prior to casting blinding concrete. If conditions differ from the design assumptions, it is necessary to adjust foundation dimensions accordingly.
Quantity of crushed gravel bedding (fraction 0/32) for area approx. 29.25 m^2: approx. 5.85 m^3.
Concrete volume for strip foundations: approx. 4.34 m^3.
Concrete volume for foundation slab, thickness 150 mm, area 19.25 m^2: approx. 2.90 m^3.
Other concreting works: footings, foundation strip edges, lintel supports, reinforced slabs, stairs.
Concrete grade: STN EN 206 – C 20/25 – XC2 (SK) – Cl 0.4 – Dmax 16 – S2.
Reinforcement steel: B500B (STN 10505–R).
Concrete cover: 50 mm for strip foundations, 30 mm for foundation slab.

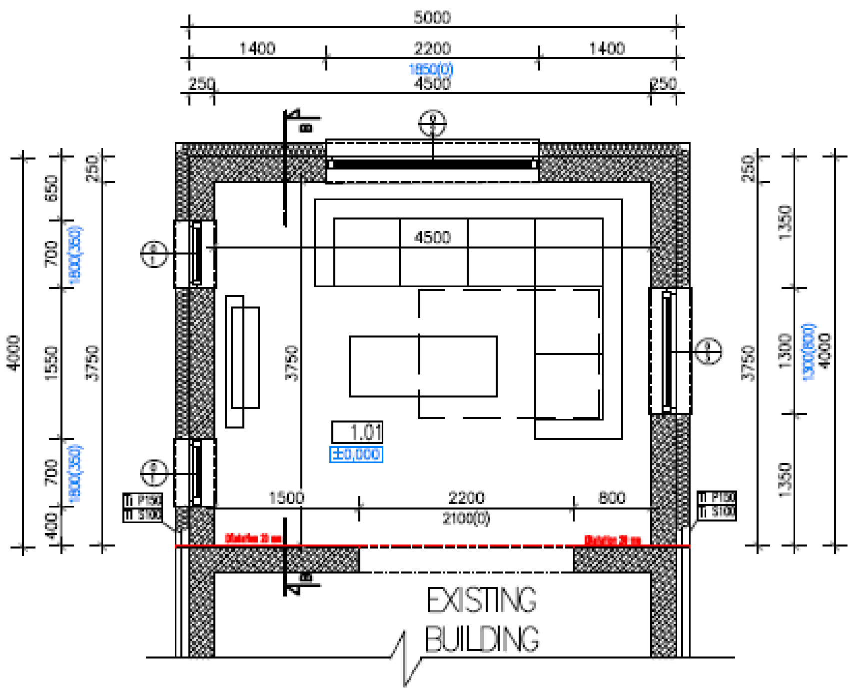
NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.



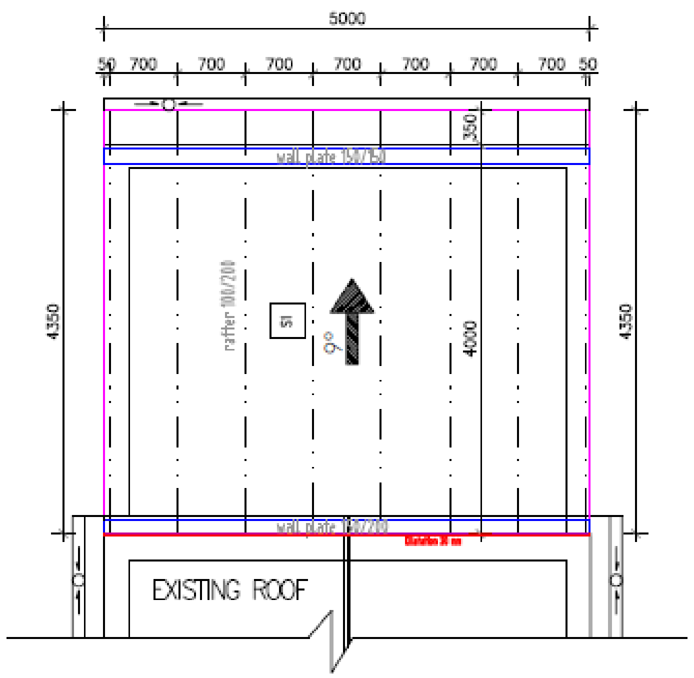
DESIGNER: DORA NAGY
RESPONSIBLE DESIGNER:
STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION
TITLE: COTTAGE HOUSE
PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY:
DISTRICT:
INVESTOR:
STRUCTURE: COTTAGE HOUSE
DRAWING: FOUNDATION PLAN
SHEET SIZE: 2xA4
SCALE: 1:50
DATE: 01/2026
DRAWING NO.: B1

EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION B–B'

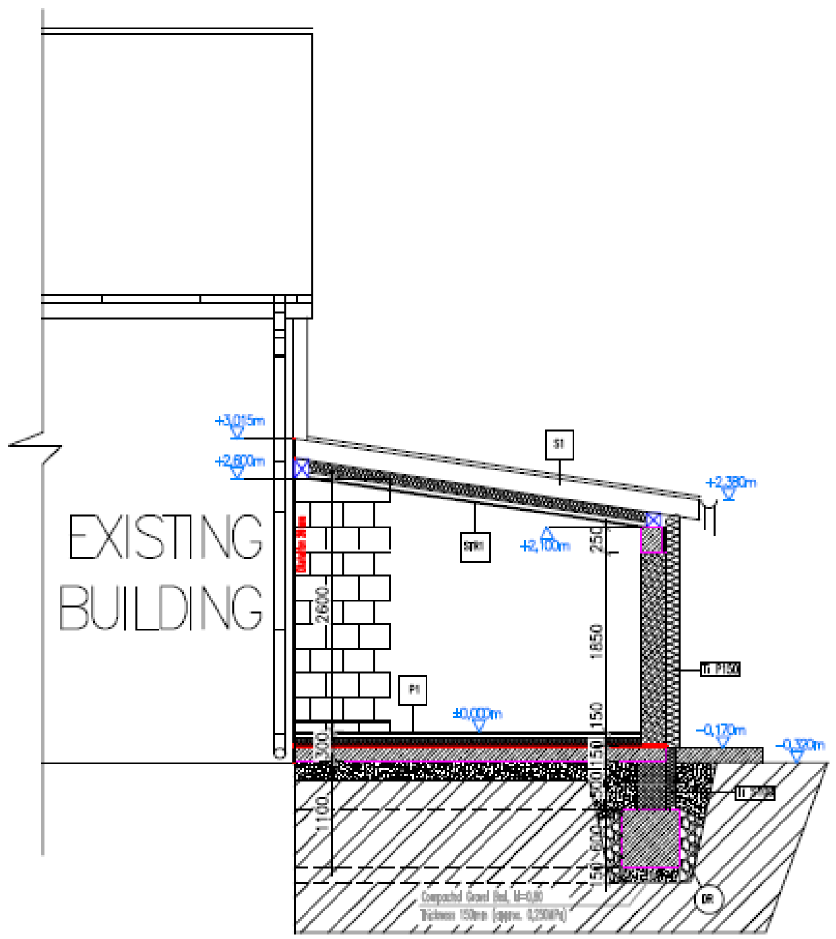
GROUND FLOOR PLAN



ROOF PLAN



SECTION B–B'



LEGENDS OF MATERIALS

- EXTERIOR AND LOAD-BEARING MASONRY POROTHERM PROFI 25 (P12), thickness 250mm, with thin-layer full-surface adhesive POROTHERM PROFI, WITH EXTERNAL INSULATION SYSTEM BAUMIT EPS-F thickness 150mm AND INTERNAL PLASTER
- CONCRETE FORM BLOCKS (DFB) DF-30 – thickness 300mm
- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL EMBANKMENT – DANUBE GRAVEL, FRACTION #20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION #20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

PX FLOORS

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – PIR (POLYISOCYANURATE) thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

STRX CEILINGS

STR1
- TIMBER RAFTERS (ACCORDING TO STRUCTURAL CALCULATION)
- CAVITY INFILL BETWEEN JOISTS WITH MINERAL WOOL, thickness 200 mm
- THERMAL INSULATION – MINERAL WOOL, thickness 100 mm
- VAPOUR-PERMEABLE MEMBRANE
- 2 × OSB BOARDS, thickness 18 mm
- SUSPENDED GYPSUM BOARD CEILING, thickness 12.5 mm

LEGEND OF DESCRIPTIONS

- D/X WOODEN CASED (LINED) DOORS
- VD/X ENTRANCE DOOR
- O/X WINDOW / GLAZED WALL
- VM VENTILATION GRILLE 150x150mm
- KV SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC–WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 21,75m².
SLOPE OF THE ROOF 9°

LEGEND

ROOM NO.	ROOM NAME	FLOORS	WALLS	CEILING TYPE	AREA /m²
1.01	LIVING ROOM	P1	GYPSUM PLASTER (S.O.)	STR1	16.88
TOTAL USABLE FLOOR AREA					16.88

NOTES:
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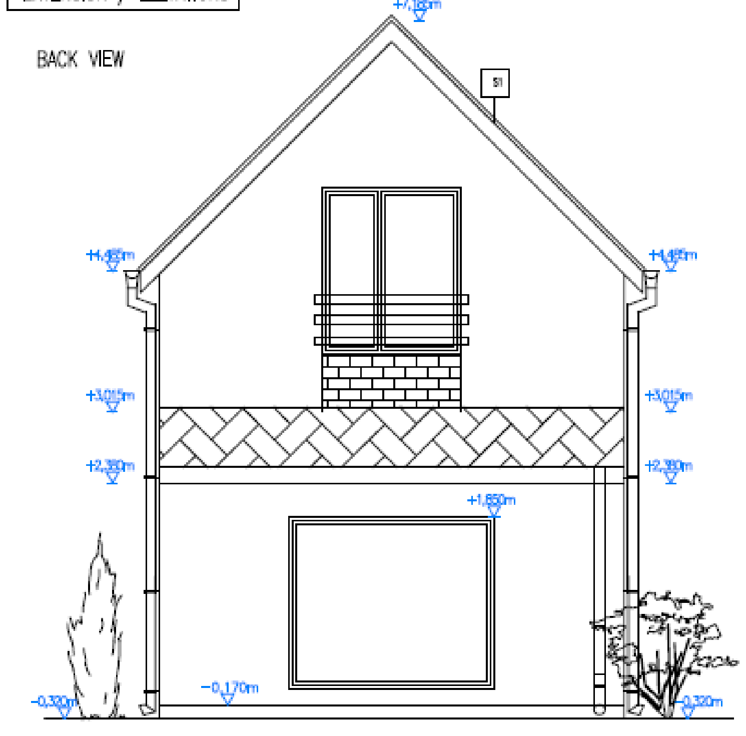
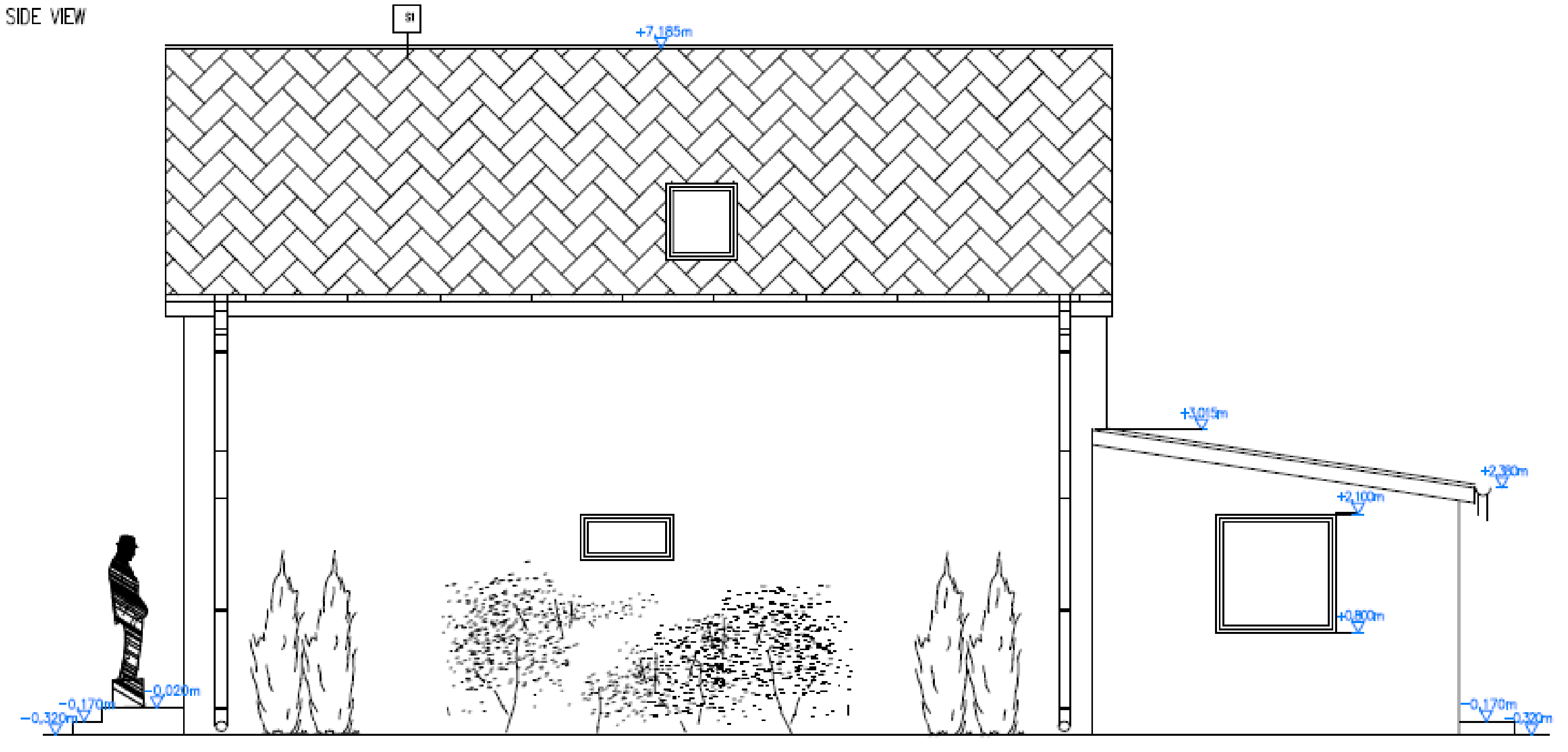
DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4 / SCALE: 1:50 / DATE: 01/2026	DRAWING NO.: B2
DRAWING: EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION B–B'		

EXTENSION / ELEVATIONS

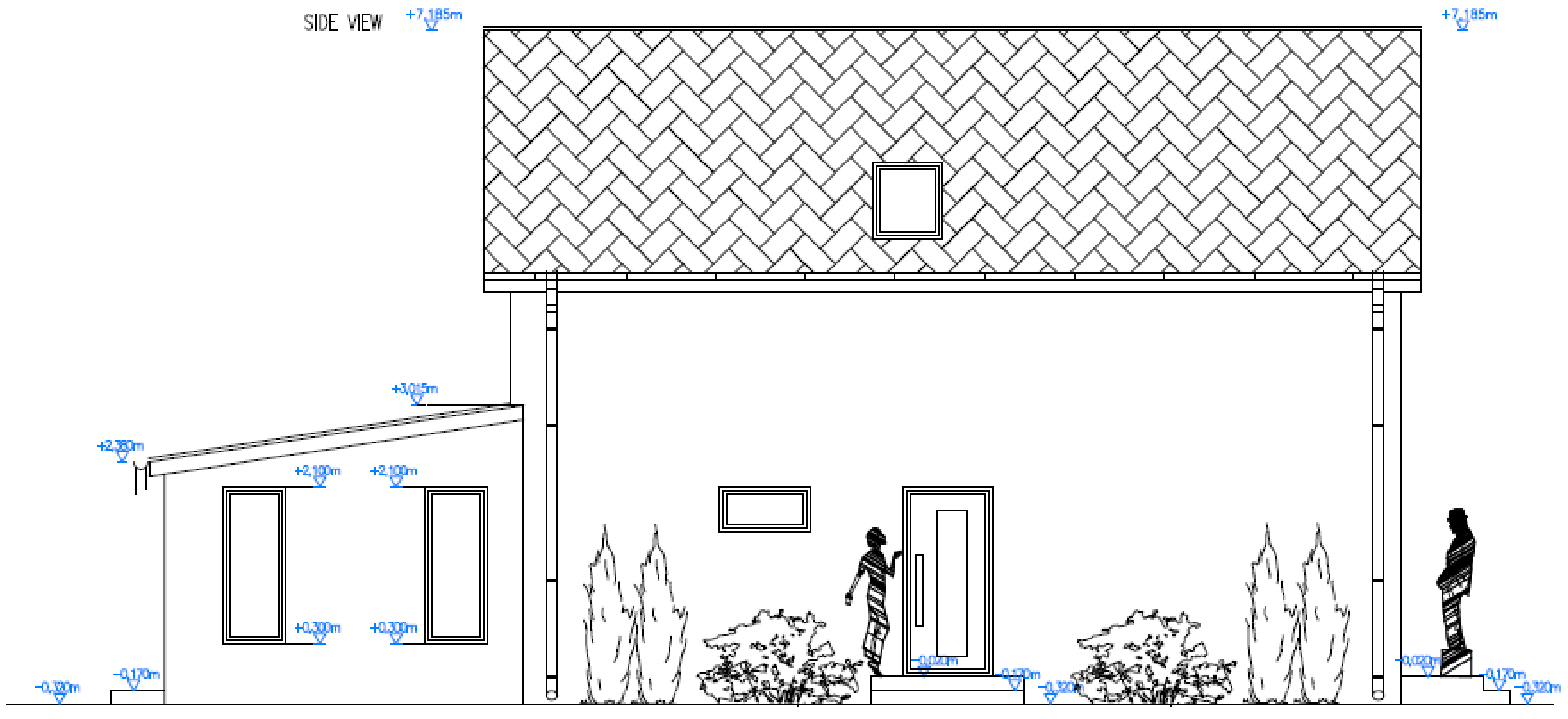
BACK VIEW



SIDE VIEW



SIDE VIEW



LEGEND OF DESCRIPTIONS

- WOODEN CASED (LINED) DOORS
- ENTRANCE DOOR
- WINDOW / GLAZED WALL
- VENTILATION GRILLE 150x150mm
- SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION - MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION - FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION - STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 21,75m².
SLOPE OF THE ROOF 9°

FX FACADES

F1
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) - STO THERM CLASSIC 1
- FINISH COAT: STO COLOR LOTUSAN, WHITE COLOR (ALTERNATIVE COLOR OPTION)
- DECORATIVE PLASTER: STOLIT K / MP / R
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASEGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F - THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

F2
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) - STO THERM CLASSIC 1
- FACE BRICKS / BRICK TILES, NATURAL COLOR OR ANTHRACITE (ALTERNATIVE OPTION)
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASERGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F - THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

NOTES:

INSTALLATION AND APPLICATION OF THE ROOF COVERING MUST BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S TECHNICAL SPECIFICATIONS!

THE GUTTER SYSTEM MUST BE EQUIPPED WITH PROTECTIVE MESH.
THE ROOFING SYSTEM MUST BE EQUIPPED WITH ACCESSORIES (SNOW GUARDS, BIRD PROTECTION MESH).

EAVES/ROOF EDGE COMPONENTS:
EAVES GUTTER ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
DOWNPIPE ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
ROOF FLASHING AT WALL JUNCTIONS
FACADE CHIMNEY FLASHING
VENT PIPE FLASHING

NOTES:
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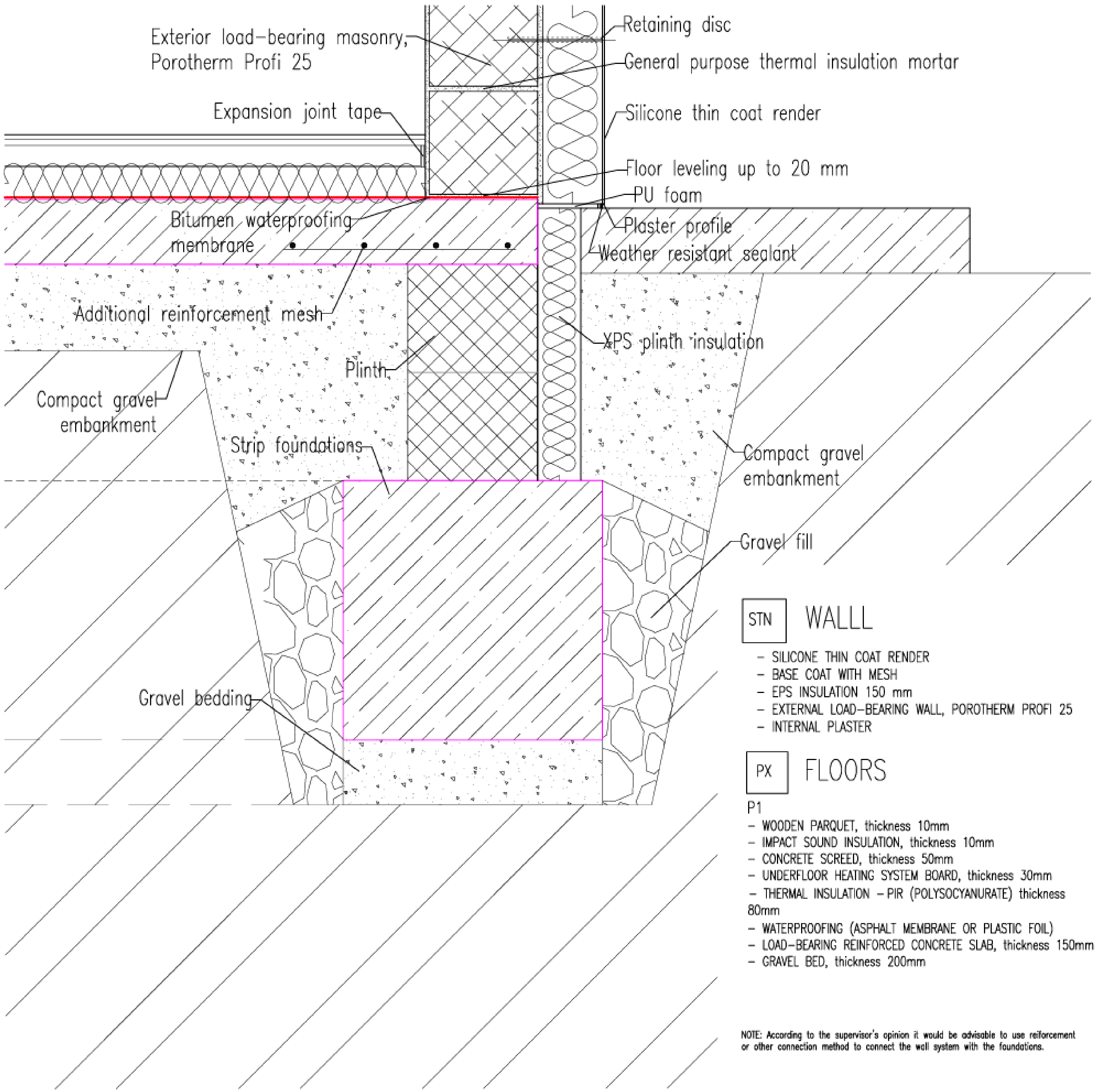
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.: B3
DRAWING: ELEVATIONS	SCALE: 1:50 / DATE: 01/2026	



STN	WALLL

- SILICONE THIN COAT RENDER
- BASE COAT WITH MESH
- EPS INSULATION 150 mm
- EXTERNAL LOAD-BEARING WALL, POROTHERM PROFI 25
- INTERNAL PLASTER

PX	FLOORS

P1

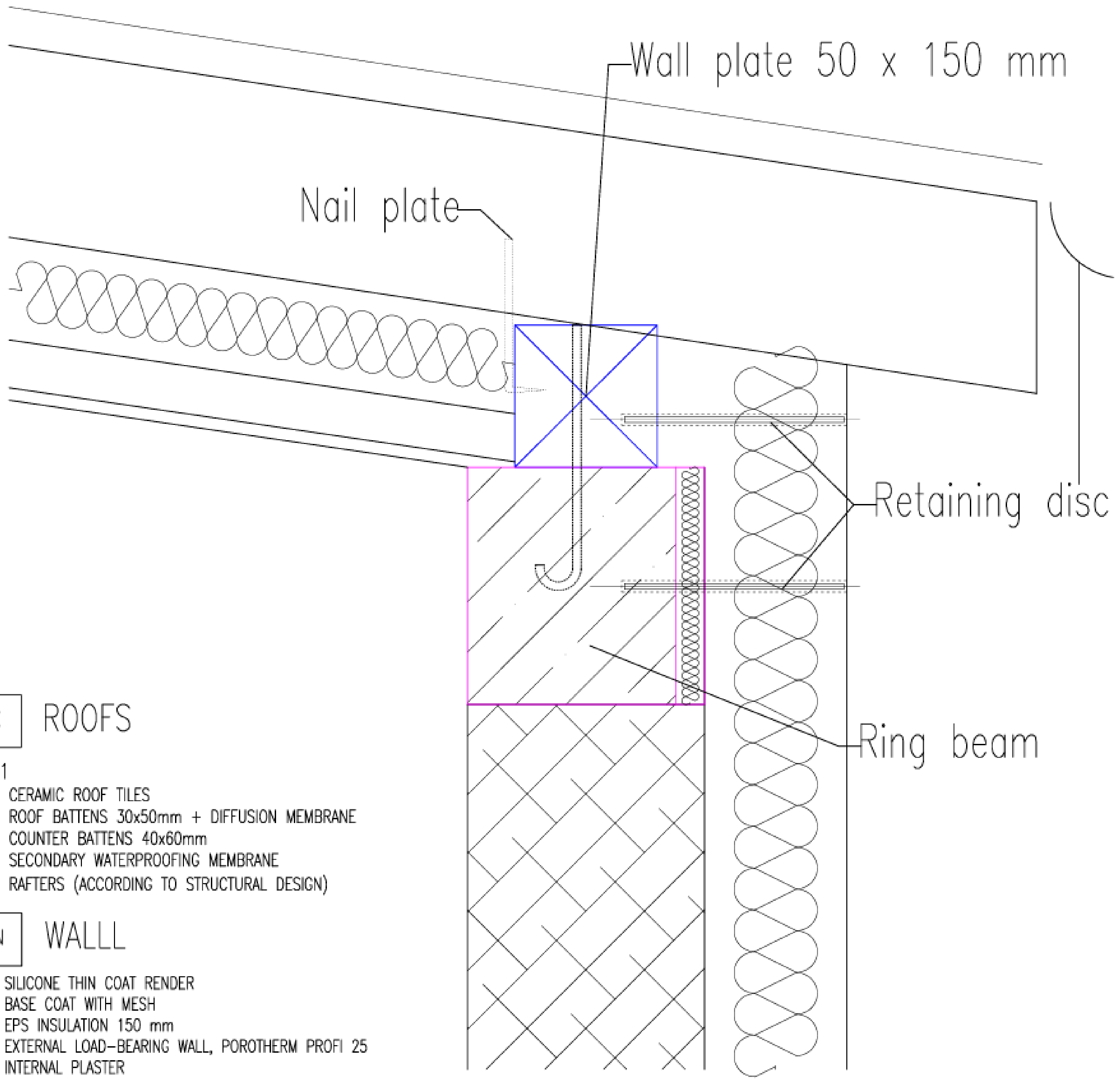
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – PIR (POLYSOCYANURATE) thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD-BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

NOTE: According to the supervisor's opinion it would be advisable to use reinforcement or other connection method to connect the wall system with the foundations.

DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.:
DRAWING: DETAIL DRAWING	SCALE: 1:5	
	DATE: 04/2026	



SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

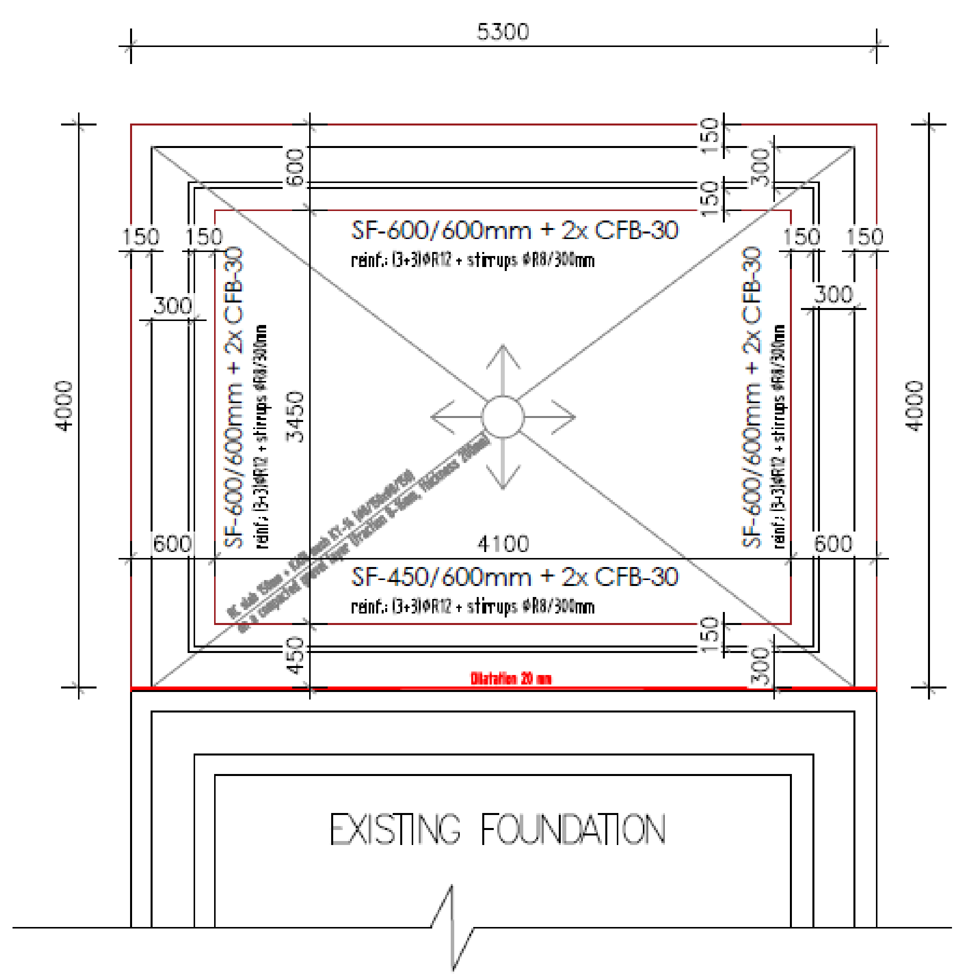
STN WALLL

- SILICONE THIN COAT RENDER
- BASE COAT WITH MESH
- EPS INSULATION 150 mm
- EXTERNAL LOAD-BEARING WALL, POROTHERM PROFI 25
- INTERNAL PLASTER

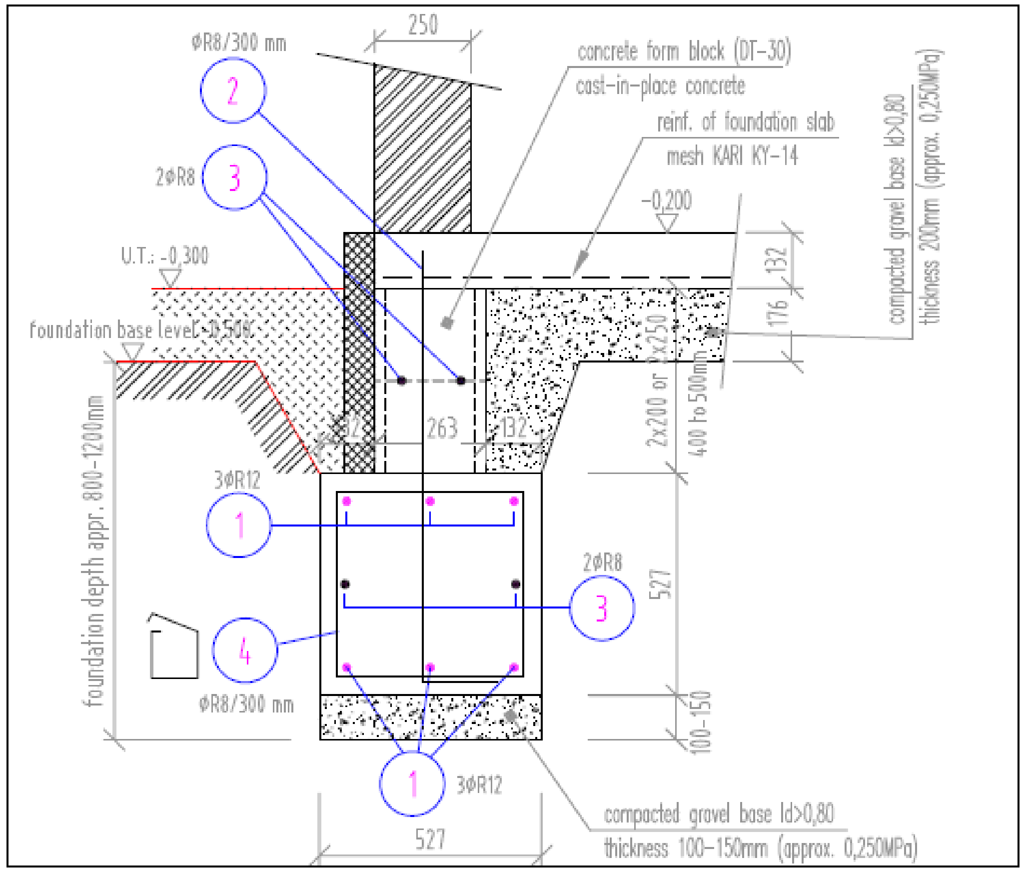
DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.:
DRAWING: DETAIL DRAWING	SCALE: 1:5	
	DATE: 04/2026	

Appendix 3. Modular section extension proposal drawings

EXTENSION / FOUNDATION PLAN



SCHEMATIC REINFORCEMENT OF STRIP FOUNDATIONS:



NOTES – GEOLOGY:

- Foundations are designed without an engineering-geological survey (IGP), based on the ASSUMED bearing capacity of the subsoil of 150 kPa (according to the principles of the 1st geo. category). However, before construction, it is necessary to verify that the actual soil in the foundation base corresponds to the design assumptions! A DETAILED ENGINEERING-GEOLOGICAL SURVEY IS STRONGLY RECOMMENDED!!!
- In the foundation base, standard soil conditions (estimated) are assumed, with fine-grained medium dense sandy to clayey soils of stiff consistency, medium plasticity, and a tabular bearing capacity Rdt = 150 kpa (without the influence of groundwater level).
- In the event that the actual foundation soils differ from the design assumptions, the proposed foundation method (dimensions, shape, reinforcement) must be reassessed and individually adjusted, or the foundation structures must be adapted to the actual soil conditions. If this is not done, the responsible author of the assessment does not take responsibility for any defects caused by incorrect foundation, faulty structures, or any resulting issues.

IMPORTANT WARNINGS:

- In the area where the family house is to be built, I strongly warn about the possible presence of fill materials, highly plastic fine-grained soils, loose to liquid sands/gravels in the foundation subsoil (low bearing capacity, compressibility, volume instability, and sensitivity to water). their consistency and compaction state are influenced by moisture or groundwater. therefore, I strongly RECOMMEND carrying out a detailed geotechnical survey to determine the actual soil conditions in the foundation trench.
- During excavation work or after exposing the foundation trench, it is recommended to invite a responsible geologist and structural engineer to ensure that the identified conditions (geotechnical parameters and classification of foundation soils) are in accordance with the project documentation (to verify design assumptions), and, if necessary, to carry out essential modifications.
- During foundation works, it is necessary to prevent potential moisture increase – such as from roof drainage, rain, utility network failures – and to protect the foundation trench from weather conditions (to avoid degradation of the foundation soil), as these factors may cause changes in the consistency of cohesive soils and a subsequent reduction in their bearing capacity (due to altered properties of the foundation soils compared to the initial design assumptions)!
- Uncovering of the foundation trench is recommended to be carried out immediately before concreting works (to minimize the risk of damage to the trench due to weather or mechanical influences). excavation work should be done during dry periods, and the foundation trench must be protected from soaking, freezing, and flooding – therefore, the last 100 mm of the covering soil layer should be removed just before concreting, and the bottom of the trench should be cleaned manually! immediately after excavation, create a layer of compacted gravel bedding / blinding concrete to protect the foundation trench, and FOUNDATIONS MAY ONLY BE BUILT ON UNDISTURBED FOUNDATION TRENCHES!

Before starting excavation work, it is absolutely necessary to mark all underground utilities and service lines located on the subject plot!

Before starting the concreting of foundations, it is necessary to mark and leave openings for the passage of pipes / cables through the foundation structures.

Concrete: C 20/25
Reinf. steel: B-500B (O 10505-R)
Concrete cover: 50mm - strip footing, 30mm - slab

Foundation slab reinforcement:
(blinding concrete)
- welded mesh rein. at the bottom surface, type KY-14
  (KY-14 = Ø8/150 x Ø8/150 -2400x6000mm)
- lap splice length of welded mesh: 450mm
  (3 mesh openings in both directions)

NOTES

Before starting foundation concreting, it is necessary to mark locations and leave openings for the passage of sewer pipelines through the foundation structure.
Compacted sub-base layer bearing capacity: 0.25 MPa.
Before casting the blinding concrete layer, underground sewer pipelines must be installed in accordance with the design documentation (sanitary engineering section). After installation of strip foundations, place gravel backfill, thickness 200 mm.
Verification of foundation soil conditions at foundation trench level and determination of groundwater presence in the subsoil must be carried out prior to casting blinding concrete. If conditions differ from the design assumptions, it is necessary to adjust foundation dimensions accordingly.
Quantity of crushed gravel bedding (fraction 0/32) for area approx. 29.25 m^2: approx. 5.85 m^3.
Concrete volume for strip foundations: approx. 4.65. m^3.
Concrete volume for foundation slab, thickness 150 mm, area 19.25 m^2: approx. 2.90 m^3.
Other concreting works: footings, foundation strip edges, lintel supports, reinforced slabs, stairs.
Concrete grade: STN EN 206 - C 20/25 - XC2 (SK) - Cl 0.4 - Dmax 16 - S2.
Reinforcement steel: B500B (STN 10505-R).
Concrete cover: 50 mm for strip foundations, 30 mm for foundation slab.

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

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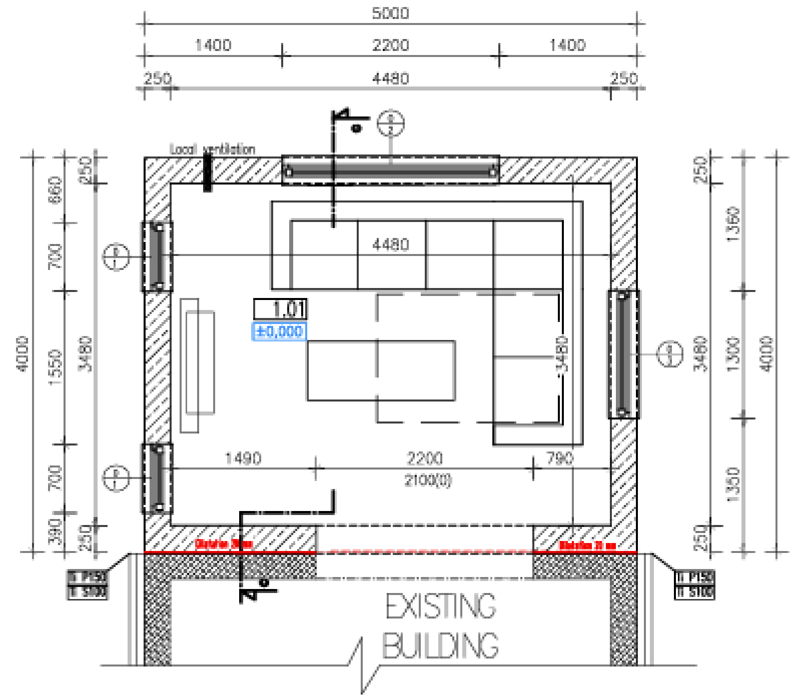
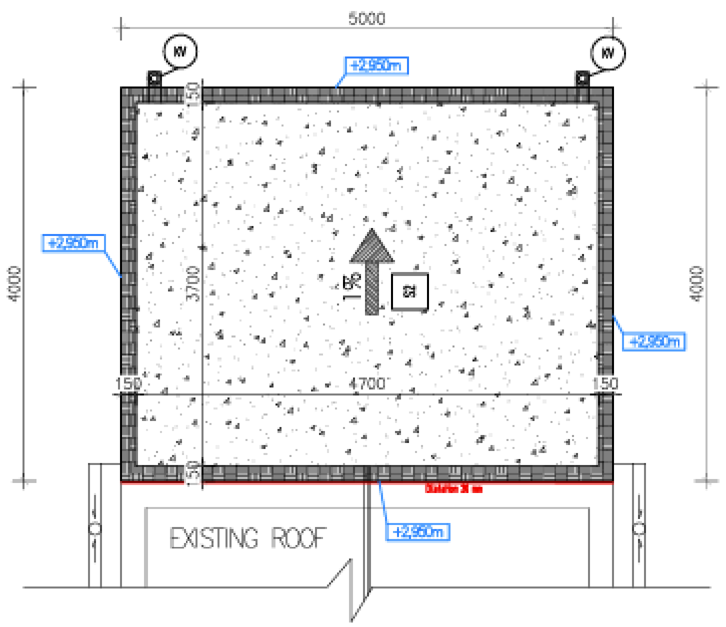
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 2xA4 / SCALE: 1:50	DRAWING NO.: C1
DRAWING: FOUNDATION PLAN	DATE: 02/2026	

EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION C–C'

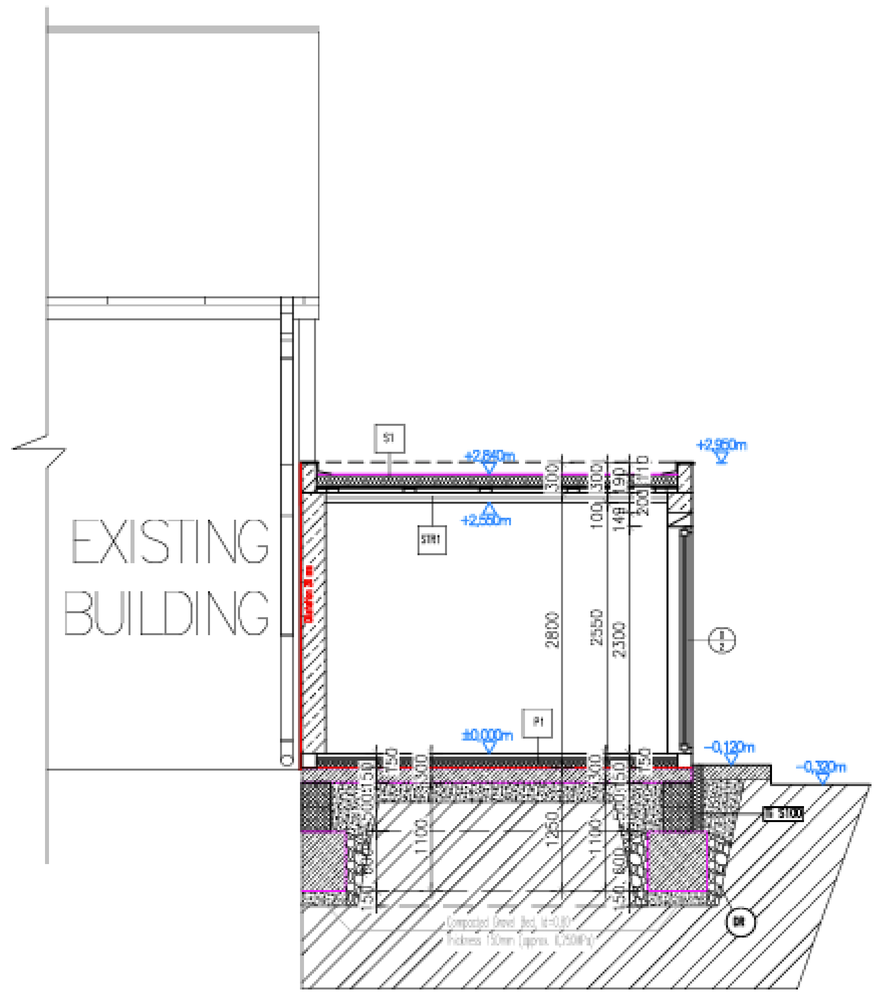
GROUND FLOOR PLAN



ROOF PLAN



SECTION C–C'



LEGENDS OF MATERIALS

- LOAD–BEARING WALL – ST1, thickness 250 mm
- CONCRETE FORM BLOCKS (CFB) DT–30 – thickness 300mm
- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL BEDDING – DANUBE GRAVEL, FRACTION #20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION #20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

FX FACADES

F1
CONTACT FACADE SYSTEM STO THERM CLASSIC 1
- COATING STO COLOR LOTUSAN, WHITE PAINT (ALT. SELECTION)
- PLASTER STOLITK MP/R
- FIBERGLASS MESH STO GLASSFASERGEWEBE
- REINFORCING COMPOUND STO ARMAT CLASSIC (CEMENT–FREE SYSTEM)
- ADHESIVE STO BAUKLEBER

F2
CONTACT FACADE SYSTEM STO THERM CLASSIC 1
- FACING BRICKS, NATURAL COLOR ALT. ANTHRACITE
- FIBERGLASS MESH STO GLASSFASERGEWEBE
- REINFORCING COMPOUND STO ARMAT CLASSIC (CEMENT–FREE SYSTEM)
- ADHESIVE STO BAUKLEBER

STX WALL

ST1
- INSULATION SLOVIZOL, thickness 100 mm + plaster, thickness 2 mm
- STEEL FRAME
- OSB/FERMACELL BOARD, thickness 15 mm
- BREATHABLE MEMBRANE JUTADACH 135
- INSULATION – MINERAL WOOL ISOVER – UNIROL PROFI thickness 120mm
- TIMBER C24 120x45mm
- VAPOR BARRIER GUTTAFOL ALU
- GYPSUM BOARD KNAUF DIAMANT X thickness 12,5mm
- PLASTERING AND BASE COAT PAINTING IN WHITE

STRX CEILING

STR1
- CEILING PROFILE UD
- CEILING PROFILE CD
- VAPOR BARRIER GUTTAFOL ALU
- GYPSUM BOARD KNAUF DIAMANT X thickness 12,5mm
- PLASTERING AND BASE COAT PAINTING – WHITE

SX ROOF

S1
- DOWNPIPES, GUTTERS – KJG SYSTEM
- ROOFING MEMBRANE FATRAFOL 810V thickness 1,5mm
- INSULATION ISOVER – UNIROL PROFI thickness 120mm
- GEOTEXTILE 300 g/m^2
- ATTIC FLASHING AL ANTRACIT thickness 0,8mm
- OSB3 BOARD thickness 15mm
- TIMBER C24 120x45mm

PX FLOOR

P1
- WOODEN PARQUET thickness 10mm
- LEVELING COMPOUND thickness 30mm
- SKIRTING BOARD + ACCESSORIES
- UNDERFLOOR HEATING WARMUP WITH THERMOSTAT
- FARMACELL BOARD thickness 15mm
- OSB3 BOARD thickness 15mm
- THERMAL INSULATION – PIR (POLYISOCYANURATE) thickness 80mm
- SHAPED GALVANIZED SHEET METAL T8
- VAPOR BARRIER GUTTAFOL ALU
- REINFFORCED CONCRETE SLAB thickness 150mm
- GRAVEL BASE LAYER thickness 200mm

LEGEND OF DESCRIPTIONS

- D/X – WOODEN CASED (LINED) DOORS
- VD/X – ENTRANCE DOOR
- O/X – WINDOW / GLAZED WALL
- VM – VENTILATION GRILLE 150x150mm
- KV – SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM – THREE–COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- TI MX – THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- TI PX – THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- TI SX – THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm

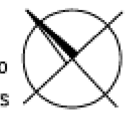
LEGEND OF ROOF DESCRIPTIONS

ROOF COVERAGE
ROOF AREA OF THE COTTAGE HOUSE : 20,00m^2.
SLOPE OF THE ROOF 1°

LEGEND

ROOM NO.	ROOM NAME	FLOORS	WALLS	CEILING TYPE	AREA /m^2
1.01	LIVING ROOM	P1	GYPSUM PLASTER (S.O.)	STR1	15.60
TOTAL USABLE FLOOR AREA					15.60

NOTES:
ANY POTENTIAL CHANGES TO THE PROJECT MUST BE CONSULTED WITH THE AUTHOR BEFORE IMPLEMENTATION. THEIR EXECUTION IS ONLY POSSIBLE WITH THEIR WRITTEN CONSENT.
ANY AMBIGUITIES OR INCONSISTENCIES IN THE PROJECT MUST BE REPORTED TO THE RESPONSIBLE PROJECT DESIGNER.
THE DESIGNED DIMENSIONS OF ALL CONSTRUCTION PRODUCTS AND STRUCTURES MUST BE VERIFIED BY ON–SITE MEASUREMENT BEFORE BEING ORDERED FOR PRODUCTION.
ANY CHANGES DURING CONSTRUCTION MUST BE CONSULTED WITH THE PROJECT DESIGNER.



DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE

PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY:
DISTRICT:

INVESTOR:

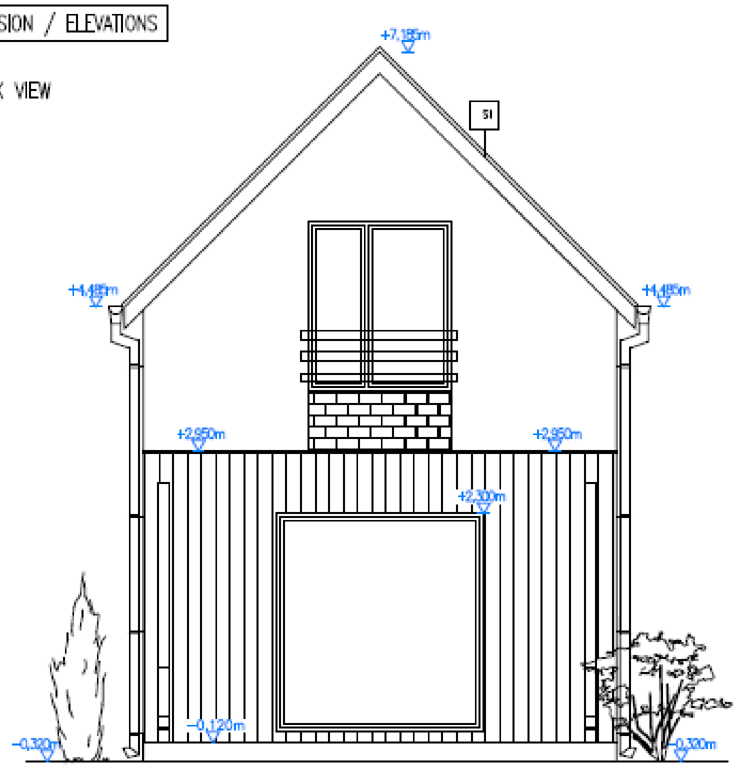
STRUCTURE: COTTAGE HOUSE

DRAWING: EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION C–C'

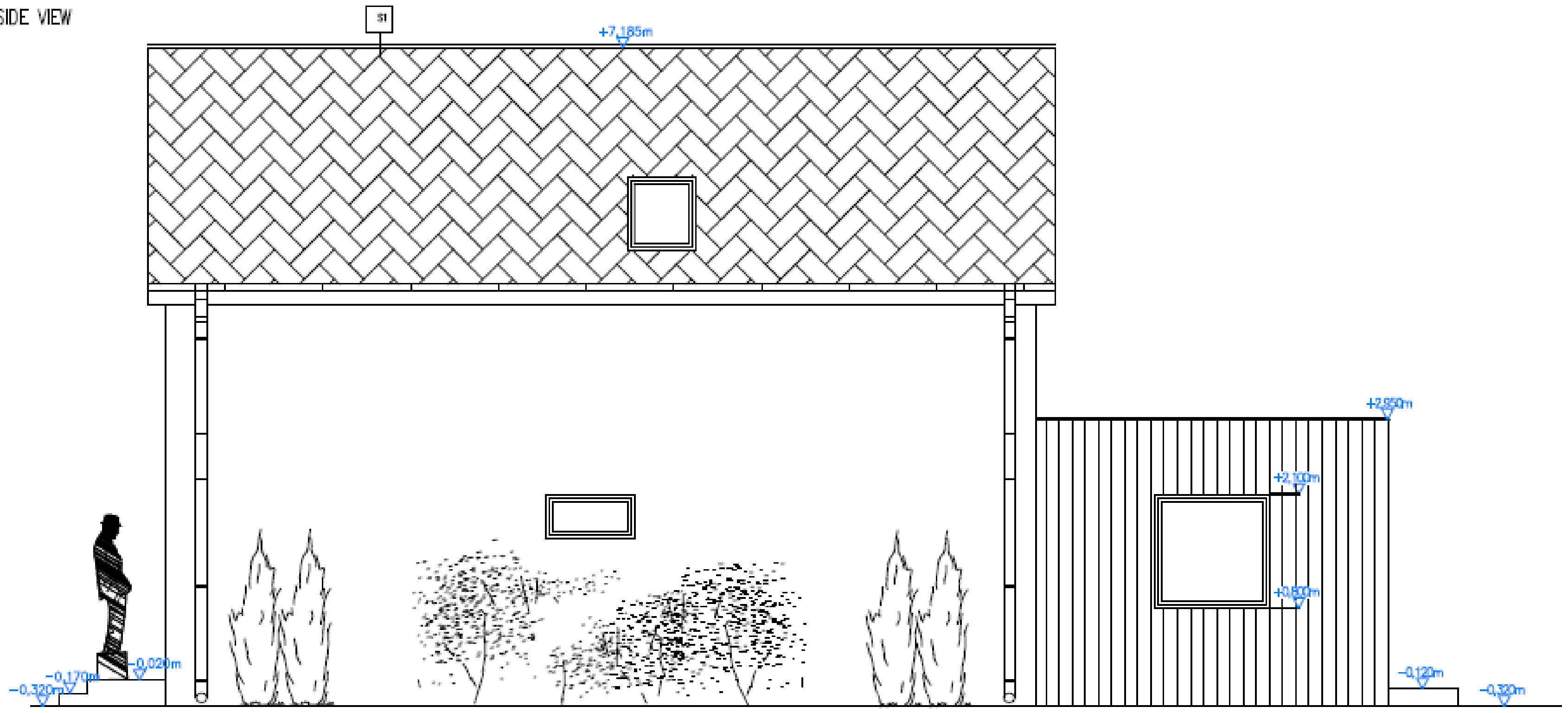
SHEET SIZE: 4xA4
SCALE: 1:50
DATE: 02/2008
DRAWING NO.: C2

