Aliquam eget risus vitae lacus hendrerit laoreet. Pellentesque habitant morbi tristique senectus et netus.

Daniel Aguado Hernández

University of Minho

Czech Republic | 2023

SAHC

ADVANCED MASTERS IN STRUCTURAL ANALYSIS
OF MONUMENTS AND HISTORICAL CONSTRUCTIONS

Master's Thesis

Daniel Aguado Hernández

Winery Wilomenna Chlumčany u Loun: Revitalization of the winery grounds

Czech Republic | 2023

CZECH TECHNICAL UNIVERSITY IN PRAGUE
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DIPLOMA THESIS ASSIGNMENT FORM

I. PERSONAL AND STUDY DATA

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Assigning Department: Department of Architecture

Study programme: Civil Engineering

Study branch/spec.: Advanced Masters in Structural Analysis of Monuments and Historical Constructions

II. DIPLOMA THESIS DATA

Diploma Thesis (DT) title: Winery Chlumčany u Loun: Revitalization of the Winery Grounds

Diploma Thesis title in English: Winery Chlumčany u Loun: Revitalization of the Winery Grounds

Instructions for writing the thesis:
The aim of the project is to propose the revitalization of the entire 19th century winery site and to focus in detail on the restoration and stabilization of the existing historic former pressing plant building to meet the current requirements of winery operations.
The project to revitalize the present-day Wilomenna Winery is focused on several sub-works:
- An analysis of the use of the winery site as a whole,
- a structural, historical and structural engineering analysis of the former pressing plant,
- the design of a visitor centre with the possibility of sales,
- the proposal for the rehabilitation and stabilisation of the historic structures of the former pressing plant (according to the extent of the proposed architectural modifications, e.g. dehumidification of the buildings, stabilisation of the stonework, securing the roof structure, etc.).

List of recommended literature:
Conti, A.: History of the restoration and conservation of works of art, Oxford 2007. ISBN 978-0750669535
Jokilehto, J.: A History of Architectural Conservation, Butterworth-Heinemann, Oxford 1999. ISBN 978-0750655118
Page, M. Giving Preservation a History, Taylor and Francis Ltd, 2004. ISBN 9780415934435
Feilden, H. Conservation, RIBA Publishing, 2017. ISBN 9781859465905
Conti, A.: History of the restoration and conservation of works of art, Oxford 2007. ISBN 978-0750669535

Name of Diploma Thesis Supervisor: doc. Ing. Klára Kroftová, Ph.D.

DT assignment date: 14.3.2023 DT submission date in IS KOS: 6.7.2023
see the schedule of the current acad. year

DT Supervisor's signature Head of Department's signature

III. ASSIGNMENT RECEIPT

I declare that I am obliged to write the Diploma Thesis on my own, without anyone's assistance, except for provided consultations. The list of references, other sources and consultants' names must be stated in the Diploma Thesis and in referencing I must abide by the CTU methodological manual "How to Write University Final Theses" and the CTU methodological instruction "On the Observation of Ethical Principles in the Preparation of University Final Theses".

14/03/2023 Daniel Aguado Hernández
Assignment receipt date Student's name

DECLARATION

Name: Daniel Aguado Hernández

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Supervisor(s): Klára Kroftová

Year: 2023

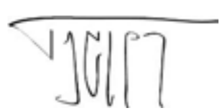
I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

I hereby declare that the MSc Consortium responsible for the Advanced Masters in Structural Analysis of Monuments and Historical Constructions is allowed to store and make available electronically the present MSc Dissertation.

University: Czech Technical University in Prague

Date: 6/07/2023

Signature:



DEDICATION

To my loving parents and the architects which have shaped into friends Juan Carlos Cano, Pavel Escobedo, Andrés Solis and Brian Slocum.

ACKNOWLEDGEMENTS

I