EXTENSION / ELEVATIONS

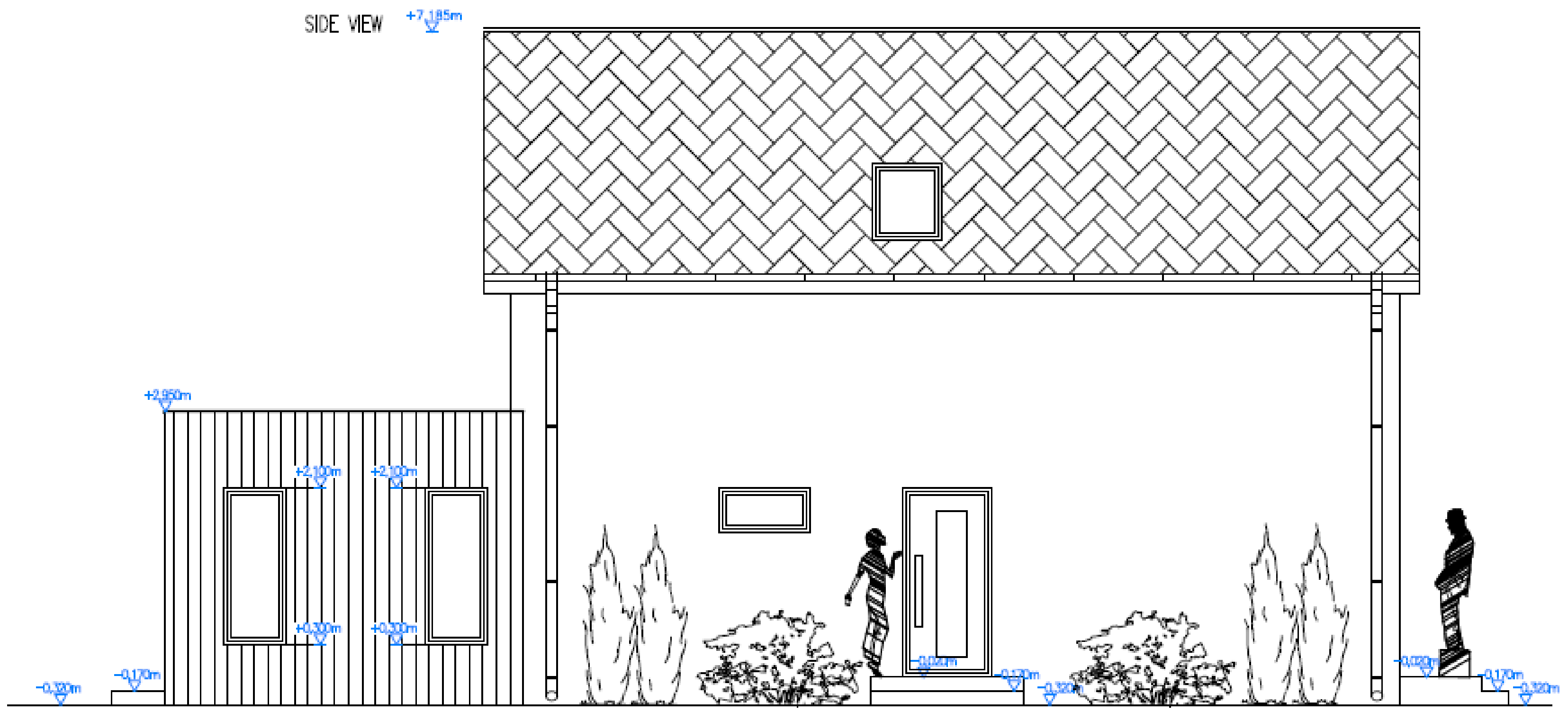
BACK VIEW



SIDE VIEW



SIDE VIEW



LEGEND OF DESCRIPTIONS

- WOODEN CASED (LINED) DOORS
- ENTRANCE DOOR
- WINDOW / GLAZED WALL
- VM — VENTILATION GRILLE 150x150mm
- KV — SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM — THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOF

S1
- DOWNPIPES, GUTTERS – KJG SYSTEM
- INSULATION ISOVER – UNIROL PROFI thickness 120mm
- GEOTEXTILE 300 g/m²
- ROOFING MEMBRANE FATRAFOL 810V thickness 1,5mm
- ATTIC FLASHING AL ANTRACIT thickness 0,8mm
- OSB3 BOARD thickness 15mm
- TIMBER C24 120x45mm

LEGEND OF ROOF DESCRIPTIONS

ROOF COVERAGE
ROOF AREA OF THE COTTAGE HOUSE : 20,00m².
SLOPE OF THE ROOF 1°

FX FACADES

F1
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) – STO THERM CLASSIC 1
- FINISH COAT: STO COLOR LOTUSAN, WHITE COLOR (ALTERNATIVE COLOR OPTION)
- DECORATIVE PLASTER: STOLITK / MP / R
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASEGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F – THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

F2
EXTERNAL THERMAL INSULATION COMPOSITE SYSTEM (ETICS) – STO THERM CLASSIC 1
- FACE BRICKS / BRICK TILES, NATURAL COLOR OR ANTHRACITE (ALTERNATIVE OPTION)
- GLASS FIBER REINFORCEMENT MESH: STO GLASSFASERGEWEBE
- REINFORCEMENT MORTAR: STO ARMAT CLASSIC (CEMENT-FREE SYSTEM)
- THERMAL INSULATION: EPS 100F – THICKNESS ACCORDING TO DESIGN
- ADHESIVE: STO BAUKLEBER

NOTES:

INSTALLATION AND APPLICATION OF THE ROOF COVERING MUST BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S TECHNICAL SPECIFICATIONS!

THE GUTTER SYSTEM MUST BE EQUIPPED WITH PROTECTIVE MESH.
THE ROOFING SYSTEM MUST BE EQUIPPED WITH ACCESSORIES (SNOW GUARDS, BIRD PROTECTION MESH).

EAVES/ROOF EDGE COMPONENTS:
EAVES GUTTER ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
DOWNPIPE ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
ROOF FLASHING AT WALL JUNCTIONS
FACADE CHIMNEY FLASHING
VENT PIPE FLASHING

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

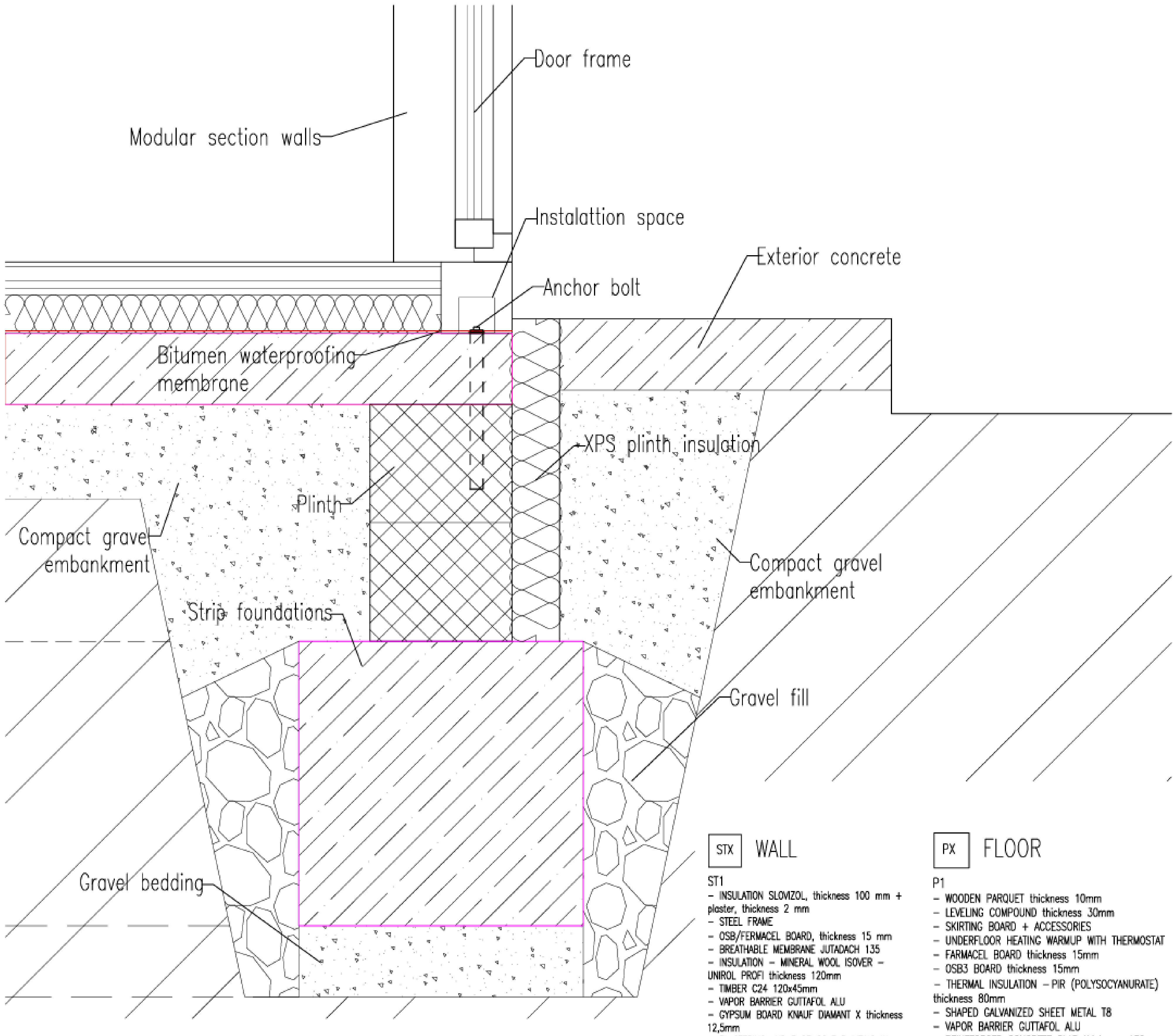
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE

PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY: | DISTRICT:

INVESTOR:

STRUCTURE: COTTAGE HOUSE
DRAWING: ELEVATIONS
SHEET SIZE: 4xA4
SCALE: 1:50
DATE: 02/2026
DRAWING NO.: C3



STX WALL

ST1
- INSULATION SLOVIZOL, thickness 100 mm + plaster, thickness 2 mm
- STEEL FRAME
- OSB/FERMACEL BOARD, thickness 15 mm
- BREATHABLE MEMBRANE JUTADACH 135
- INSULATION – MINERAL WOOL ISOVER – UNIROL PROFI thickness 120mm
- TIMBER C24 120x45mm
- VAPOR BARRIER GUTTAFOL ALU
- GYPSUM BOARD KNAUF DIAMANT X thickness 12,5mm
- PLASTERING AND BASE COAT PAINTING IN WHITE

PX FLOOR

P1
- WOODEN PARQUET thickness 10mm
- LEVELING COMPOUND thickness 30mm
- SKIRTING BOARD + ACCESSORIES
- UNDERFLOOR HEATING WARMUP WITH THERMOSTAT
- FARMACEL BOARD thickness 15mm
- OSB3 BOARD thickness 15mm
- THERMAL INSULATION – PIR (POLYSOCYANURATE) thickness 80mm
- SHAPED GALVANIZED SHEET METAL T8
- VAPOR BARRIER GUTTAFOL ALU
- REINFFORCED CONCRETE SLAB thickness 150mm
- GRAVEL BASE LAYER thickness 200mm

DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE

PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY: DISTRICT:

INVESTOR:

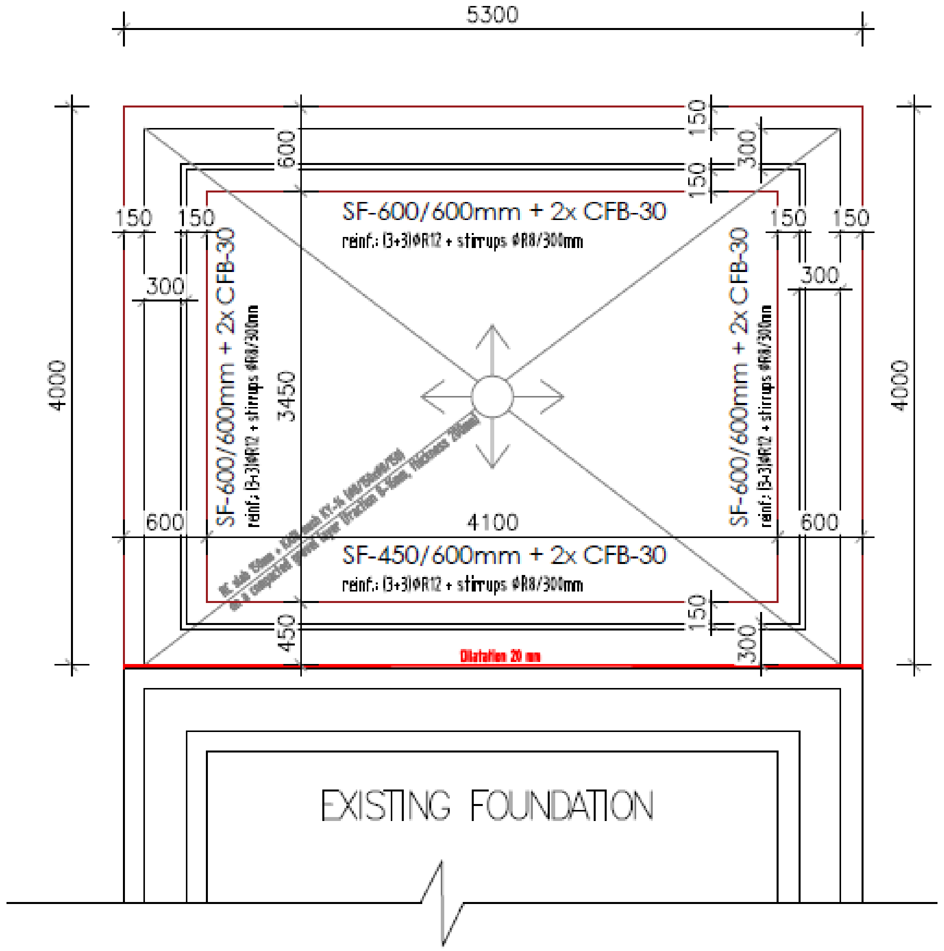
STRUCTURE: COTTAGE HOUSE

DRAWING: DETAIL DRAWING

SHEET SIZE: 4xA4
SCALE: 1:5
DATE: 04/2026
DRAWING NO.:

Appendix 4. Timber-based extension proposal drawings

EXTENSION / FOUNDATION PLAN



NOTES – GEOLOGY:

- Foundations are designed without an engineering-geological survey (IGP), based on the ASSUMED bearing capacity of the subsoil of 150 kPa (according to the principles of the 1st geo. category). However, before construction, it is necessary to verify that the actual soil in the foundation base corresponds to the design assumptions! A DETAILED ENGINEERING-GEOLOGICAL SURVEY IS STRONGLY RECOMMENDED!!!
- In the foundation base, standard soil conditions (estimated) are assumed, with fine-grained medium dense sandy to clayey soils of stiff consistency, medium plasticity, and a tabular bearing capacity Rdt = 150 kpa (without the influence of groundwater level).
- In the event that the actual foundation soils differ from the design assumptions, the proposed foundation method (dimensions, shape, reinforcement) must be reassessed and individually adjusted, or the foundation structures must be adapted to the actual soil conditions. If this is not done, the responsible author of the assessment does not take responsibility for any defects caused by incorrect foundation, faulty structures, or any resulting issues.

IMPORTANT WARNINGS:

- In the area where the family house is to be built, I strongly warn about the possible presence of fill materials, highly plastic fine-grained soils, loose to liquid sands/gravels in the foundation subsoil (low bearing capacity, compressibility, volume instability, and susceptibility to water). their consistency and compaction state are influenced by moisture or groundwater. therefore, I strongly RECOMMEND carrying out a detailed geotechnical survey to determine the actual soil conditions in the foundation trench.

- During excavation work or after exposing the foundation trench, it is recommended to invite a responsible geologist and structural engineer to ensure that the identified conditions (geotechnical parameters and classification of foundation soils) are in accordance with the project documentation (to verify design assumptions), and, if necessary, to carry out essential modifications.
- During foundation works, it is necessary to prevent potential moisture increase – such as from roof drainage, rain, utility network failures – and to protect the foundation trench from weather conditions (to avoid degradation of the foundation soil), as these factors may cause changes in the consistency of cohesive soils and a subsequent reduction in their bearing capacity (due to altered properties of the foundation soils compared to the initial design assumptions)!
- Uncovering of the foundation trench is recommended to be carried out immediately before concreting works (to minimize the risk of damage to the trench due to weather or mechanical influences). excavation work should be done during dry periods, and the foundation trench must be protected from soaking, freezing, and flooding – therefore, the last 100 mm of the covering soil layer should be removed just before concreting, and the bottom of the trench should be cleaned manually! immediately after excavation, create a layer of compacted gravel bedding / blinding concrete to protect the foundation trench, and FOUNDATIONS MAY ONLY BE BUILT ON UNDISTURBED FOUNDATION TRENCHES!

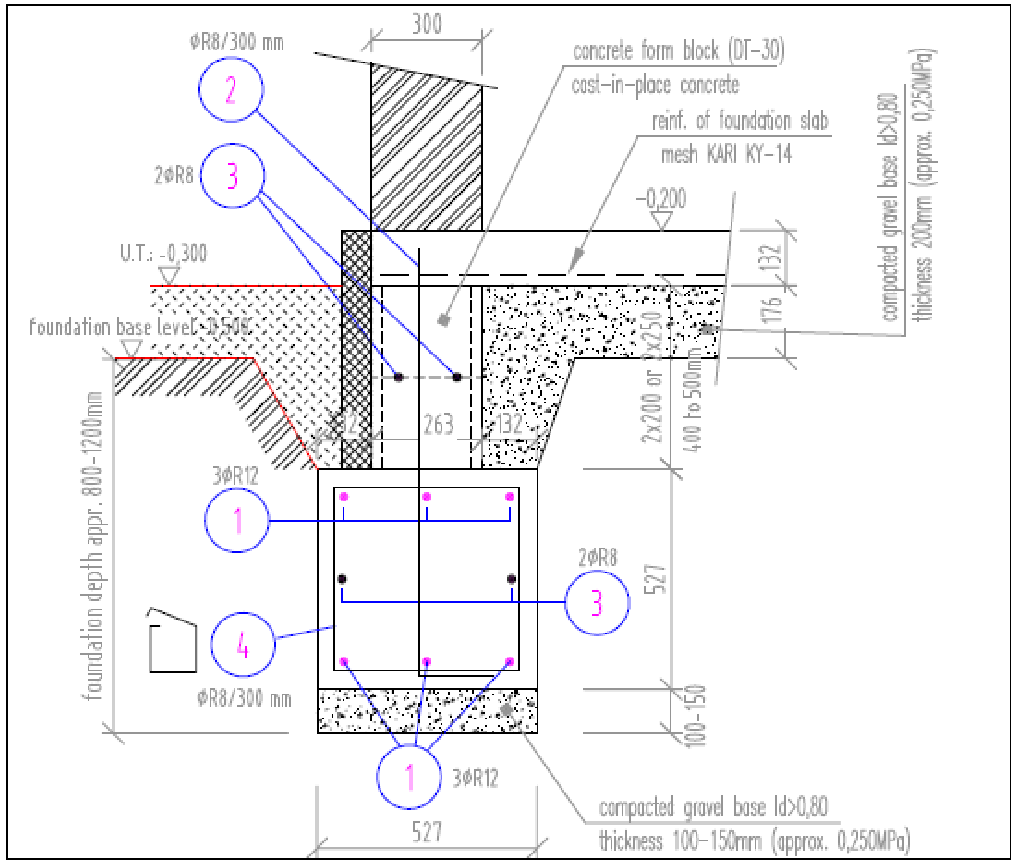
Before starting excavation work, it is absolutely necessary to mark all underground utilities and service lines located on the subject plot!

Before starting the concreting of foundations, it is necessary to mark and leave openings for the passage of pipes / cables through the foundation structures.

NOTES

Before starting foundation concreting, it is necessary to mark locations and leave openings for the passage of sewer pipelines through the foundation structure.
Compacted sub–base layer bearing capacity: 0.25 MPa.
Before casting the blinding concrete layer, underground sewer pipelines must be installed in accordance with the design documentation (sanitary engineering section). After installation of strip foundations, place gravel backfill, thickness 200 mm.
Verification of foundation soil conditions at foundation trench level and determination of groundwater presence in the subsoil must be carried out prior to casting blinding concrete. If conditions differ from the design assumptions, it is necessary to adjust foundation dimensions accordingly.
Quantity of crushed gravel bedding (fraction 0/32) for area approx. 29.25 m^2: approx. 5.85 m^3.
Concrete volume for strip foundations: approx. 4.65. m^3.
Concrete volume for foundation slab, thickness 150 mm, area 19.25 m^2: approx. 2.90 m^3.
Other concreting works: footings, foundation strip edges, lintel supports, reinforced slabs, stairs.
Concrete grade: STN EN 206 – C 20/25 – XC2 (SK) – Cl 0.4 – Dmax 16 – S2.
Reinforcement steel: B500B (STN 10505–R).
Concrete cover: 50 mm for strip foundations, 30 mm for foundation slab.

SCHEMATIC REINFORCEMENT OF STRIP FOUNDATIONS:



Concrete: C 20/25
Reinf. steel: B-500B (O 10505-R)
Concrete cover: 50mm - strip footing, 30mm - slab

Foundation slab reinforcement:
(blinding concrete)
- welded mesh rein. at the bottom surface, type KY-14 (KY-14 = Ø8/150 x Ø8/150 -2400x6000mm)
- lap splice length of welded mesh: 450mm (3 mesh openings in both directions)

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

TITLE: COTTAGE HOUSE

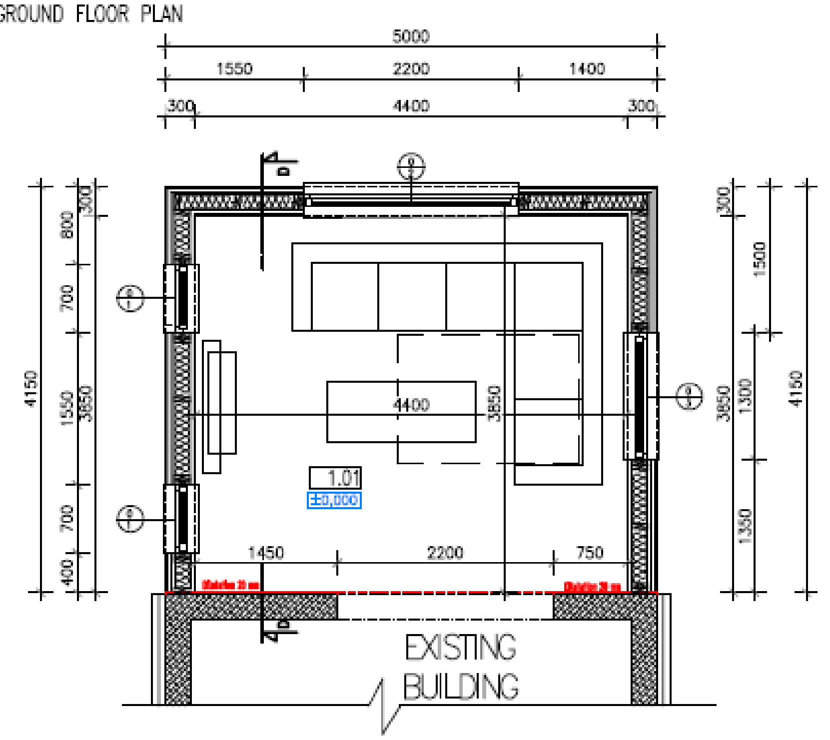
PLOT NO.:
CADASTRAL AREA:
MUNICIPALITY: DISTRICT:

INVESTOR:

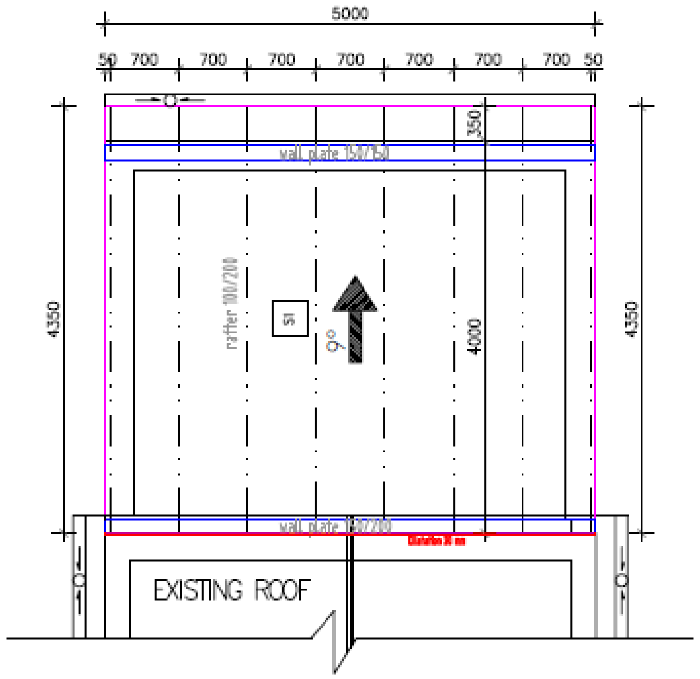
STRUCTURE: COTTAGE HOUSE
DRAWING: FOUNDATION PLAN
SHEET SIZE: 2xA4
SCALE: 1:50
DATE: 03/2026
DRAWING NO.: D1

EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION D–D'

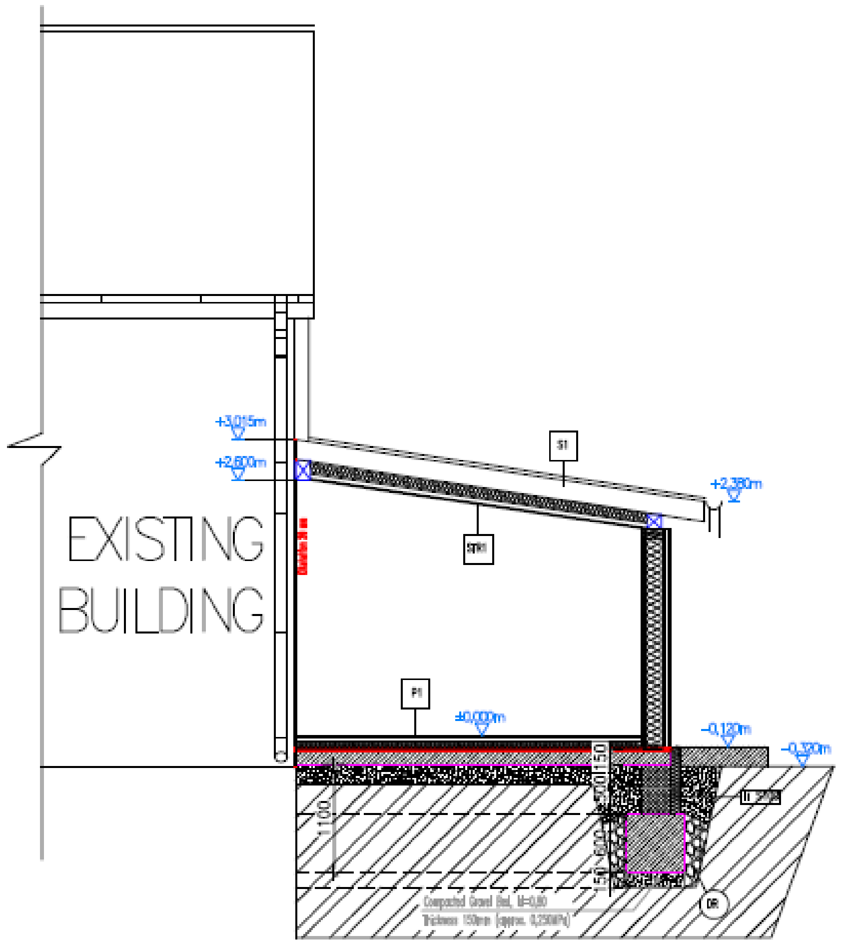
GROUND FLOOR PLAN



ROOF PLAN



SECTION B–B'



LEGENDS OF MATERIALS

- CONCRETE FORM BLOCKS (CFB) ZT–30 – thickness 300mm
- REINFORCED CONCRETE STRUCTURE CONCRETE – ACCORDING TO STRUCTURAL DESIGN
- PLAIN CONCRETE STRUCTURES CONCRETE C12/15
- COMPACTED GRAVEL EMBANKMENT – DANUBE GRAVEL, FRACTION #20–30
- ORIGINAL SOIL FILLED SOIL
- GRAVEL FILL – SORTED ROUNDED GRAVEL, FRACTION #20–30
- WATERPROOFING
- THERMAL INSULATION (FACADE POLYSTYRENE, MINERAL WOOL, EXTRUDED POLYSTYRENE)

STX WALL

ST1
- EXTERNAL CLADDING thickness 20 mm
- VENTILATION AIR GAP + VERTICAL FRAME ELEMENTS 40x60 mm, k600, thickness 40 mm
- BREATHER MEMBRANE thickness 3 mm
- OSB BOARD thickness 22 mm
- STUD MEMBERS 50x160 mm, k600 + MINERAL WOOL INSULATION, thickness 160 mm
- VAPOUR BARRIER thickness 3 mm
- MINERAL WOOL INSULATION + HORIZONTAL FRAMING ELEMENTS 40x40, thickness 40 mm, k600
- PLASTERBOARD thickness 12.5 mm
- FINISHING LAYER – PAINTING

PX FLOORS

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – PIR (POLYISOCYANURATE) thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD–BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

STRX CEILINGS

STR1
- TIMBER RAFTERS (ACCORDING TO STRUCTURAL CALCULATION)
- CAVITY INFILL BETWEEN JOISTS WITH MINERAL WOOL, thickness 200 mm
- THERMAL INSULATION – MINERAL WOOL, thickness 100 mm
- VAPOUR–PERMEABLE MEMBRANE
- 2 × OSB BOARDS, thickness 18 mm
- SUSPENDED GYPSUM BOARD CEILING, thickness 12.5 mm

LEGEND OF DESCRIPTIONS

- D/X – WOODEN CASED (LINED) DOORS
- VD/X – ENTRANCE DOOR
- O/X – WINDOW / GLAZED WALL
- VM – VENTILATION GRILLE 150x150mm
- KV – SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM – THREE–COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI–SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE–FORMAT DECKING BOARDS (WPC–WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 21,75m².
SLOPE OF THE ROOF 9°

LEGEND

ROOM NO.	ROOM NAME	FLOORS	WALLS	CEILING TYPE	AREA /m²
1.01	LIVING ROOM	P1	GYPSUM PLASTER (S.O.)	STR1	16.88
TOTAL USABLE FLOOR AREA					16.88

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

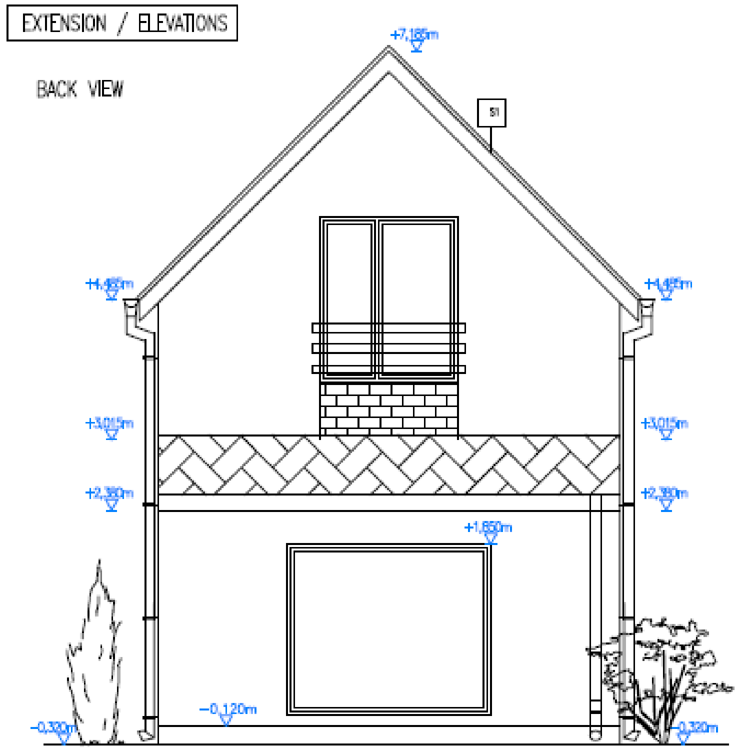
DESIGNER:	RESPONSIBLE DESIGNER:	STAMP:
DORA NAGY		

BUILDING DESIGN FOR BUILDING PERMIT APPLICATION

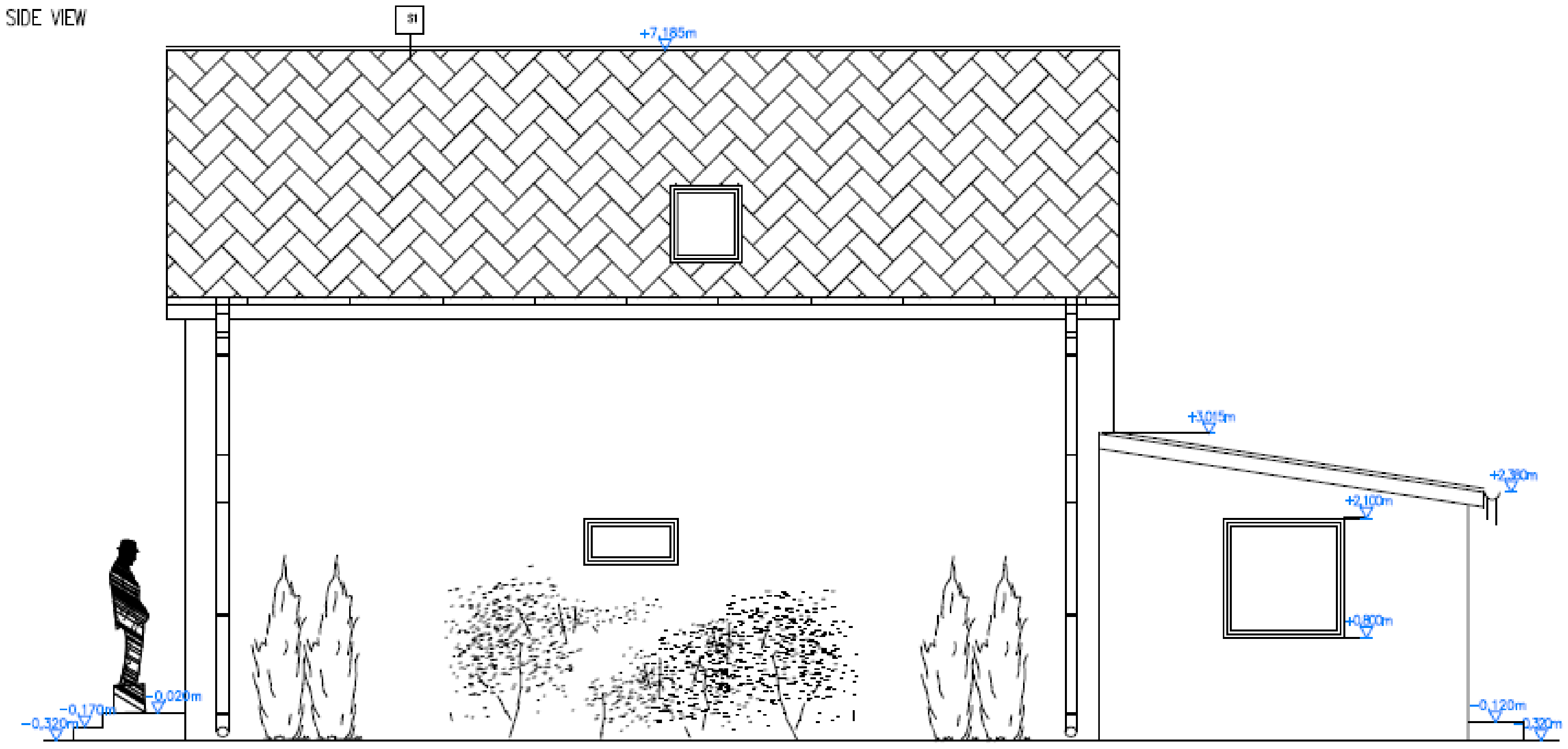
TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	
DRAWING: EXTENSION / GROUND FLOOR PLAN, ROOF PLAN, SECTION D–D'	SCALE: 1:50	DRAWING NO.: D2
	DATE: 03/2026	

EXTENSION / ELEVATIONS

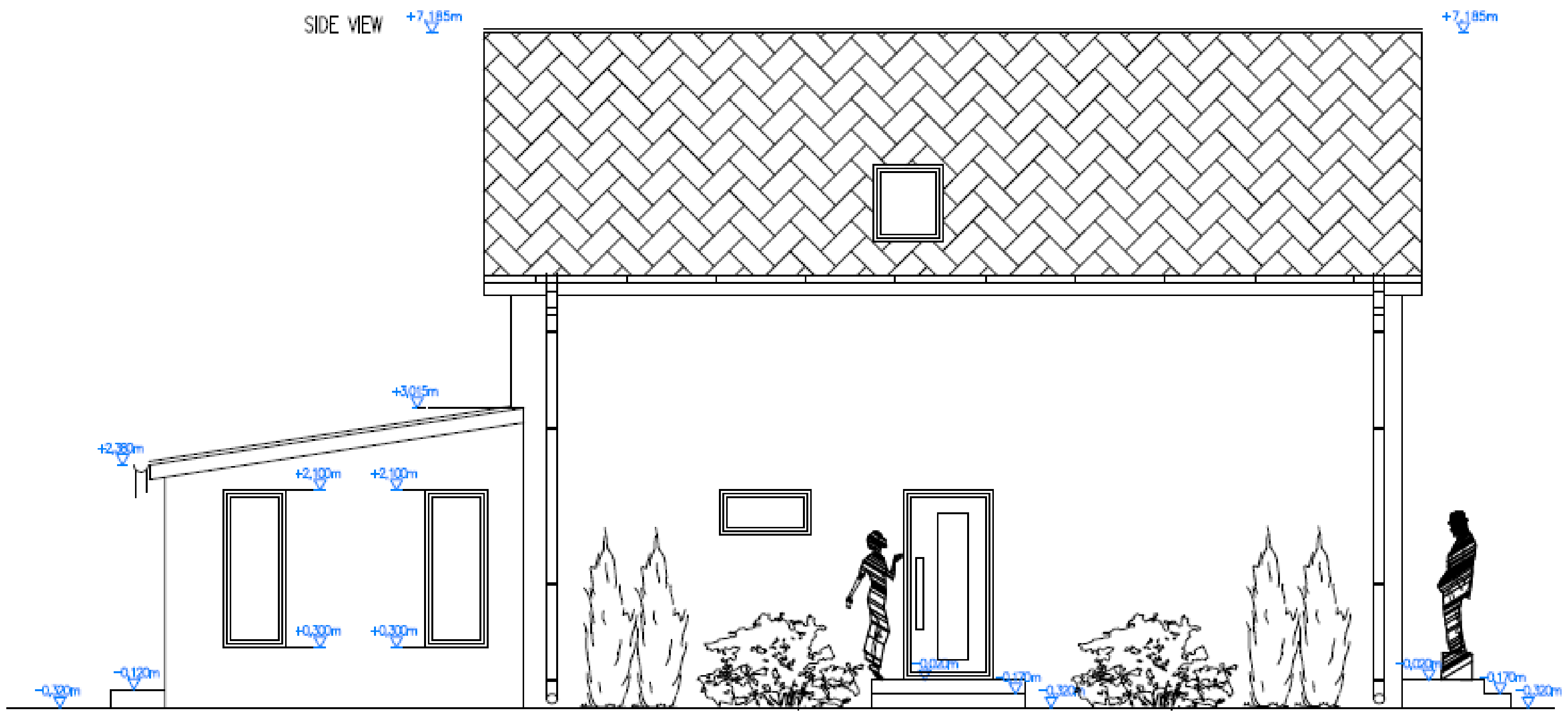
BACK VIEW



SIDE VIEW



SIDE VIEW



LEGEND OF DESCRIPTIONS

- WOODEN CASED (LINED) DOORS
- ENTRANCE DOOR
- WINDOW / GLAZED WALL
- VW — VENTILATION GRILLE 150x150mm
- KV — SHEET METAL PRODUCT, EAVES GUTTER AND DOWNPIPE
- KOM — THREE-COMPONENT CHIMNEY FOR FIREPLACE SCHIEDEL UNI
- THERMAL INSULATION – MINERAL WOOL, thickness 100mm, 180mm
- THERMAL INSULATION – FACADE POLYSTYRENE, thicknesses 50, 70, 80, 100, 120, 150mm, 180
- THERMAL INSULATION – STYRODUR, thicknesses 30, 50, 80, 100mm
- STONE ANTI-SLIP EXTERIOR PAVING COLOR ACCORDING TO INVESTOR'S CHOICE, thickness 8 cm
- TERRACE FINISH: LARGE-FORMAT DECKING BOARDS (WPC-WOOD PLASTIC COMPOSITE), thickness 150 mm

SX ROOFS

S1
- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

LEGEND OF ROOF DESCRIPTIONS

ROOF SHEETING
ROOF AREA OF THE COTTAGE HOUSE : 21,75m².
SLOPE OF THE ROOF 9°

FX FACADES

F1
- SURFACE TREATMENT
- CLADDING ACCORDING TO THE INVESTOR'S CHOICE

NOTES:

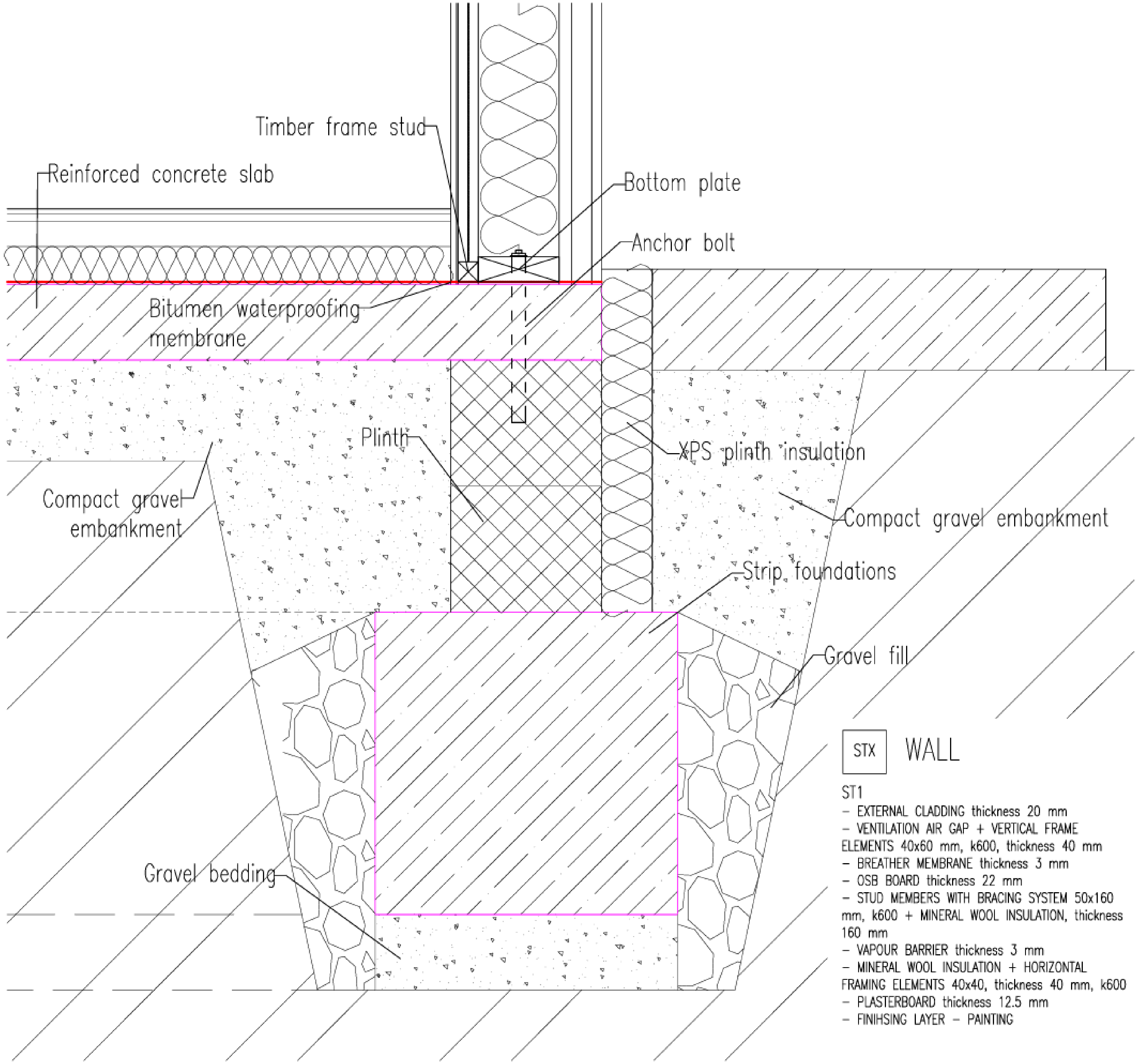
INSTALLATION AND APPLICATION OF THE ROOF COVERING MUST BE CARRIED OUT IN ACCORDANCE WITH THE MANUFACTURER'S TECHNICAL SPECIFICATIONS!

THE GUTTER SYSTEM MUST BE EQUIPPED WITH PROTECTIVE MESH.
THE ROOFING SYSTEM MUST BE EQUIPPED WITH ACCESSORIES (SNOW GUARDS, BIRD PROTECTION MESH).

EAVES/ROOF EDGE COMPONENTS:
EAVES GUTTER ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
DOWNPIPE ⌀125mm, COLOR ACCORDING TO INVESTOR'S SELECTION
ROOF FLASHING AT WALL JUNCTIONS
FACADE CHIMNEY FLASHING
VENT PIPE FLASHING

NOTES:
All proposed design changes must be consulted with the project author before execution. Implementation is permitted only with the designer's written approval. Any ambiguities or discrepancies in the project documentation must be consulted with the responsible project designer. Verification of dimensions of all building components and structural elements must be carried out prior to submitting them for fabrication. Measurements must be taken directly on site. Any changes during construction must be consulted with the project designer.

DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.:	
	CADASTRAL AREA:	
	MUNICIPALITY:	DISTRICT:
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.: D3
DRAWING: ELEVATIONS	SCALE: 1:50	
	DATE: 03/2026	



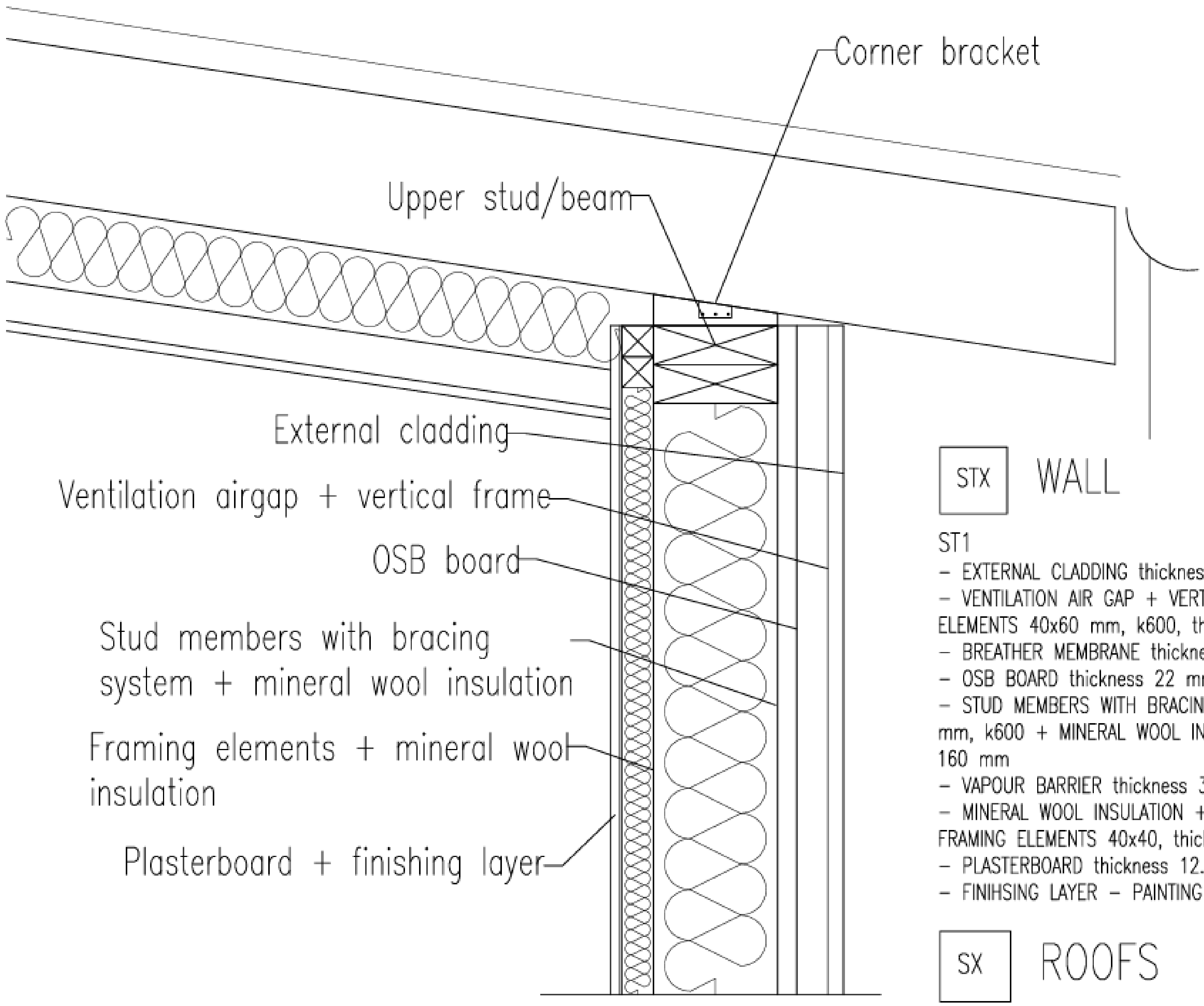
STX **WALL**

ST1
- EXTERNAL CLADDING thickness 20 mm
- VENTILATION AIR GAP + VERTICAL FRAME ELEMENTS 40x60 mm, k600, thickness 40 mm
- BREATHER MEMBRANE thickness 3 mm
- OSB BOARD thickness 22 mm
- STUD MEMBERS WITH BRACING SYSTEM 50x160 mm, k600 + MINERAL WOOL INSULATION, thickness 160 mm
- VAPOUR BARRIER thickness 3 mm
- MINERAL WOOL INSULATION + HORIZONTAL FRAMING ELEMENTS 40x40, thickness 40 mm, k600
- PLASTERBOARD thickness 12.5 mm
- FINIHSING LAYER – PAINTING

PX **FLOORS**

P1
- WOODEN PARQUET, thickness 10mm
- IMPACT SOUND INSULATION, thickness 10mm
- CONCRETE SCREED, thickness 50mm
- UNDERFLOOR HEATING SYSTEM BOARD, thickness 30mm
- THERMAL INSULATION – PIR (POLYSOCYANURATE) thickness 80mm
- WATERPROOFING (ASPHALT MEMBRANE OR PLASTIC FOIL)
- LOAD–BEARING REINFORCED CONCRETE SLAB, thickness 150mm
- GRAVEL BED, thickness 200mm

DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.:
DRAWING: DETAIL DRAWING	SCALE: 1:5 / DATE: 04/2026	



STX WALL

ST1

- EXTERNAL CLADDING thickness 20 mm
- VENTILATION AIR GAP + VERTICAL FRAME ELEMENTS 40x60 mm, k600, thickness 40 mm
- BREATHER MEMBRANE thickness 3 mm
- OSB BOARD thickness 22 mm
- STUD MEMBERS WITH BRACING SYSTEM 50x160 mm, k600 + MINERAL WOOL INSULATION, thickness 160 mm
- VAPOUR BARRIER thickness 3 mm
- MINERAL WOOL INSULATION + HORIZONTAL FRAMING ELEMENTS 40x40, thickness 40 mm, k600
- PLASTERBOARD thickness 12.5 mm
- FINIHSING LAYER – PAINTING

SX ROOFS

S1

- CERAMIC ROOF TILES
- ROOF BATTENS 30x50mm + DIFFUSION MEMBRANE
- COUNTER BATTENS 40x60mm
- SECONDARY WATERPROOFING MEMBRANE
- RAFTERS (ACCORDING TO STRUCTURAL DESIGN)

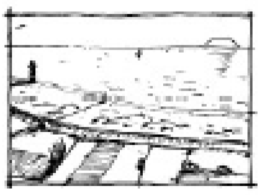
DESIGNER: DORA NAGY	RESPONSIBLE DESIGNER:	STAMP:
BUILDING DESIGN FOR BUILDING PERMIT APPLICATION		
TITLE: COTTAGE HOUSE	PLOT NO.: / CADASTRAL AREA: / MUNICIPALITY: / DISTRICT:	
INVESTOR:		
STRUCTURE: COTTAGE HOUSE	SHEET SIZE: 4xA4	DRAWING NO.:
DRAWING: DETAIL DRAWING	SCALE: 1:5 / DATE: 04/2026	

Appendix 5. Wind load calculations

Wind Load Calculation

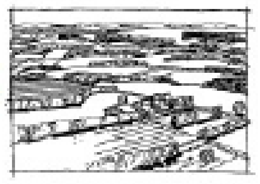
A.1 Illustrations of the upper roughness of each terrain category

Terrain category 0
Sea, coastal area exposed to the open sea

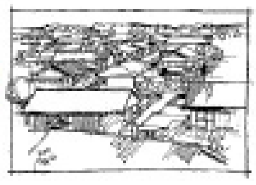


Terrain category I
Lakes or area with negligible vegetation and without obstacles

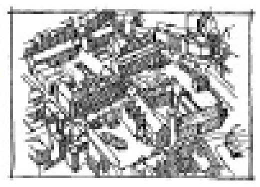
Terrain category II
Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights



Terrain category III
Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)



Terrain category IV
Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m



Peak Velocity Calculation - SFS EN 1991-1-1 - 4.3-4.5(p. 19-23)

Height of the structure $Z := 3.015\ m$

Roughness length and min. height $\begin{bmatrix} Z_0 \\ Z_{min} \end{bmatrix} :=$ Terrain category: III

Maximum height $Z_{max} := 200\ m$

Table 4.1 — Terrain categories and terrain parameters

Terrain category		z_0 m	z_{min} m
0	Sea or coastal area exposed to the open sea	0,003	1
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0,01	1
II	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0,05	2
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0,3	5
IV	Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m	1,0	10
NOTE: The terrain categories are illustrated in A.1.			

Condition to meet $Z_0 \le 0.003\ m = 0$

Terrain factor $K_r := 0.19 \cdot \left(\dfrac{Z_0}{0.05\ m}\right)^{0.07} = 0.215$

Condition to meet $Z_{min} \le Z \le Z_{max} = 0$

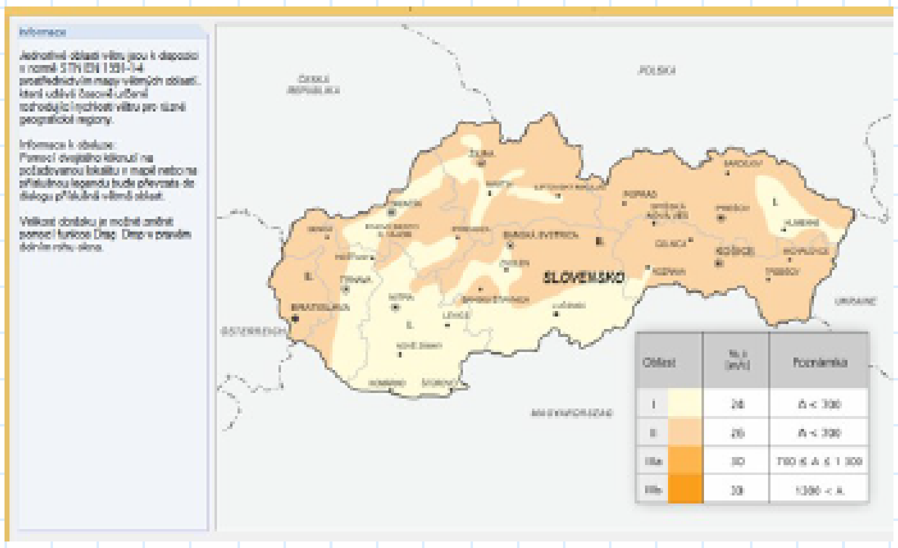
$Z \le Z_{min} = 1$

Expression (4.4)

$$c_r(z) = k_r \cdot \ln\left(\frac{z}{z_0}\right) \quad \text{for} \quad z_{min} \le z \le z_{max}$$

$$c_r(z) = c_r(z_{min}) \quad \text{for} \quad z \le z_{min}$$

Terrain roughness $C_r := K_r \cdot \ln\left(\dfrac{Z_{min}}{Z_0}\right) = 0.606$



Turbulance factor $K := 1$

Ortography factor $C_o := 1$

Basic wind velocity $v_b := 24\ \dfrac{m}{s}$

Basic wind pressure $q_b := 360\ Pa$

Air density $\rho := 1.25\ \dfrac{kg}{m^3}$

Mean wind velocity $v_m := C_r \cdot C_o \cdot v_b = 14.543\ \dfrac{m}{s}$

$$v_m(z) = c_r(z) \cdot c_o(z) \cdot v_b$$ Expression (4.3)

Condition to meet $Z_{min} \le Z \le Z_{max} = 0$

$Z \le Z_{min} = 1$

Expression (4.7)

$$I_v(z) = \frac{\sigma_v}{v_m(z)} = \frac{k_I}{c_o(z) \cdot \ln(z/z_0)} \quad \text{for} \quad z_{min} \le z \le z_{max}$$

$$I_v(z) = I_v(z_{min}) \quad \text{for} \quad z < z_{min}$$

Wind turbulence $I_v := \dfrac{K}{C_o \cdot \ln\left(\dfrac{Z_{min}}{Z_0}\right)} = 0.355$

Peak velocity pressure $q_p := (1 + 7 \cdot I_v) \cdot \frac{1}{2} \cdot \rho \cdot v_m^{\,2} = 461.109 \; Pa$

Wind Calculation on the Walls in Direction 1 (0°) - SFS EN 1991-1-1 - 5-7.2.2(p. 24-37)

Height of the building $h_{w1} := 3.015 \; m$

Wall length imposed to wind $b_{w1} := 5 \; m$

Wall length parallel to wind $d_{w1} := 4 \; m$

Elevation $e_1 := min(b_{w1}, 2 \cdot h_{w1}) = 5 \; m$

Ratio $\frac{h_{w1}}{d_{w1}} = 0.754$

Length of zone D $D_1 := b_{w1} = 5 \; m$

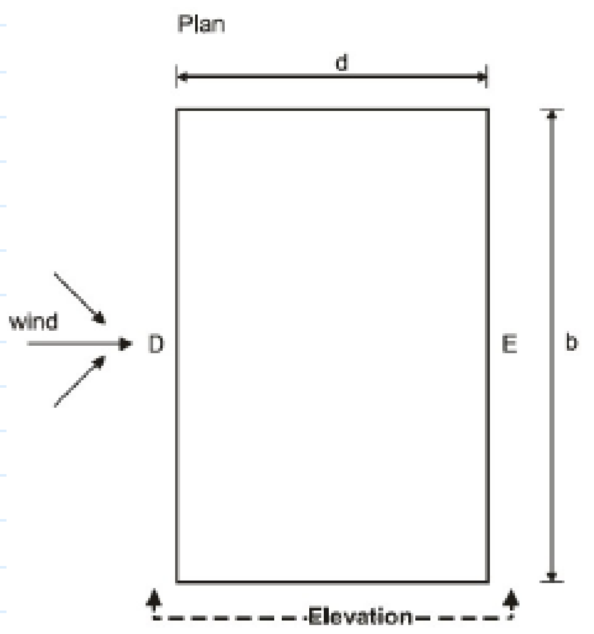


Figure (7.5)

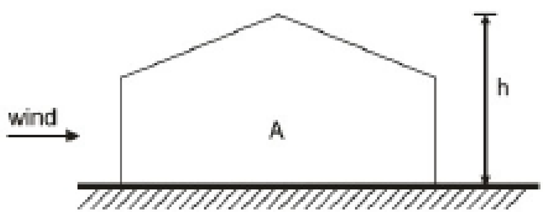
Length of zone A

$e_1 < d_{w1} = 0$

$e_1 \ge d_{w1} = 1$

$A_1 := \frac{e_1}{5} = 1 \; m$

Figure (7.5)



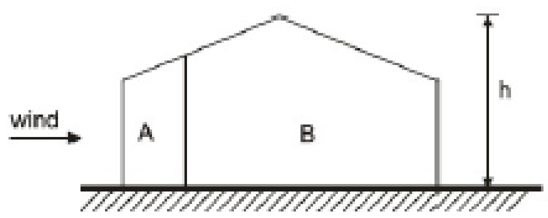
Length of zone B

$e_1 < d_{w1} = 0$

$e_1 \ge d_{w1} = 1$

$B_1 := d_{w1} - \frac{e_1}{5} = 3 \; m$

Figure (7.5)



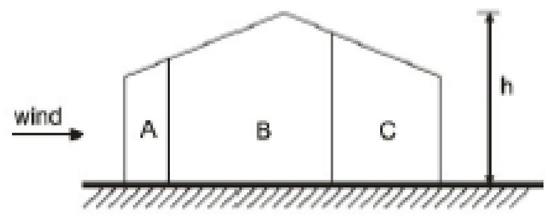
Length of zone C

$e_1 < d_{w1} = 0$

$e_1 \ge d_{w1} = 1$

$C_1 := 0 \; m$

Figure (7.5)



Areas of zones for wind on the wall

Zone A	Zone B	Zone C	Zone D
$A_{area.1} := A_1 \cdot h_{w1}$	$B_{area.1} := B_1 \cdot h_{w1}$	$C_{area.1} := C_1 \cdot h_{w1}$	$D_{area.1} := D_1 \cdot h_{w1}$
$A_{area.1} = 3.015 \; m^2$	$B_{area.1} = 9.045 \; m^2$	$C_{area.1} = 0 \; m^2$	$D_{area.1} = 15.075 \; m^2$

Internal pressure coefficients

Negative $C_{pi1} := 0.2$

Positive $C_{pi2} := -0.3$

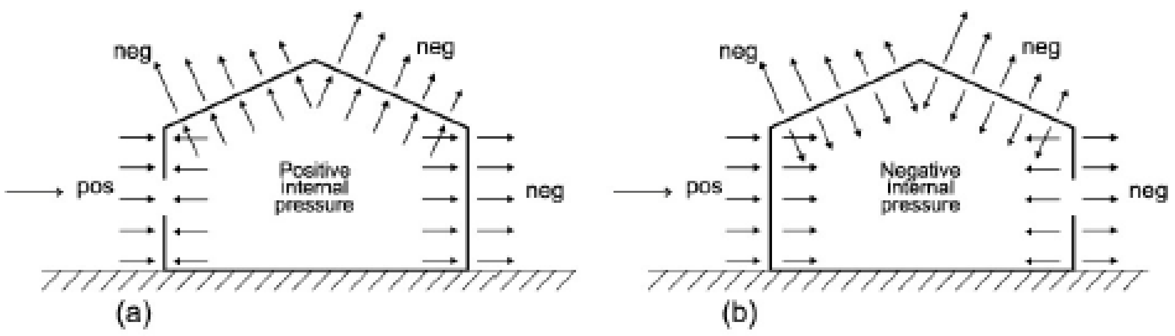


Figure (5.1)

External pressure coefficients

Table 7.1 — Recommended values of external pressure coefficients for vertical walls of rectangular plan buildings

Zone	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

For zones with area of less than $10\ m^2$, we use $C_{pe.1}$, for the rest $C_{pe.10}$!!!

$ZoneA_1 := -1.4$ $\quad ZoneB_1 := -0.8$

$ZoneD_1 := 0.8$ $\quad ZoneE_1 := -0.5$

External pressure values for the zones

$$\begin{bmatrix} C_{peA.1} \\ C_{peB.1} \\ C_{peD.1} \\ C_{peE.1} \end{bmatrix} := \begin{bmatrix} ZoneA_1 \\ ZoneB_1 \\ ZoneD_1 \\ ZoneE_1 \end{bmatrix} = \begin{bmatrix} -1.4 \\ -0.8 \\ 0.8 \\ -0.5 \end{bmatrix}$$

Total pressure coefficient at zone A

$ZoneA_1 < 0 = 1$

$C_{pA.1} := C_{peA.1} - C_{pi1} = -1.6$

Total pressure coefficient at zone B

$ZoneB_1 < 0 = 1$

$C_{pB.1} := C_{peB.1} - C_{pi1} = -1$

Total pressure coefficient at zone D

$ZoneD_1 < 0 = 0$

$C_{pD.1} := C_{peD.1} - C_{pi2} = 1.1$

Total pressure coefficient at zone E

$ZoneE_1 < 0 = 1$

$C_{pE.1} := C_{peE.1} - C_{pi1} = -0.7$

Wind pressure for each zone in direction 1 (0°)

$$\begin{bmatrix} W_{A.1} \\ W_{B.1} \\ W_{D.1} \\ W_{E.1} \end{bmatrix} := \begin{bmatrix} C_{pA.1} \cdot q_p \\ C_{pB.1} \cdot q_p \\ C_{pD.1} \cdot q_p \\ C_{pE.1} \cdot q_p \end{bmatrix} = \begin{bmatrix} -737.775 \\ -461.109 \\ 507.22 \\ -322.777 \end{bmatrix} Pa$$

Wind Calculation on the Walls in Direction 2 (90°) - SFS EN 1991-1-1 - 5-7.2.2(p. 24-37)

Height of the building $\quad h_{w2} := 2.38\ m$

Wall length imposed to wind $\quad b_{w2} := 4\ m$

Wall length parallel to wind $\quad d_{w2} := 5\ m$

Elevation $\quad e_2 := min\left(b_{w2}, 2 \cdot h_{w2}\right) = 4\ m$

Ratio $\quad \dfrac{h_{w2}}{d_{w2}} = 0.476$

Length of zone D $\quad D_2 := b_{w2} = 4\ m$

Length of zone E $\quad E_2 := b_{w2} = 4\ m$

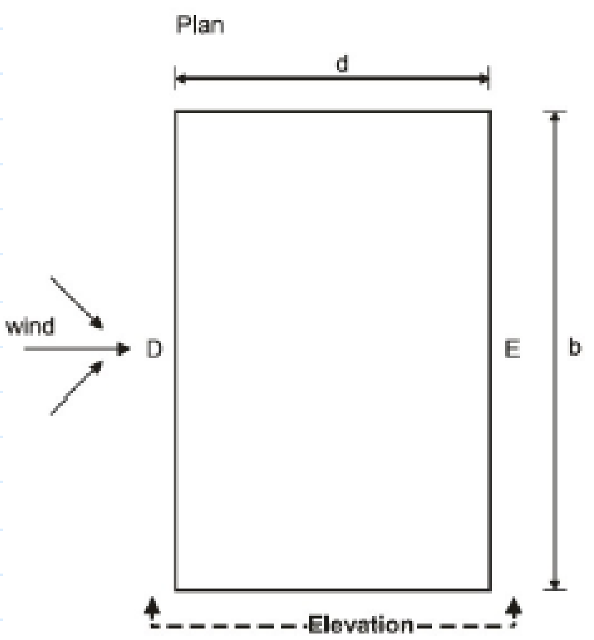


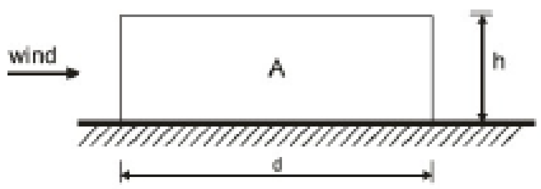
Figure (7.5)

Length of zone A

$e_2 < d_{w2} = 1$

$A_2 := \frac{e_2}{5} = 0.8\ m$

Figure (7.5)
Elevation for e ≥ 5d

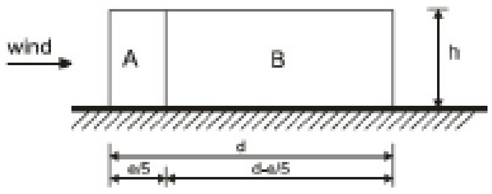


Length of zone B

$e_2 < d_{w2} = 1$

$B_2 := \frac{4}{5} \cdot e_2 = 3.2\ m$

Figure (7.5)
Elevation for e ≥ d

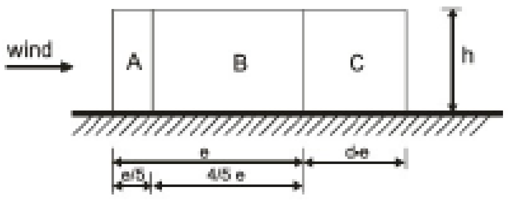


Length of zone C

$e_2 < d_{w2} = 1$

$C_2 := d_{w2} - e_2 = 1\ m$

Figure (7.5)
Elevation for e < d



Areas of zones for wind on the wall

Zone A

$A_{area.2} := A_2 \cdot h_{w2}$

$A_{area.2} = 1.904\ m^2$

Zone B

$B_{area.2} := B_2 \cdot h_{w2}$

$B_{area.2} = 7.616\ m^2$

Zone C

$C_{area.2} := C_2 \cdot h_{w2}$

$C_{area.2} = 2.38\ m^2$

Zone D

$D_{area.2} := D_2 \cdot h_{w2}$

$D_{area.2} = 9.52\ m^2$

Zone E

$E_{area.2} := E_2 \cdot h_{w2}$

$E_{area.2} = 9.52\ m^2$

External pressure coefficients

Table 7.1 — Recommended values of external pressure coefficients for vertical walls of rectangular plan buildings

Zone	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

For zones with area of less than $10\ m^2$, we use $C_{pe.1}$, for the rest $C_{pe.10}$!!!

$ZoneA_2 := -1.4$ $ZoneB_2 := -0.8$

$ZoneC_2 := -0.5$ $ZoneD_2 := 0.8$

$ZoneE_2 := -0.5$

External pressure values for the zones

$$\begin{bmatrix} C_{peA.2} \\ C_{peB.2} \\ C_{peC.2} \\ C_{peD.2} \\ C_{peE.2} \end{bmatrix} := \begin{bmatrix} ZoneA_2 \\ ZoneB_2 \\ ZoneC_2 \\ ZoneD_2 \\ ZoneE_2 \end{bmatrix} = \begin{bmatrix} -1.4 \\ -0.8 \\ -0.5 \\ 0.8 \\ -0.5 \end{bmatrix}$$

Total pressure coefficient at zone A

$ZoneA_2 < 0 = 1$

$C_{pA.2} := C_{peA.2} - C_{pi1} = -1.6$

Total pressure coefficient at zone B

$ZoneB_2 < 0 = 1$

$C_{pB.2} := C_{peB.2} - C_{pi1} = -1$

Total pressure coefficient at zone C

$ZoneC_2 < 0 = 1$

$C_{pC.2} := C_{peC.2} - C_{pi1} = -0.7$

Total pressure coefficient at zone D

$ZoneD_2 < 0 = 0$

$C_{pD.2} := C_{peD.2} - C_{pi2} = 1.1$

Total pressure coefficient at zone E

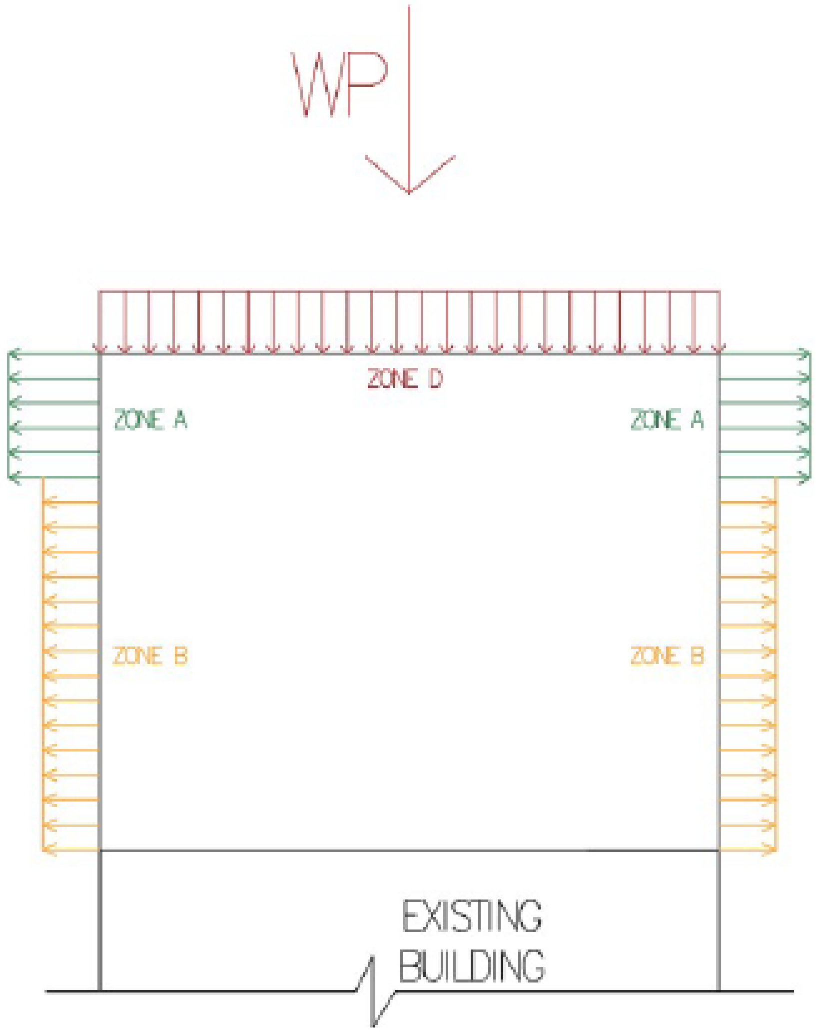
$ZoneE_2 < 0 = 1$

$C_{pE.2} := C_{peE.2} - C_{pi1} = -0.7$

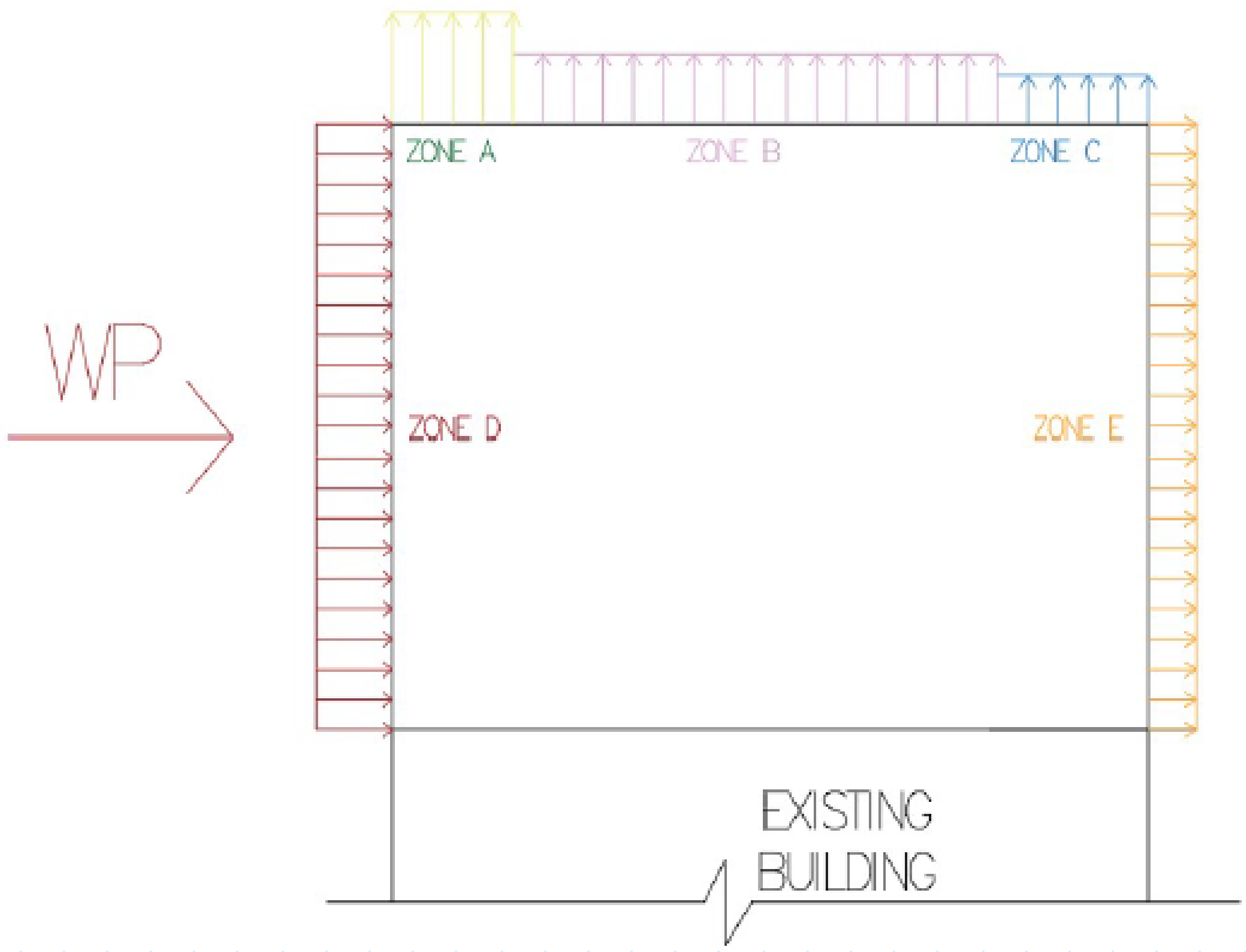
Wind pressure for each zone in direction 2 (90°)

$$\begin{bmatrix} W_{A.2} \\ W_{B.2} \\ W_{C.2} \\ W_{D.2} \\ W_{E.2} \end{bmatrix} := \begin{bmatrix} C_{pA.2} \cdot q_p \\ C_{pB.2} \cdot q_p \\ C_{pC.2} \cdot q_p \\ C_{pD.2} \cdot q_p \\ C_{pE.2} \cdot q_p \end{bmatrix} = \begin{bmatrix} -737.775 \\ -461.109 \\ -322.777 \\ 507.22 \\ -322.777 \end{bmatrix} Pa$$

Wind Calculation on the Walls in Direction 1 (0°)



Wind Calculation on the Walls in Direction 2 (90°)



Appendix 6. Mono-pitched roof design check

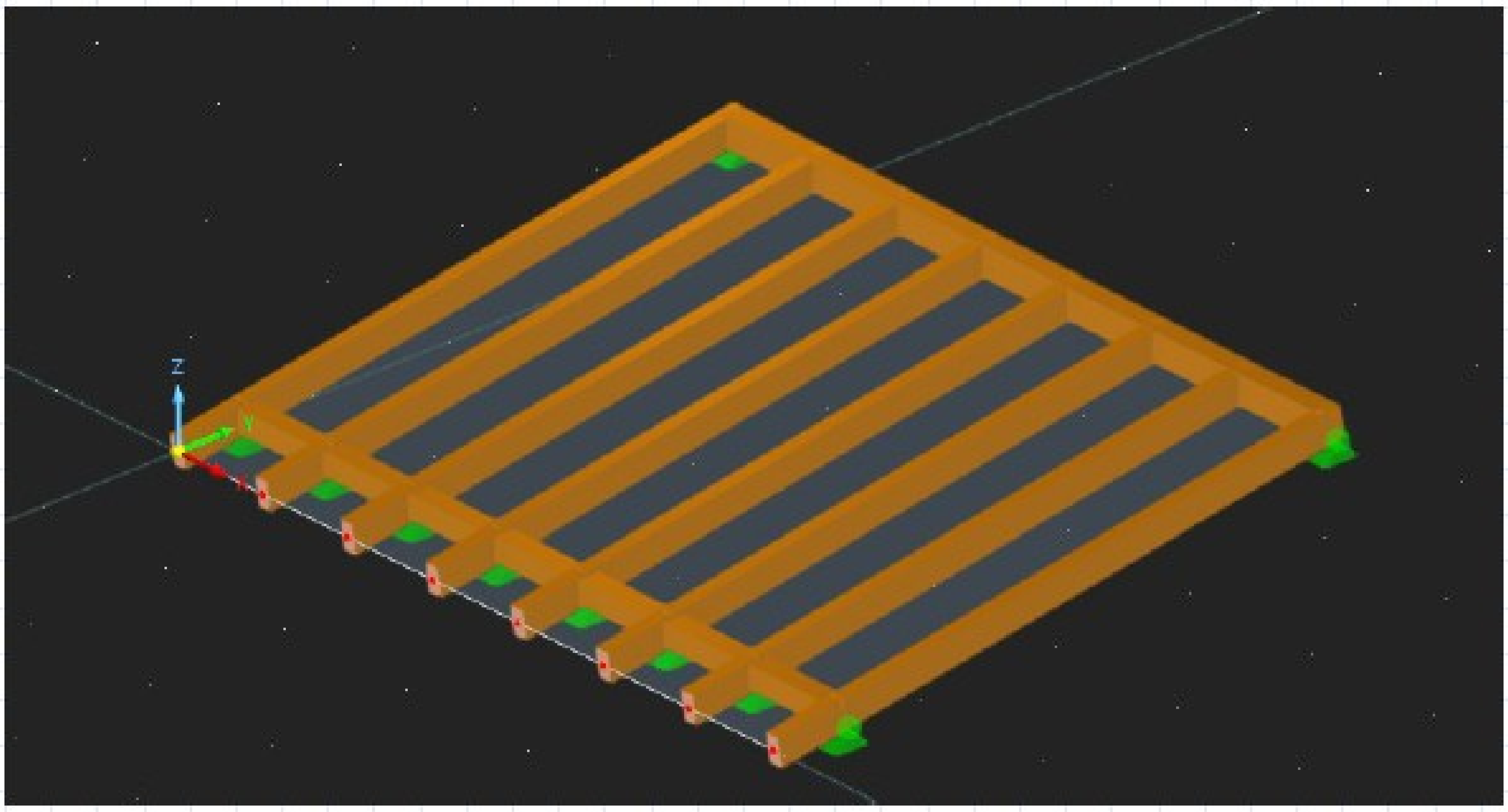
Timber Roof Calculations

Bending parallel to grain	$f_{m.k} := 24\ MPa$
Tension parallel to grain	$f_{t.0.k} := 14.5\ MPa$
Tension perpendicular to grain	$f_{t.90.k} := 0.4\ MPa$
Compression parallel to grain	$f_{c.0.k} := 21\ MPa$
Compression perpendicular to grain	$f_{c.90.k} := 2.5\ MPa$
Shear	$f_{v.k} := 4\ MPa$
Elastic modulus	$E_{0.05} := 7400\ MPa$
Shear modulus	$G_{0.05} := 690\ MPa$

Property	C24	C27	C30	C35	C40
Strength values					
Bending parallel to grain $f_{m,k}$	24	27	30	35	40
Tension parallel to grain $f_{t,0,k}$	14,5	16,5	19	22,5	26
Tension perpendicular to grain $f_{t,90,k}$	0,4	0,4	0,4	0,4	0,4
Compression parallel to grain $f_{c,0,k}$	21	22	24	25	27
Compression perpendicular to grain $f_{c,90,k}$	2,5	2,5	2,7	2,7	2,8
Shear $f_{v,k}$	4,0	4,0	4,0	4,0	4,0
Stiffness value for capacity analysis					
Elastic modulus $E_{0,05}$	7 400	7 700	8 000	8 700	9 400
Stiffness values for deformation calculations, mean values					
Elastic modulus parallel to grain $E_{0,mean}$	11 000	11 500	12 000	13 000	14 000
Elastic modulus perpendicular to grain $E_{90,mean}$	370	380	400	430	470
Shear modulus G_{mean}	690	720	750	810	880
Density					
Density ρ_k [1]	350	360	380	390	400
Density ρ_{mean} [1]	420	430	460	470	480

Partial coefficient for material	$\gamma_M := 1.3$
Service class	$sc := 2$
Strength modification factor	$k_{mod} := 0.9$

The table and the values were obtained from:
Swedish Wood, Design of timber structures - Volume 2



The structural design was carried out using the Dlubal RFEM software. Load combinations were generated in accordance with Eurocode provisions and the Slovak National Annex. Load cases and combinations were defined using EN 1990 (STN 2010-11) via the Combination Wizard, while load definitions followed EN 1991 and its Slovak National Annex (STN 2016-01).

Timber design verification was performed according to EN 1995 (Eurocode 5) together with the Slovak National Annex (STN 2019-12).

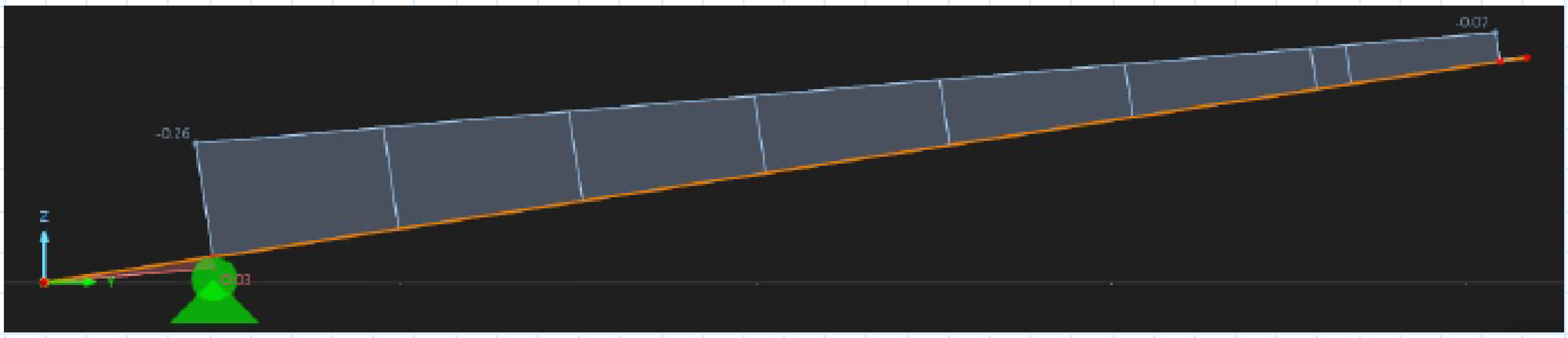
Ultimate limit state (ULS) combinations were determined using Equation 6.10 of EN 1990. RFEM automatically evaluated all combinations, and the most unfavourable internal force effects were selected for design verification.

The maximum design values of axial force (N_ed), shear force (V_ed), and bending moment (M_ed) were then extracted for each structural element.

Design Check for Rafter

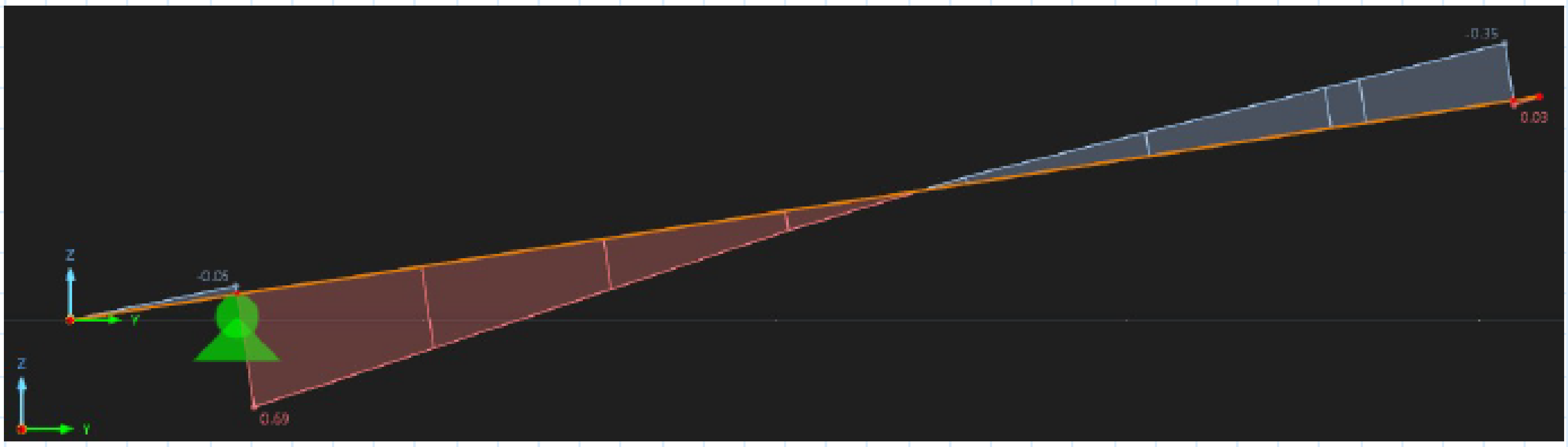
Width of the section	$b_r := 100\ mm$	
Height of the section	$h_r := 200\ mm$	
Area of the section	$A_{rafter} := b_r \cdot h_r = 20000\ mm^2$	

Compression resistance



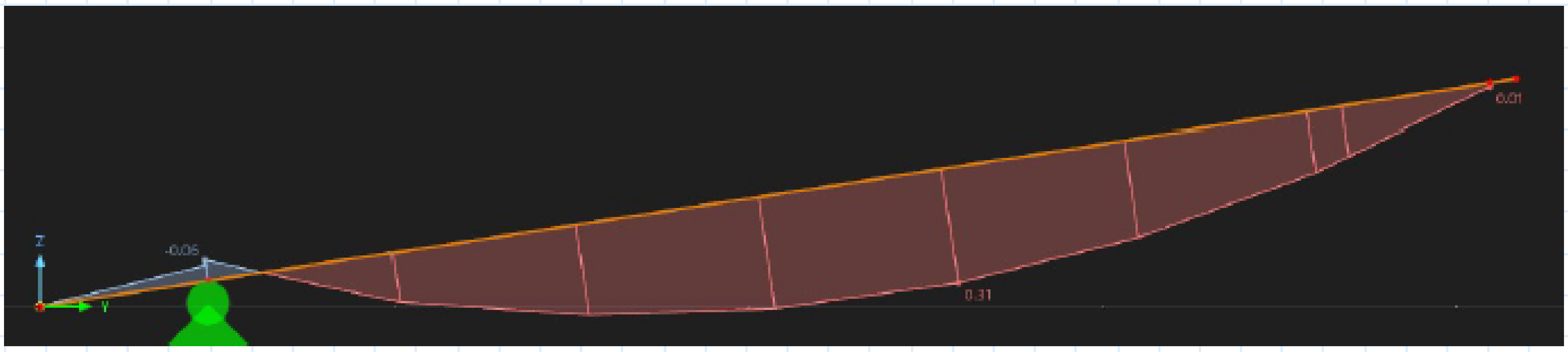
Maximum compression force	$N_{Ed.c.max.rafter} := 0.26\ kN$	Dlubal RFEM
Design compression strength parallel to the grain	$f_{c.0.d.r} := \frac{k_{mod} \cdot f_{c.0.k}}{\gamma_M} = 14.538\ MPa$	SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design compression stress parallel to the grain	$\sigma_{c.0.d.r} := \frac{N_{Ed.c.max.rafter}}{A_{rafter}} = 0.013\ MPa$	
Design check for compression resistance	$\sigma_{c.0.d.r} < f_{c.0.d.r} = 1$ **Design check: OK.**	SFS EN 1995-1-1 - 6.1.4(1) (6.2)
Utilization ratio for compression resistance	$UR := \frac{\sigma_{c.0.d.r}}{f_{c.0.d.r}} = 0.09\%$	

Shear resistance



Maximum shear force	$V_{Ed.rafter} := 0.69\ kN$	Dlubal RFEM Simulation
End crack factor	$k_{cr} := 0.67$	SFS EN 1995-1-1/A1 - 6.1.7(2)
Design shear strength	$f_{v.d.r} := \frac{k_{mod} \cdot f_{v.k}}{\gamma_M} = 2.769\ MPa$	SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design shear stress	$\tau_{d.r} := \frac{3 \cdot V_{Ed.rafter}}{2 \cdot A_{rafter} \cdot k_{cr}} = 0.077\ MPa$	Swedish Wood, Design of timber structures - Volume 2
Design check for shear resistance	$\tau_{d.r} \le f_{v.d.r} = 1$ **Design check: OK.**	SFS EN 1995-1-1 - 6.1.7(1) (6.13)
Utilization ratio of shear resistance	$UR_r := \frac{\tau_{d.r}}{f_{v.d.r}} = 2.79\%$	

Bending resistance



Maximum bending moment	$M_{Ed.rafter} := 0.31\ kN \cdot m$	Dlubal RFEM Simulation
Re-distribution factor	$k_m := 0.7$	SFS EN 1995-1-1 - 6.1.6(2)
Elastic section modulus about y-y	$W_{y.r} := \frac{b_r \cdot h_r^2}{6} = (6.667 \cdot 10^5)\ mm^3$	
Design bending strength	$f_{m.d.r} := \frac{k_{mod} \cdot f_{m.k}}{\gamma_M} = 16.615\ MPa$	SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design bending stress	$\sigma_{m.d.r} := \frac{M_{Ed.rafter}}{W_{y.r}} = 0.465\ MPa$	
Design check for bending resistance	$\sigma_{m.d.r} \le f_{m.d.r} = 1$ **Design check: OK.**	SFS EN 1995-1-1 - 6.1.6(1) (6.11/6.12)
Utilization ratio of bending resistance	$UR_{bending.rafter.resistance} := \frac{\sigma_{m.d.r}}{f_{m.d.r}} = 2.8\%$	

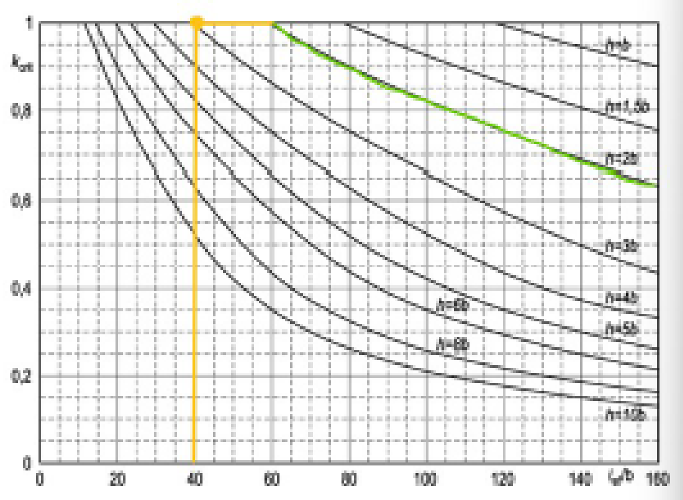
Combined bending and axial compression

Re-distribution factor	$k_m = 0.7$	SFS EN 1995-1-1 - 6.1.6(2)
Condition 1 to meet	$\left(\frac{\sigma_{c.0.d.r}}{f_{c.0.d.r}}\right)^2 + \frac{\sigma_{m.d.r}}{f_{m.d.r}} \le 1 = 1$	SFS EN 1995-1-1 - 6.2.4(1) (6.19)
Condition 2 to meet	$\left(\frac{\sigma_{c.0.d.r}}{f_{c.0.d.r}}\right)^2 + k_m \cdot \frac{\sigma_{m.d.r}}{f_{m.d.r}} \le 1 = 1$	SFS EN 1995-1-1 - 6.2.4(1) (6.20)

Lateral torsional buckling resistance - Eurokoodi 5 lyhennety suunnitteluohje 5.4

Length of the beam	$L_{t.b} := 3.66\ m$	
Spcacing distance	$a := L_{t.b} = 3.66\ m$	
Effective length	$l_{eff.b} := a + 2 \cdot h_r = 4.06\ m$	Eurokoodi 5 lyhennety suunnitteluohje 5.4, p. 26
Conditions to meet in order to get k_{crit}	$\frac{l_{eff.b}}{b_r} = 40.6$ $\frac{h_r}{b_r} = 2$	

Critical bending parameter $k_{crit} := 1$ SFS EN 1995-1-1 - 6.3.3(5)



Lateral torsional buckling check $\sigma_{m.d.r} \le k_{crit} \cdot f_{m.d.r} = 1$

Design Check for the Wall Plate

Width of the section $b_{wp} := 150\ mm$

Height of the section $h_{wp} := 200\ mm$

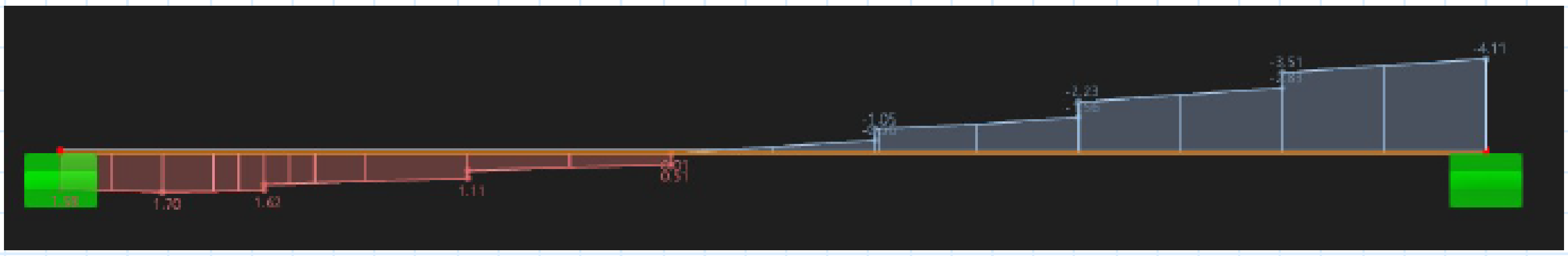
Area of the section $A_{wallplate} := b_{wp} \cdot h_{wp} = 30000\ mm^2$

Compression resistance

Maximum compression force $N_{Ed.c.max.wp} := 0\ kN$ Dlubal RFEM Simulation

According to the simulation, this member dos not contain any compression stresses.

Shear resistance



Maximum shear force $V_{Ed.wp} := 4.11\ kN$ Dlubal RFEM Simulation

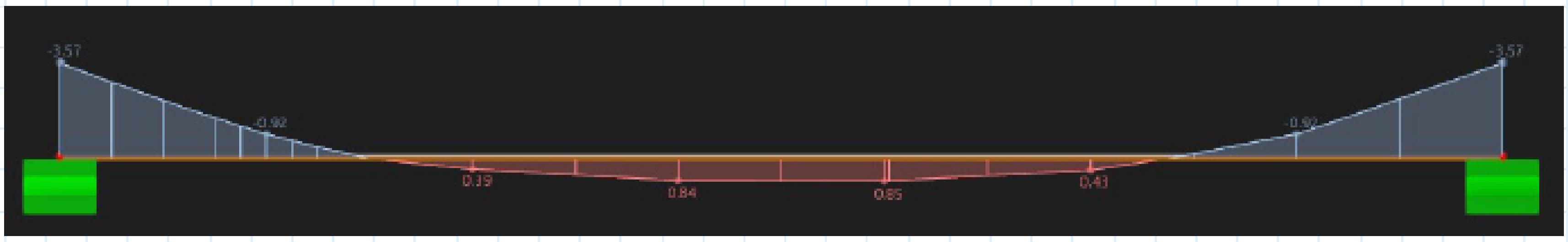
Design shear strength $f_{v.d.wp} := f_{v.k} \cdot \dfrac{k_{mod}}{\gamma_M} = 2.769\ MPa$ SFS EN 1995-1-1 - 2.4.1(1) (2.14)

Design shear stress $\tau_{d.wp} := \dfrac{3 \cdot V_{Ed.wp}}{2 \cdot A_{wallplate}} = 0.206\ MPa$ Swedish Wood, Design of timber structures - Volume 2

Design check for shear resistance $\tau_{d.wp} \le f_{v.d.wp} = 1$ **Design check: OK.** SFS EN 1995-1-1 - 6.1.7(1) (6.13)

Utilization ratio of shear resistance $UR_{shear.wp.resistance} := \dfrac{\tau_{d.wp}}{f_{v.d.wp}} = 7.42\%$ SFS EN 1995-1-1 - 6.1.7(1) (6.13)

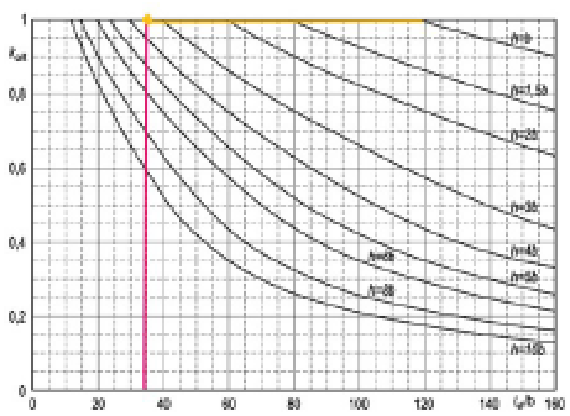
Bending resistance



Maximum bending moment	$M_{Ed.wp} := 3.57\ kN \cdot m$	Dlubal RFEM Simulation
Re-distribution factor	$k_m = 0.7$	SFS EN 1995-1-1 - 6.1.6(2)
Elastic section modulus about y-y	$W_{y.wp} := \frac{b_{wp} \cdot h_{wp}^{2}}{6} = \left(1 \cdot 10^{6}\right)\ mm^3$	
Design bending strength	$f_{m.d.wp} := f_{m.k} \cdot \frac{k_{mod}}{\gamma_M} = 16.615\ MPa$	SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design bending stress	$\sigma_{m.d.wp} := \frac{M_{Ed.wp}}{W_{y.wp}} = 3.57\ MPa$	
Design check for bending resistance	$\sigma_{m.d.wp} \le f_{m.d.wp} = 1$ **Design check: OK.**	SFS EN 1995-1-1 - 6.1.6(1) (6.11/6.12)
Utilization ratio of bending resistance	$UR_{bending.wp.resistance} := \frac{\sigma_{m.d.wp}}{f_{m.d.wp}} = 21.49\%$	

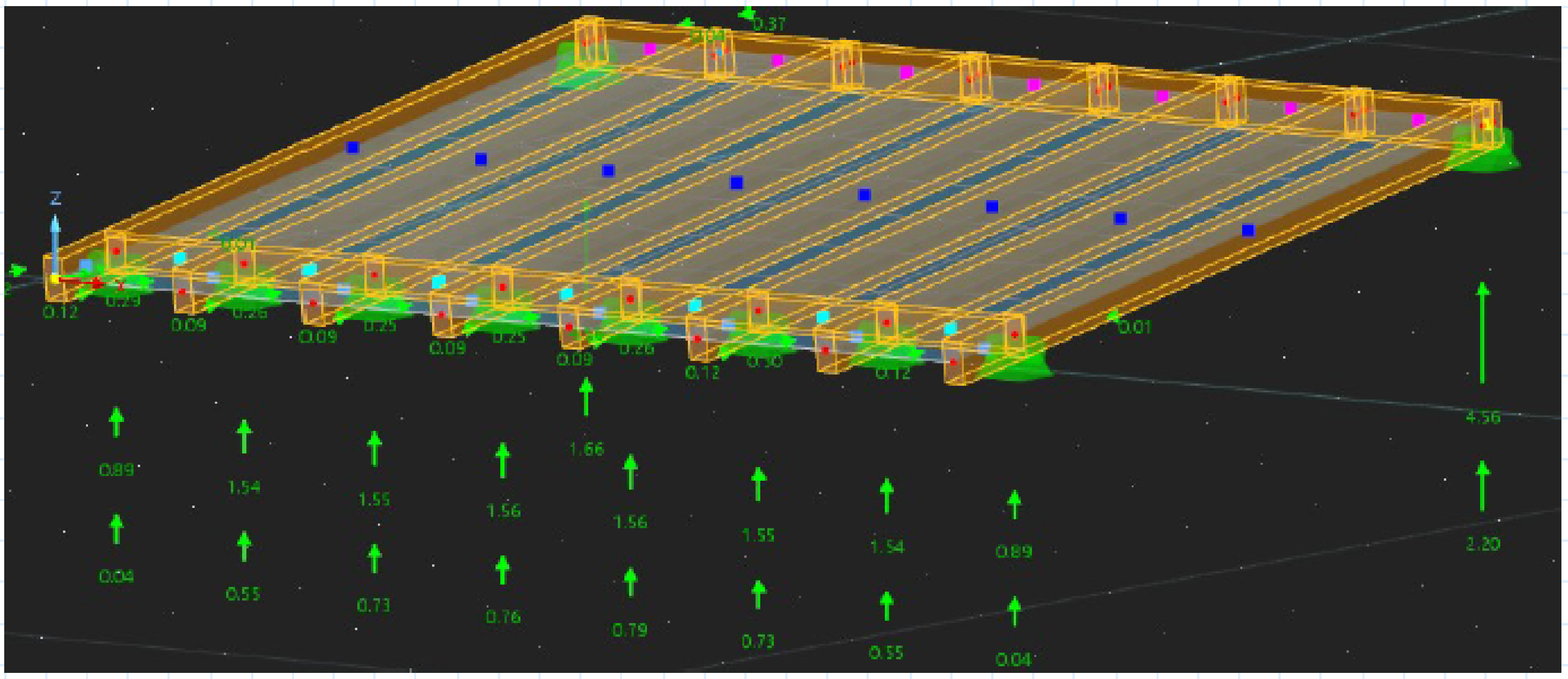
Lateral torsional buckling resistance

Length of the wall plate	$L_{t.wp} := 4.9\ m$	
Spcacing distance	$a_{wp} := L_{t.wp} = 4.9\ m$	
Effective length	$l_{eff.b.wp} := a_{wp} + 2 \cdot h_{wp} = 5.3\ m$	Eurokoodi 5 lyhennety suunnitteluohje 5.4, p. 26
Conditions to meet in order to get k_{crit}	$\frac{l_{eff.b.wp}}{b_{wp}} = 35.333$ $\frac{h_{wp}}{b_{wp}} = 1.333$	
Critical bending parameter	$k_{crit.wp} := 1$	SFS EN 1995-1-1 - 6.3.3(5)



Lateral torsional buckling check $\sigma_{m.d.wp} \le k_{crit.wp} \cdot f_{m.d.wp} = 1$

Support reactions



Appendix 7. Soil bearing capacity calculation for masonry construction

STRIP FOOTING - MASONRY

Basic data

Exposure class	$EC := \text{"XC2"}$	
Structural class	$SC := \text{"S2"}$	
Reinforced concrete weight	$\rho_{c.r} := 25 \frac{kN}{m^3}$	
Normal concrete weight	$\rho_c := 24 \frac{kN}{m^3}$	

Footing Data - obtained from the drawings

Slab length over the plinth	$s_l := 1000\ mm$	
Slab width over the plinth	$s_w := 300\ mm$	
Slab height over the plinth	$s_h := 150\ mm$	
Load from slab	$P_{slab} := 1.35 \cdot (s_w \cdot s_h \cdot \rho_{c.r}) = 1.519 \frac{kN}{m}$	
Strip footing length	$l_f := 1000\ m$	
Strip footing width	$w_f := 600\ mm$	
Strip footing height	$h_f := 600\ mm$	
Strip footing weight	$P_{footing} := 1.35 \cdot (w_f \cdot h_f \cdot \rho_{c.r}) = 12.15 \frac{kN}{m}$	
Plinth length	$l_p := 500\ mm$	
Plinth width	$w_p := 300\ mm$	
Plinth height	$h_p := 250\ mm$	
Plinth weight for a piece	$m_p := 26\ kg$	
Plinth row number	$n_r := 2$	
Plinth piece number for a meter	$n_p := \frac{2}{m}$	
Plinth weight for a meter	$P_{plinth} := 1.35 \cdot (m_p \cdot g \cdot n_r \cdot n_p) = 1.377 \frac{kN}{m}$	
Load from superstructure	$P_{super} := 11.775 \frac{kN}{m}$	Value was calculated in the Wall Calculation document
Total line load acting on the soil	$P_{Ed} := P_{super} + P_{slab} + P_{plinth} + P_{footing} = 26.821 \frac{kN}{m}$	

Soil Bearing Resistance

Design bearing resistance	$q_d := 150\ kPa$	Design bearing resistance was obtained from the AutoCAD drawings from the existing project
Utilization ratio	$UR := \frac{\frac{P_{Ed}}{w_f}}{q_d} = 29.8\%$	SFS EN 1997-1 - 6.5.2.1(1) (6.1)
Condition to meet - SK	$UR \le 1 = 1$	

Appendix 8. Masonry wall design check

Masonry Wall Calculations

Masonry type	*CLAY*
Masonry class	*Class 2*
Masonry and mortar category	*Category A*
Masonry density	$\rho_m := 800\ \frac{kg}{m^3}$
Masonry length	$l_m := 375\ mm$
Masonry width	$w_m := 250\ mm$
Masonry height	$h_m := 249\ mm$
Mortar thickness	$t_{mo} := 1\ mm$
Wall thickness	$t_w := 250\ mm$
Wall width	$w_w := 1000\ mm$
Wall height	$h_w := 2500\ mm$
Masonry mean compressive strength (given by manufacturer)	$f_{b.o} := 12\ MPa$
Mortar compressive strength (given by manufacturer)	$f_m := 10\ MPa$
Height of the beam	$h_{beam} := 250\ mm$
Width of the beam	$b_{beam} := 250\ mm$
Height of the plate	$h_{plate} := 200\ mm$
Width of the plate	$b_{plate} := 150\ mm$

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Ultimate Limit State (ULS)

Load from wall plate
$$P_{plate} := 1.35 \cdot \left(h_{plate} \cdot b_{plate} \cdot 5\ \frac{kN}{m^3}\right) = 0.203\ \frac{kN}{m}$$

Load from ring beam
$$P_{beam} := 1.35 \cdot \left(h_{beam} \cdot b_{beam} \cdot 25\ \frac{kN}{m^3}\right) = 2.109\ \frac{kN}{m}$$

Load from wind
$$W_{wind} := 1.5 \cdot \left(0.50722\ \frac{kN}{m^2} \cdot 1\ m\right) = 0.761\ \frac{kN}{m}$$

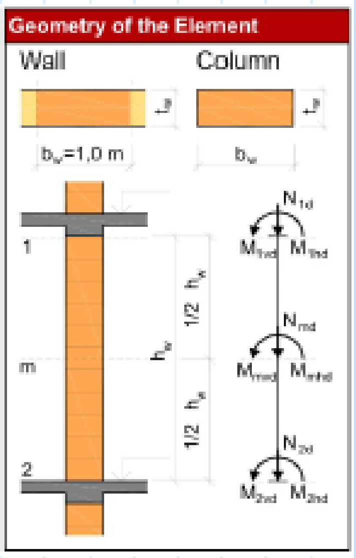
Self-weight of the masonry
$$P_{masonry} := \rho_m \cdot g \cdot w_m \cdot 1\ m = 1.961\ \frac{kN}{m}$$

Total load acting on top of the wall from truss
$$P_{truss} := \frac{4.56\ kN}{w_w} = 4.56\ \frac{kN}{m}$$

Vertical line load acting at the top of wall
$$N_{1d} := \left(P_{plate} + P_{beam}\right) + P_{truss} = 6.872\ \frac{kN}{m}$$

Bending moment acting at the top of wall and resulting from the eccentricity of horizontal loads
$$M_{1hd} := \frac{\frac{\left(W_{wind} \cdot h_w^{\ 2}\right)}{12}}{w_w} = 0.396\ \frac{kN \cdot m}{m}$$

Bending moment acting at the top of wall and resulting from the eccentricity of vertical loads
$$M_{1vd} := 0\ \frac{kN \cdot m}{m}$$



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Vertical line load acting at the middle of wall height	$N_{md} := N_{1d} + \frac{P_{masonry} \cdot h_w \cdot 0.5}{w_w} = 9.324 \frac{kN}{m}$	
Bending moment acting at the middle of wall height and resulting from the eccentricity of horizontal loads	$M_{mhd} := \frac{\left(\frac{W_{wind} \cdot (h_w)^2}{24}\right)}{w_w} = 0.198 \frac{kN \cdot m}{m}$	
Bending moment acting at the middle of wall height and resulting from the eccentricity of vertical loads	$M_{mvd} := 0 \frac{kN \cdot m}{m}$	
Vertical load acting at the bottom of wall	$N_{2d} := N_{1d} + \frac{P_{masonry} \cdot h_w}{w_w} = 11.775 \frac{kN}{m}$	
Bending moment acting at the bottom of wall and resulting from the eccentricity of horizontal loads	$M_{2hd} := \frac{\left(\frac{W_{wind} \cdot (h_w)^2}{12}\right)}{w_w} = 0.396 \frac{kN \cdot m}{m}$	
Bending moment acting at the bottom of wall and resulting from the eccentricity of vertical loads	$M_{2vd} := 0 \frac{kN \cdot m}{m}$	
Partial safety factor	$\gamma_M := 2$	STN EN 1996-1-1/NA - Table 4.6
Material combination factor	$K := 0.7$	STN EN 1996-1-1/NA - Table 3.1
Modulus of elasticity factor	$K_E := 1000$	SFS EN 1996-1-1 - 3.7.2(2)
Shape factor (interpolated, EN772-1)	$\delta_s := \left(\frac{1.15 - 1.10}{250 - 200}\right) \cdot (249 - 200) + 1.10 = 1.149$	SFS EN 772-1 - Table A.1
Normalised masonry mean compressive strength	$f_b := \delta_s \cdot \frac{f_{b.o}}{1\ MPa} = 13.79$	SFS EN 1996-1-1 - 3.1.2(1)
Characteristic masonry compressive strength	$f_k := \left(K \cdot f_b^{\ 0.7}\right) \cdot 1\ MPa = 4.39\ MPa$	SFS EN 1996-1-1 - 3.6.1.2(2) (3.4)
Modulus of elasticity	$E := K_E \cdot f_k = 4.393\ GPa$	SFS EN 1996-1-1 - 3.7.2(2)
Design masonry compressive strength	$f_d := \frac{f_k}{\gamma_M} = 2.2\ MPa$	SFS EN 1996-1-1 - 2.4.1(1)
Reduction factor	$\rho_2 := 1$	SFS EN 1996-1-1 - 5.5.1.2(11) (5.5)
Effective height of the wall	$h_{ef} := h_w \cdot \rho_2 = 2500\ mm$	SFS EN 1996-1-1 - 5.5.1.2(10) (5.2)
Thickness coefficient	$\rho_t := 1$	SFS EN 1996-1-1 - 5.5.1.3 Table 5.1
Effective thickness of the wall	$t_{ef} := \rho_t \cdot t_w = 250\ mm$	SFS EN 1996-1-1 - 5.5.1.3(2) (5.10)
Slenderness ratio	$\lambda := \frac{h_{ef}}{t_{ef}} = 10$	SFS EN 1996-1-1 - 6.1.2.2(2)
Condition to meet	$\frac{h_{ef}}{t_{ef}} \le 27 = 1$	STN EN 1996-1-1/NA - 5.5.1.4(2)
Eccentricity at the top of the wall from vertical loads	$e_{1ve} := \frac{M_{1vd}}{N_{1d}} = 0\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)

Eccentricity at the top of the wall from horizontal loads	$e_{1he} := \frac{M_{1hd}}{N_{1d}} = 57.66\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Initial eccentricity at the top of the wall	$e_{1init} := \frac{h_{ef}}{450} = 5.56\ mm$	SFS EN 1996-1-1 - 5.5.1.1(4)
Eccentricity at the top of the wall	$e_1 := e_{1ve} + e_{1he} + e_{1init} = 63.22\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.5)
Condition to meet	$e_1 \geq 0.05 \cdot t_w = 1$	
Design eccentricity at the top of the wall	$e_{1d} := e_1 = 63.22\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Reduction factor for slenderness and eccentricity at the top of the wall	$\Phi_1 := 1 - 2 \cdot \frac{e_{1d}}{t_w} = 0.49$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.4)
Design axial resistance at the top of the wall	$N_{1Rd} := \left(\Phi_1 \cdot t_w \cdot f_d\right) = 271.4\ \frac{kN}{m}$	SFS EN 1996-1-1 - 6.1.2.1(2) (6.2)
Utilization ratio of loads	$UR_{top} := \frac{N_{1d}}{N_{1Rd}} = 2.53\%$	SFS EN 1996-1-1 - 6.1.2.1(1) (6.1)
Eccentricity at the middle of the wall height from vertical loads	$e_{mve} := \frac{M_{mvd}}{N_{md}} = 0\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Eccentricity at the middle of the wall height from horizontal loads	$e_{mhe} := \frac{M_{mhd}}{N_{md}} = 21.25\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Initial eccentricity middle of the wall height	$e_{minit} := \frac{h_{ef}}{450} = 5.56\ mm$	SFS EN 1996-1-1 - 5.5.1.1(4)
Eccentricity at the middle of the wall height	$e_m := e_{mve} + e_{mhe} + e_{minit} = 26.81\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.7)
Final creep coefficient	$\phi_\infty := 1$	SFS EN 1996-1-1 - 3.7.4(2)
Condition to meet	$\lambda \leq 15 = 1$	
Eccentricity due to creep	$e_k := 0$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.8)
Eccentricity at the middle of the wall height	$e_{mk} := e_m + e_k = 26.81\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.6)
Condition to meet	$e_{mk} \geq 0.05 \cdot t_w = 1$	
Design eccentricity at the middle of the wall height	$e_{md} := e_{mk} = 26.81\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Coefficient for reduction factor	$A_1 := 1 - 2 \cdot \frac{e_{md}}{t_w} = 0.786$	SFS EN 1996-1-1 - Annex G (G.2)
Coefficient for reduction factor	$u := \frac{\frac{h_{ef}}{t_{ef}} - 2}{23 - 37 \cdot \frac{e_{md}}{t_w}} = 0.42$	SFS EN 1996-1-1 - Annex G (G.6)
Reduction factor for slenderness and eccentricity at the middle of the wall height	$\Phi_m := A_1 \cdot e^{-\frac{u^2}{2}} = 0.72$	SFS EN 1996-1-1 - Annex G (G.1)
Design axial resistance at the middle of the wall height	$N_{mRd} := \left(\Phi_m \cdot t_w \cdot f_d\right) = 394.9\ \frac{kN}{m}$	SFS EN 1996-1-1 - 6.1.2.1(2) (6.2)

Utilization ratio of loads	$UR_{mid} := \frac{N_{md}}{N_{mRd}} = 2.36\%$	SFS EN 1996-1-1 - 6.1.2.1(1) (6.1)
Eccentricity at the bottom of the wall from vertical loads	$e_{2ve} := \frac{M_{2vd}}{N_{2d}} = 0\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Eccentricity at the bottom of the wall from horizontal loads	$e_{2he} := \frac{M_{2hd}}{N_{2d}} = 33.65\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1)
Initial eccentricity at the bottom of the wall	$e_{2init} := \frac{h_{ef}}{450} = 5.56\ mm$	SFS EN 1996-1-1 - 5.5.1.1(4)
Eccentricity at the bottom of the wall	$e_2 := e_{2ve} + e_{2he} + e_{2init} = 39.208\ mm$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.5)
Condition to meet	$e_2 \geq 0.05 \cdot t_w = 1$	
Design eccentricity at the bottom of the wall	$e_{2d} := e_2$	SFS EN 1996-1-1 - 6.1.2.2(1)
Reduction factor for slenderness and eccentricity at the bottom of the wall	$\Phi_2 := 1 - 2 \cdot \frac{e_{2d}}{t_w} = 0.69$	SFS EN 1996-1-1 - 6.1.2.2(1) (6.4)
Design axial resistance at the bottom of the wall	$N_{2Rd} := \Phi_2 \cdot t_w \cdot f_d = 376.9\ \frac{kN}{m}$	SFS EN 1996-1-1 - 6.1.2.1(2) (6.2)
Utilization ratio of loads	$UR_{bot} := \frac{N_{2d}}{N_{2Rd}} = 3.12\%$	SFS EN 1996-1-1 - 6.1.2.1(1) (6.1)
Design utilization ratio of ULS	$UR := \max\left(UR_{top}, UR_{mid}, UR_{bot}\right) = 3.12\%$	

Appendix 9. Soil bearing capacity calculation for timber construction

Basic data

Exposure class $EC := \text{"XC2"}$

Structural class $SC := \text{"S2"}$

Reinforced concrete weight $\rho_{c.r} := 25 \frac{kN}{m^3}$

Normal concrete weight $\rho_c := 24 \frac{kN}{m^3}$

Footing Data - obtained from the drawings

Slab length over the plinth $s_l := 1000\ mm$

Slab width over the plinth $s_w := 300\ mm$

Slab height over the plinth $s_h := 150\ mm$

Load from slab $P_{slab} := 1.35 \cdot (s_w \cdot s_h \cdot \rho_{c.r}) = 1.519 \frac{kN}{m}$

Strip footing length $l_f := 1000\ m$

Strip footing width $w_f := 600\ mm$

Strip footing height $h_f := 600\ mm$

Strip footing weight $P_{footing} := 1.35 \cdot (w_f \cdot h_f \cdot \rho_{c.r}) = 12.15 \frac{kN}{m}$

Plinth length $l_p := 500\ mm$

Plinth width $w_p := 300\ mm$

Plinth height $h_p := 250\ mm$

Plinth weight for a piece $m_p := 26\ kg$

Plinth row number $n_r := 2$

Plinth piece number for a meter $n_p := \frac{2}{m}$

Plinth weight for a meter $P_{plinth} := 1.35 \cdot (m_p \cdot g \cdot n_r \cdot n_p) = 1.377 \frac{kN}{m}$

Load from roof $P_{roof} := \frac{4.56\ kN}{1000\ mm} = 4.56 \frac{kN}{m}$

Wall height $h_w := 2.6\ m$

Load from wall $P_{wall} := 48 \frac{kg}{m^2} \cdot g \cdot h_w = 1.224 \frac{kN}{m}$ Obtained from Ubakus, when setting the layer properties

Load from the wall plate $P_{plate} := 0.203 \frac{kN}{m}$ Obtained from masonry wall calculation

Load from timber beam $P_{beam} := 3 \cdot 50\ mm \cdot 160\ mm \cdot 450 \frac{kg}{m^3} \cdot g = 0.106 \frac{kN}{m}$

Load from superstructure $P_{super} := 1.35 \cdot (P_{roof} + P_{wall}) = 7.808 \frac{kN}{m}$ Value was calculated in the Wall Calculation document

Total line load acting on the soil $P_{Ed} := P_{super} + P_{slab} + P_{plinth} + P_{footing} = 22.854 \frac{kN}{m}$

Soil Bearing Resistance

Design bearing resistance	$q_d := 150\ kPa$	Design bearing resistance was obtained from the AutoCAD drawings from the existing project
Utilization ratio	$UR := \frac{\frac{P_{Ed}}{w_f}}{q_d} = 25.39\%$	SFS EN 1997-1 - 6.5.2.1(1) (6.1)
Condition to meet - SK	$UR \le 1 = 1$	

Appendix 10. Timber-wall design check

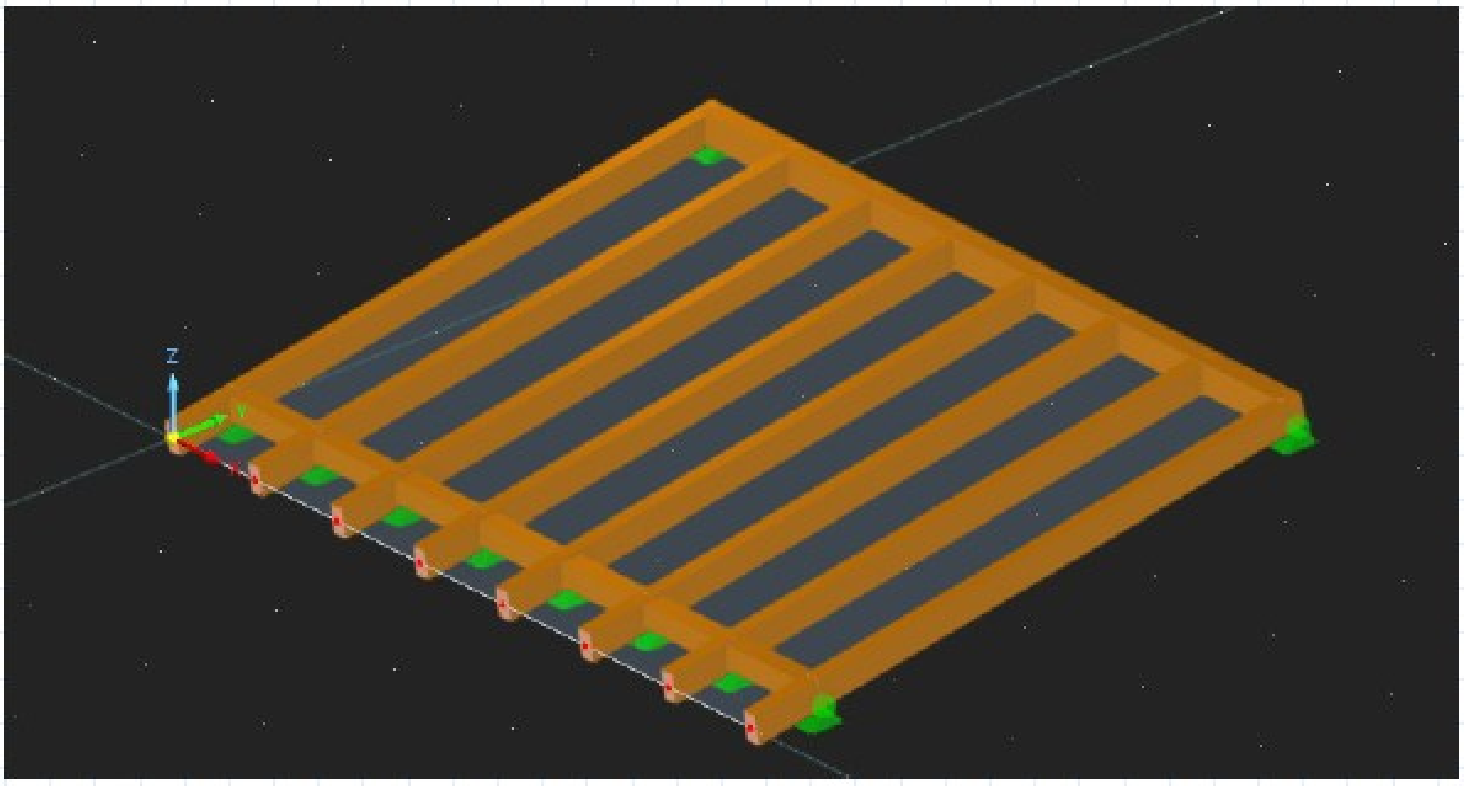
Timber Wall Calculations

Bending parallel to grain $f_{m.k} := 24\ MPa$
Compression parallel to grain $f_{c.0.k} := 21\ MPa$
Compression perpendicular to grain $f_{c.90.k} := 2.5\ MPa$
Shear $f_{v.k} := 4\ MPa$
Elastic modulus $E_{0.05} := 7400\ MPa$
Shear modulus $G_{0.05} := 690\ MPa$

Partial coefficient for material $\gamma_M := 1.3$
Service class $sc := 2$
Strength modification factor $k_{mod} := 0.9$

Property	C24	C27	C30	C35	C40
Strength values					
Bending parallel to grain $f_{m,k}$	24	27	30	35	40
Tension parallel to grain $f_{t,0,k}$	14,5	16,5	19	22,5	26
Tension perpendicular to grain $f_{t,90,k}$	0,4	0,4	0,4	0,4	0,4
Compression parallel to grain $f_{c,0,k}$	21	22	24	25	27
Compression perpendicular to grain $f_{c,90,k}$	2,5	2,5	2,7	2,7	2,8
Shear $f_{v,k}$	4,0	4,0	4,0	4,0	4,0
Stiffness value for capacity analysis					
Elastic modulus $E_{0,05}$	7 400	7 700	8 000	8 700	9 400
Stiffness values for deformation calculations, mean values					
Elastic modulus parallel to grain $E_{0,mean}$	11 000	11 500	12 000	13 000	14 000
Elastic modulus perpendicular to grain $E_{90,mean}$	270	380	400	430	470
Shear modulus G_{mean}	690	720	750	810	880
Density					
Density ρ_k [1]	350	360	380	390	400
Density ρ_{mean} [1]	420	430	460	470	480

The table and the values were obtained from:
Swedish Wood, Design of timber structures - Volume 2



The structural design was carried out using the Dlubal RFEM software. Load combinations were generated in accordance with Eurocode provisions and the Slovak National Annex. Load cases and combinations were defined using EN 1990 (STN 2010-11) via the Combination Wizard, while load definitions followed EN 1991 and its Slovak National Annex (STN 2016-01).

Timber design verification was performed according to EN 1995 (Eurocode 5) together with the Slovak National Annex (STN 2019-12).

Ultimate limit state (ULS) combinations were determined using Equation 6.10 of EN 1990. RFEM automatically evaluated all combinations, and the most unfavourable internal force effects were selected for design verification.

The maximum design values of axial force (N_d), shear force (V_d), and bending moment (M_d) were then extracted for each structural element.

Design Check for Column - basic data were obtained from the software

Width of the section	$b := 50\ mm$		
Height of the section	$h := 160\ mm$		
Area of the section	$A := b \cdot h = 8000\ mm^2$		

Compression resistance

Maximum compression force	$N_{Ed} := 4.56\ kN$		Dlubal RFEM
Design compression strength parallel to the grain	$f_{c.0.d} := \dfrac{k_{mod} \cdot f_{c.0.k}}{\gamma_M} = 14.538\ MPa$		SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design compression stress parallel to the grain	$\sigma_{c.0.d} := \dfrac{N_{Ed}}{A} = 0.57\ MPa$		
Design check for compression resistance	$\sigma_{c.0.d} < f_{c.0.d} = 1$	**Design check: OK.**	SFS EN 1995-1-1 - 6.1.4(1) (6.2)
Utilization ratio for compression resistance	$UR := \dfrac{\sigma_{c.0.d}}{f_{c.0.d}} = 3.92\%$		

Bending resistance

Length of the column	$L := 2.65\ m$		
Wind load acting on the wall surface	$q_w := 0.507\ \dfrac{kN}{m^2}$		
Spacing of columns	$k_{s.column} := 0.6\ m$		
Load acting on the column	$q_d := q_w \cdot \dfrac{k_{s.column}}{2} = 0.152\ \dfrac{kN}{m}$		
Maximum bending moment	$M_{Ed} := \dfrac{q_d \cdot L^2}{8} = 0.134\ kN \cdot m$		Mestarin taulukot - p. 39
Re-distribution factor	$k_m := 0.7$		SFS EN 1995-1-1 - 6.1.6(2)
Elastic section modulus about y-y	$W_y := \dfrac{b \cdot h^2}{6} = \left(2.133 \cdot 10^5\right)\ mm^3$		Mestarin taulukot - p. 42
Design bending strength	$f_{m.y.d} := \dfrac{k_{mod} \cdot f_{m.k}}{\gamma_M} = 16.615\ MPa$		SFS EN 1995-1-1 - 2.4.1(1) (2.14)
Design bending stress	$\sigma_{m.y.d} := \dfrac{M_{Ed}}{W_y} = 0.626\ MPa$		
Design check for bending resistance	$\sigma_{m.y.d} \le f_{m.y.d} = 1$	**Design check: OK.**	SFS EN 1995-1-1 - 6.1.6(1) (6.11/6.12)
Utilization ratio of bending resistance	$UR_{bending.resistance} := \dfrac{\sigma_{m.y.d}}{f_{m.y.d}} = 3.77\%$		

Combined bending and axial compression

Re-distribution factor	$k_m = 0.7$	SFS EN 1995-1-1 - 6.1.6(2)
Condition 1 to meet	$\left(\dfrac{\sigma_{c.0.d}}{f_{c.0.d}}\right)^2 + \dfrac{\sigma_{m.y.d}}{f_{m.y.d}} \le 1 = 1$	SFS EN 1995-1-1 - 6.2.4(1) (6.19)
Condition 2 to meet	$\left(\dfrac{\sigma_{c.0.d}}{f_{c.0.d}}\right)^2 + k_m \cdot \dfrac{\sigma_{m.y.d}}{f_{m.y.d}} \le 1 = 1$	SFS EN 1995-1-1 - 6.2.4(1) (6.20)

Buckling resistance

Critical length $L_{c.y} := L = 2.65\ m$

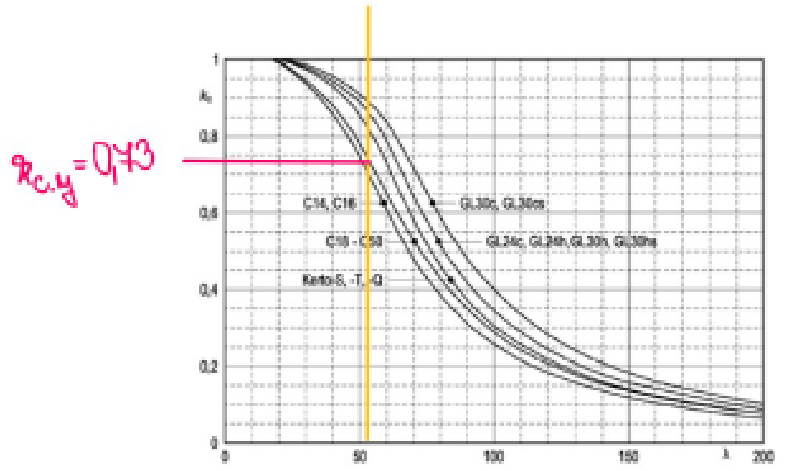
Radius of gyration in the "y" axis $i_y := \frac{h}{\sqrt{12}} = 46.188\ mm$

Slenderness of the column in "y" direction $\lambda_y := \frac{L_{c.y}}{i_y} = 57.374$

Design of timber structures - volume 2, 5.2

Buckling factor $k_{c.y} := 0.73$

SFS EN 1995-1-1 - 6.3.2(1) (6.27)



Critical length $L_{c.z} := L = 2.65\ m$

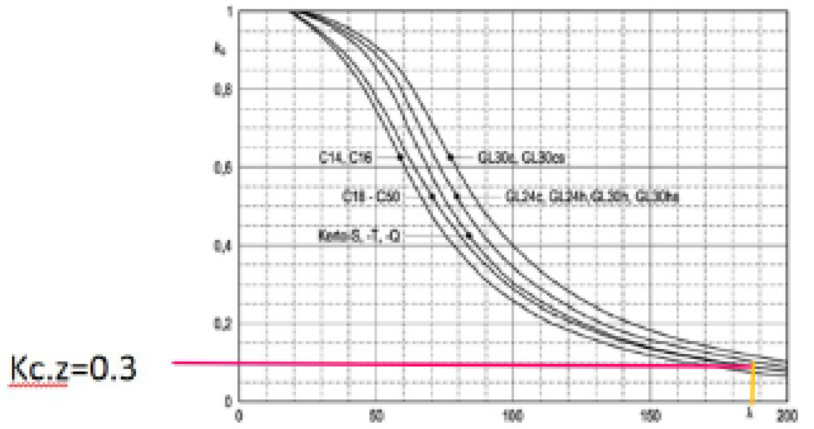
Radius of gyration in the "z" axis $i_z := \frac{b}{\sqrt{12}} = 14.434\ mm$

Slenderness of the column in "z" direction $\lambda_z := \frac{L_{c.z}}{i_z} = 183.597$

Design of timber structures - volume 2, 5.2

Buckling factor $k_{c.z} := 0.3$

SFS EN 1995-1-1 - 6.3.2(1) (6.27)



Condition to meet $\frac{\sigma_{m.y.d}}{f_{m.y.d}} + \frac{\sigma_{c.0.d}}{k_{c.y} \cdot f_{c.0.d}} \le 1 = 1$

Condition to meet $k_m \cdot \frac{\sigma_{m.y.d}}{f_{m.y.d}} + \frac{\sigma_{c.0.d}}{k_{c.y} \cdot f_{c.0.d}} \le 1 = 1$

Puurakenteiden lyhennetty suunnitteluohje: Eurokoodi 5 5.2 (5.8)

Appendix 11. Load calculation and soil bearing capacity for the modular section

Load Calculation for the Modular Section

Snow Load Calculation

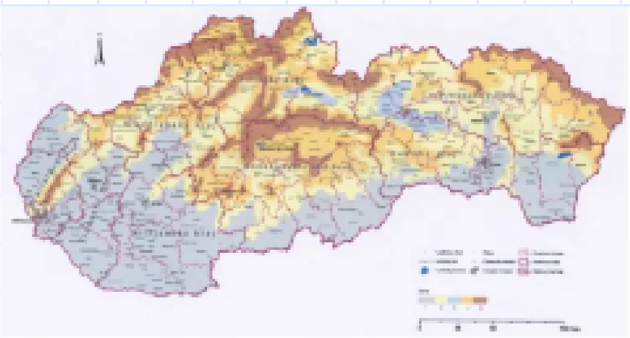
Roof slope $\alpha := 1\,°$

Exposure coefficient $C_e := 1$ SFS EN 1991-1-3 - 5.2(7) Table 5.1

Thermal coefficient $C_t := 1$ STN EN 1991-1-3/NA - 4.2(1)

Snow zone 1 coefficient $a := 0.454$

Snow zone 1 coefficient $b := 970$ STN EN 1991-1-3/NA - 4.1(1)



Zone	1 and 3	2	4	5
a	0,454	0,425	0,716	0,934
b	970	505	430	315

Altitude above sea level (m) $A := 115$ STN EN 1991-1-3/NA - 4.1(1)

Characteristic value of the snow load on the ground in Dunajská Streda $s_k := \left(a + \frac{A}{b}\right) \cdot 1\,\frac{kN}{m^2} = 0.573\,\frac{kN}{m^2}$ STN EN 1991-1-3/NA - 4.1(1)

Snow load shape coefficient 1 $0\ deg \le \alpha \le 30\ deg = 1$ SFS EN 1991-1-3 - 5.3.2 (2) Table 5.2

$\mu_i := 0.8$

Load arrangement for flat roof $S_k := \mu_i \cdot C_e \cdot C_t \cdot s_k = 0.46\,\frac{kN}{m^2}$ SFS EN 1991-1-3 - 5.2(3) (5.1)

Wind Load Calculation

Peak Velocity Calculation - SFS EN 1991-1-1 - 4.3-4.5(p. 19-23)

Height of the structure $Z := 3.015\ m$

Roughness length and min. height $\begin{bmatrix} Z_0 \\ Z_{min} \end{bmatrix} :=$ Terrain category: III

Maximum height $Z_{max} := 200\ m$

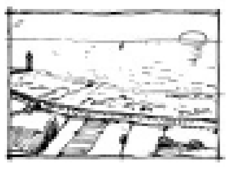
Table 4.1 — Terrain categories and terrain parameters

	Terrain category	z_0 m	z_{min} m
0	Sea or coastal area exposed to the open sea	0,003	1
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0,01	1
II	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0,05	2
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0,3	5
IV	Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m	1,0	10

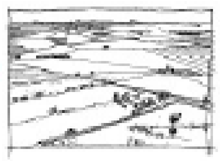
NOTE: The terrain categories are illustrated in A.1.

A.1 Illustrations of the upper roughness of each terrain category

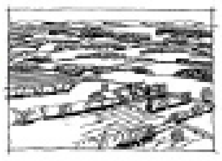
Terrain category 0
Sea, coastal area exposed to the open sea



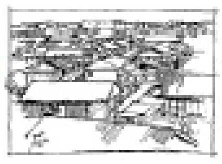
Terrain category I
Lakes or area with negligible vegetation and without obstacles



Terrain category II
Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights



Terrain category III
Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)



Terrain category IV
Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m

Condition to meet $Z_0 \leq 0.003\ m = 0$

Terrain factor $K_r := 0.19 \cdot \left(\dfrac{Z_0}{0.05\ m}\right)^{0.07} = 0.215$

Condition to meet $Z_{min} \leq Z \leq Z_{max} = 0$

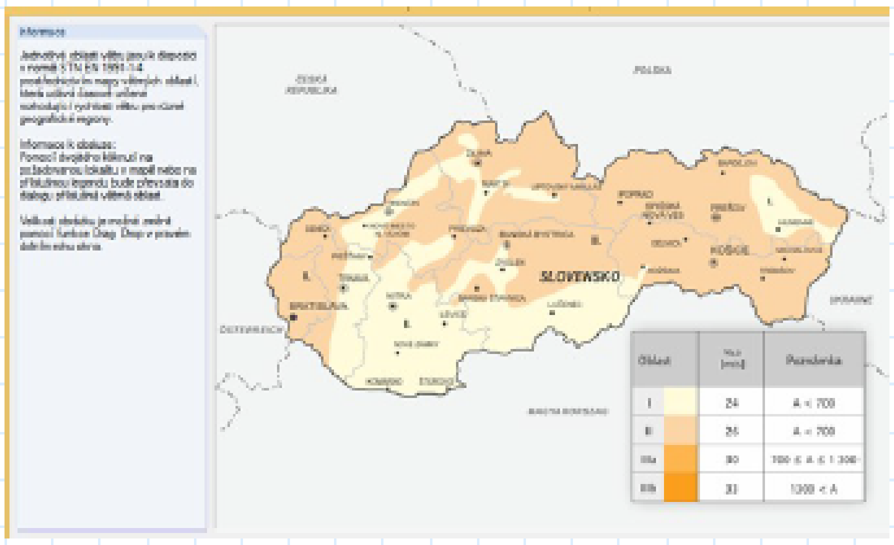
$Z \leq Z_{min} = 1$

Expression (4.4)

$c_r(z) = k_r \cdot \ln\left(\dfrac{z}{z_0}\right)$ for $z_{min} \leq z \leq z_{max}$

$c_r(z) = c_r(z_{min})$ for $z \leq z_{min}$

Terrain roughness $C_r := K_r \cdot \ln\left(\dfrac{Z_{min}}{Z_0}\right) = 0.606$



Turbulance factor $K := 1$

Ortography factor $C_o := 1$

Basic wind velocity $v_b := 24\ \dfrac{m}{s}$

Basic wind pressure $q_b := 360\ Pa$

Air density $\rho := 1.25\ \dfrac{kg}{m^3}$

Mean wind velocity $v_m := C_r \cdot C_o \cdot v_b = 14.543\ \dfrac{m}{s}$

$v_m(z) = c_r(z) \cdot c_o(z) \cdot v_b$ Expression (4.3)

Condition to meet $Z_{min} \leq Z \leq Z_{max} = 0$

Wind turbulence	$Z \le Z_{min} = 1$ $I_v := \dfrac{K}{C_o \cdot \ln\left(\dfrac{Z_{min}}{Z_0}\right)} = 0.355$	Expression (4.7) $I_v(z) = \dfrac{\sigma_v}{v_m(z)} = \dfrac{k_I}{c_o(z) \cdot \ln(z/z_0)}$ for $z_{min} \le z \le z_{max}$ $I_v(z) = I_v(z_{min})$ for $z < z_{min}$
Peak velocity pressure	$q_p := \left(1 + 7 \cdot I_v\right) \cdot \dfrac{1}{2} \cdot \rho \cdot v_m^{\ 2} = 461.109\ Pa$	

Internal pressure coefficients

Negative $C_{pi1} := 0.2$

Positive $C_{pi2} := -0.3$

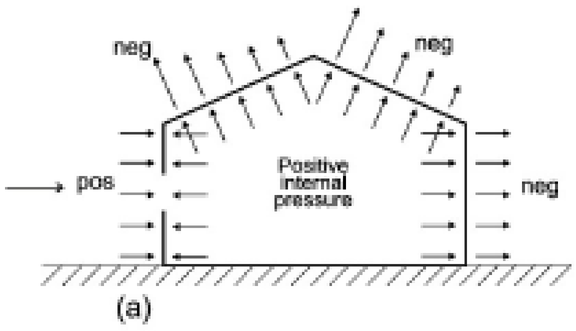
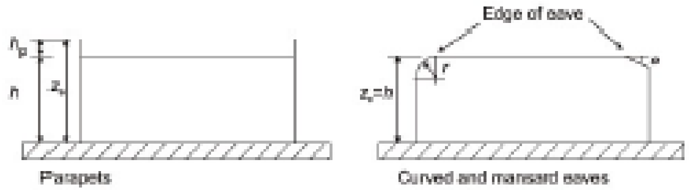


Figure (5.1)

Wind Calculation on the Roof

SFS EN 1991-1-1 - 7.2.5(p.43-46)



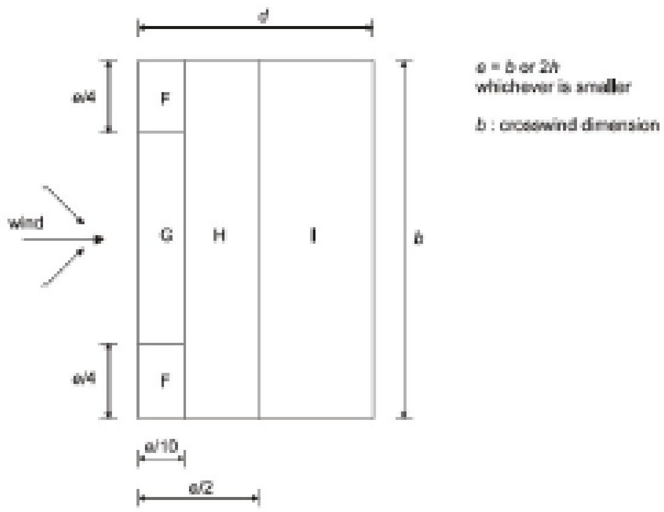


Figure 7.6 — Key for flat roofs

Wind direction 0 degrees

Direction of Wind	$DirecW = 0$
Height of the building	$h_{w0} := 2.84\ m$
Wind direction	$b_{w0} := 5\ m$
Crosswind direction	$d_{w0} := 4\ m$
Elevation	$e_0 := min\left(b_{w0}, 2 \cdot h_{w0}\right) = 5\ m$

Zones for wind direction 0 degrees

Zone F length in y-direction	$Fy_0 := \dfrac{e_0}{4} = 1.25\ m$
Zone F length in x-direction	$Fx_0 := \dfrac{e_0}{10} = 0.5\ m$
Zone G length in y-direction	$Gy_0 := b_{w0} - 2\left(\dfrac{e_0}{4}\right) = 2.5\ m$
Zone G length in x-direction	$Gx_0 := \dfrac{e_0}{10} = 0.5\ m$
Zone H length in y-direction	$Hy_0 := b_{w0} = 5\ m$
Zone H length in x-direction	$Hx_0 := \dfrac{d_{w0}}{2} - \dfrac{e_0}{10} = 1.5\ m$
Zone I length in y-direction	$Iy_0 := b_{w0} = 5\ m$
Zone I length in x-direction	$Ix_0 := \dfrac{d_{w0}}{2} = 2\ m$

Area of zones for wind direction 0 degrees

Zone F

$A_{F.0} := Fy_0 \cdot Fx_0$

$A_{F.0} = 0.625\ m^2$

Zone G

$A_{G.0} := Gy_0 \cdot Gx_0$

$A_{G.0} = 1.25\ m^2$

Zone H

$A_{H.0} := Hy_0 \cdot Hx_0$

$A_{H.0} = 7.5\ m^2$

Zone I

$A_{I.0} := Iy_0 \cdot Ix_0$

$A_{I.0} = 10\ m^2$

External pressure coefficients

Height of parapet $h_p := 110\ mm$

Roof with parapet $\frac{h_p}{h_{w0}} = 0.039$

Table 7.2 — External pressure coefficients for flat roofs

Roof type		Zone F $c_{pe,10}$	F $c_{pe,1}$	G $c_{pe,10}$	G $c_{pe,1}$	H $c_{pe,10}$	H $c_{pe,1}$	I $c_{pe,10}$	I $c_{pe,1}$
Sharp eaves		-1,8	-2,5	-1,2	-2,0	-0,7	-1,2	+0,2 -0,2	
With Parapets	h_p/h=0,025	-1,6	-2,2	-1,1	-1,8	-0,7	-1,2	+0,2 -0,2	
	h_p/h=0,05	-1,4	-2,0	-0,9	-1,6	-0,7	-1,2	+0,2 -0,2	
	h_p/h=0,10	-1,2	-1,8	-0,8	-1,4	-0,7	-1,2	+0,2 -0,2	
Curved Eaves	r/h = 0,05	-1,0	-1,5	-1,2	-1,8	-0,4		+0,2 -0,2	
	r/h = 0,10	-0,7	-1,2	-0,8	-1,4	-0,3		+0,2 -0,2	
	r/h = 0,20	-0,5	-0,8	-0,5	-0,8	-0,3		+0,2 -0,2	
Mansard Eaves	α = 30°	-1,0	-1,5	-1,0	-1,5	-0,3		+0,2 -0,2	
	α = 45°	-1,2	-1,8	-1,3	-1,9	-0,4		+0,2 -0,2	
	α = 60°	-1,3	-1,9	-1,3	-1,9	-0,5		+0,2 -0,2	

Case A for Zones

$ZoneF_{0.a} := -2$

$ZoneG_{0.a} := -1.6$

$ZoneH_{0.a} := -0.7$

$ZoneI_{0.a} := -0.2$

External pressure values for the zones

$$\begin{bmatrix} C_{peF.0.a} \\ C_{peG.0.a} \\ C_{peH.0.a} \\ C_{peI.0.a} \end{bmatrix} := \begin{bmatrix} ZoneF_{0.a} \\ ZoneG_{0.a} \\ ZoneH_{0.a} \\ ZoneI_{0.a} \end{bmatrix} = \begin{bmatrix} -2 \\ -1.6 \\ -0.7 \\ -0.2 \end{bmatrix}$$

Total pressure coefficient at zone F

$ZoneF_{0.a} < 0 = 1$

$C_{pF.0.a} := C_{peF.0.a} - C_{pi1} = -2.2$

Total pressure coefficient at zone G

$ZoneG_{0.a} < 0 = 1$

$C_{pG.0.a} := C_{peG.0.a} - C_{pi1} = -1.8$

Total pressure coefficient at zone H

$ZoneH_{0.a} < 0 = 1$

$C_{pH.0.a} := C_{peH.0.a} - C_{pi1} = -0.9$

Total pressure coefficient at zone I

$ZoneI_{0.a} < 0 = 1$

$C_{pI.0.a} := C_{peI.0.a} - C_{pi1} = -0.4$

Wind pressure

$$\begin{bmatrix} W_{F.0.a} \\ W_{G.0.a} \\ W_{H.0.a} \\ W_{I.0.a} \end{bmatrix} := \begin{bmatrix} C_{pF.0.a} \cdot q_p \\ C_{pG.0.a} \cdot q_p \\ C_{pH.0.a} \cdot q_p \\ C_{pI.0.a} \cdot q_p \end{bmatrix} = \begin{bmatrix} -1.014 \\ -0.83 \\ -0.415 \\ -0.184 \end{bmatrix} \frac{kN}{m^2}$$

Wind direction 90 degrees

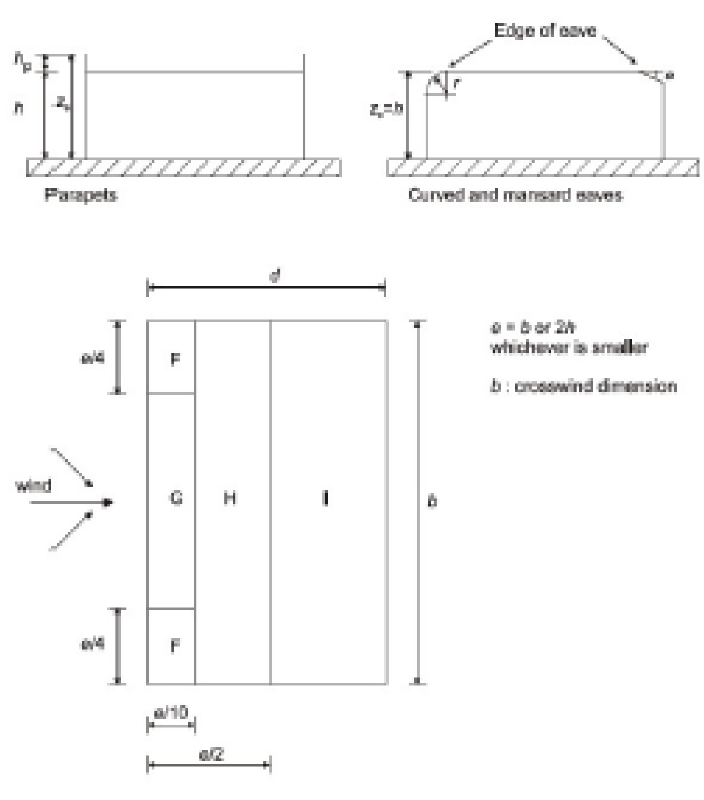


Figure 7.6 — Key for flat roofs

Direction of Wind	$DirecW = 0$
Height of the building	$h_{w90} := 2.84\ m$
Wind direction	$b_{w90} := 4\ m$
Crosswind direction	$d_{w90} := 5\ m$
Elevation	$e_{90} := min\left(b_{w0}, 2 \cdot h_{w0}\right) = 5\ m$

Zones for wind direction 90 degrees

Zone F length in y-direction	$Fy_{90} := \frac{e_0}{4} = 1.25\ m$
Zone F length in x-direction	$Fx_{90} := \frac{e_0}{10} = 0.5\ m$
Zone G length in y-direction	$Gy_{90} := b_{w0} - 2\left(\frac{e_0}{4}\right) = 2.5\ m$
Zone G length in x-direction	$Gx_{90} := \frac{e_0}{10} = 0.5\ m$
Zone H length in y-direction	$Hy_{90} := b_{w0} = 5\ m$
Zone H length in x-direction	$Hx_{90} := \frac{d_{w0}}{2} - \frac{e_0}{10} = 1.5\ m$
Zone I length in y-direction	$Iy_{90} := b_{w0} = 5\ m$
Zone I length in x-direction	$Ix_{90} := \frac{d_{w0}}{2} = 2\ m$

Area of zones for wind direction 90 degrees

Zone F	Zone G	Zone H	Zone I
$A_{F.90} := Fy_0 \cdot Fx_0$	$A_{G.90} := Gy_0 \cdot Gx_0$	$A_{H.90} := Hy_0 \cdot Hx_0$	$A_{I.90} := Iy_0 \cdot Ix_0$
$A_{F.90} = 0.625\ m^2$	$A_{G.90} = 1.25\ m^2$	$A_{H.90} = 7.5\ m^2$	$A_{I.90} = 10\ m^2$

External pressure coefficients

Height of parapet	$h_{p.90} := 110\ mm$
Roof with parapet	$\frac{h_{p.90}}{h_{w90}} = 0.039$

Table 7.2 — External pressure coefficients for flat roofs

Roof type		Zone							
		F		G		H		I	
		$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
Sharp eaves		-1,8	-2,6	-1,2	-2,0	-0,7	-1,2	+0,2 -0,2	
With Parapets	h_p/h=0,025	-1,6	-2,2	-1,1	-1,8	-0,7	-1,2	+0,2 -0,2	
	h_p/h=0,05	-1,4	-2,0	-0,9	-1,6	-0,7	-1,2	+0,2 -0,2	
	h_p/h=0,10	-1,2	-1,8	-0,8	-1,4	-0,7	-1,2	+0,2 -0,2	
Curved Eaves	r/h = 0,05	-1,0	-1,5	-1,2	-1,8	-0,4		+0,2 -0,2	
	r/h = 0,10	-0,7	-1,2	-0,8	-1,4	-0,3		+0,2 -0,2	
	r/h = 0,20	-0,5	-0,8	-0,5	-0,8	-0,3		+0,2 -0,2	
Mansard Eaves	α = 30°	-1,0	-1,5	-1,0	-1,5	-0,3		+0,2 -0,2	
	α = 45°	-1,2	-1,8	-1,3	-1,9	-0,4		+0,2 -0,2	
	α = 60°	-1,3	-1,9	-1,3	-1,9	-0,5		+0,2 -0,2	

Case A for Zones

$ZoneF_{90.a} := -2$

$ZoneG_{90.a} := -1.6$

$ZoneH_{90.a} := -0.7$

$ZoneI_{90.a} := -0.2$

External pressure values for the zones

$$\begin{bmatrix} C_{peF.90.a} \\ C_{peG.90.a} \\ C_{peH.90.a} \\ C_{peI.90.a} \end{bmatrix} := \begin{bmatrix} ZoneF_{90.a} \\ ZoneG_{90.a} \\ ZoneH_{90.a} \\ ZoneI_{90.a} \end{bmatrix} = \begin{bmatrix} -2 \\ -1.6 \\ -0.7 \\ -0.2 \end{bmatrix}$$

Total pressure coefficient at zone F

$ZoneF_{90.a} < 0 = 1$

$C_{pF.90.a} := C_{peF.90.a} - C_{pi1} = -2.2$

Total pressure coefficient at zone G

$ZoneG_{90.a} < 0 = 1$

$C_{pG.90.a} := C_{peG.90.a} - C_{pi1} = -1.8$

Total pressure coefficient at zone H

$ZoneH_{90.a} < 0 = 1$

$C_{pH.90.a} := C_{peH.90.a} - C_{pi1} = -0.9$

Total pressure coefficient at zone I

$ZoneI_{90.a} < 0 = 1$

$C_{pI.90.a} := C_{peI.90.a} - C_{pi1} = -0.4$

Wind pressure

$$\begin{bmatrix} W_{F.90.a} \\ W_{G.90.a} \\ W_{H.90.a} \\ W_{I.90.a} \end{bmatrix} := \begin{bmatrix} C_{pF.90.a} \cdot q_p \\ C_{pG.90.a} \cdot q_p \\ C_{pH.90.a} \cdot q_p \\ C_{pI.90.a} \cdot q_p \end{bmatrix} = \begin{bmatrix} -1.014 \\ -0.83 \\ -0.415 \\ -0.184 \end{bmatrix} \frac{kN}{m^2}$$

Wind load acting on the structure $q_{k.w} := W_{F.90.a}$

Live load Calculation

Live load category A $q_k := 2.0 \frac{kN}{m^2}$

Dead load Calculation

Exposure class	$EC := \text{"XC2"}$
Structural class	$SC := \text{"S2"}$
Reinforced concrete weight	$\rho_{c.r} := 25 \frac{kN}{m^3}$
Normal concrete weight	$\rho_c := 24 \frac{kN}{m^3}$

Footing Data - obtained from the drawings

Slab height over the plinth	$s_h := 150\ mm$
Load from slab	$P_{slab} := s_h \cdot \rho_{c.r} = 3.75 \frac{kN}{m^2}$
Strip footing height	$h_f := 600\ mm$
Strip footing weight	$P_{footing} := h_f \cdot \rho_{c.r} = 15 \frac{kN}{m^2}$
Plinth length	$l_p := 500\ mm$
Plinth width	$w_p := 300\ mm$
Plinth height	$h_{p.0} := 250\ mm$
Plinth weight for a piece	$m_p := 26\ kg$
Plinth row number	$n_r := 2$
Plinth piece number for a meter	$n_p := 2$
Plinth weight for a meter	$P_{plinth} := \frac{m_p \cdot g \cdot n_r \cdot n_p}{w_p \cdot 1\ m} = 3.4 \frac{kN}{m^2}$
Dead load of the modular section (From manufacturer)	$P_{modul} := 2.5 \frac{kN}{m^2}$
Total line load acting on the soil	$P_{Ed} := P_{modul} + P_{slab} + P_{plinth} + P_{footing} = 24.65 \frac{kN}{m^2}$
Wind load coefficient	$\psi_{0.w} := 0.6$
Snow load coefficient	$\psi_{0.s} := 0.7$ SFS EN 1990-1-1 A1.2.2 Table A1.1
Live load coefficient	$\psi_{0.l} := 0.7$

Load combination

$$P := \max\left(\begin{bmatrix} 1.35 \cdot P_{Ed} \\ 1.35 \cdot P_{Ed} + 1.5 \cdot q_k + 1.5 \cdot \left|W_{F.90.a}\right| \cdot \psi_{0.w} + 1.5 \cdot s_k \cdot \psi_{0.s} \\ 1.35 \cdot P_{Ed} + 1.5 \cdot \left|W_{F.90.a}\right| + 1.5 \cdot q_k \cdot \psi_{0.l} + 1.5 \cdot s_k \cdot \psi_{0.s} \\ 1.35 \cdot P_{Ed} + 1.5 \cdot s_k + 1.5 \cdot \left|W_{F.90.a}\right| \cdot \psi_{0.w} + 1.5 \cdot q_k \cdot \psi_{0.l} \end{bmatrix}\right) = 37.791 \frac{kN}{m^2}$$

Soil Bearing Resistance

Design bearing resistance	$q_d := 150\ kPa$	Design bearing resistance was obtained from the AutoCAD drawings from the existing project
Utilization ratio	$UR := \frac{P}{q_d} = 25.19\%$	SFS EN 1997-1 - 6.5.2.1(1) (6.1)
Condition to meet - SK	$UR \le 1 = 1$	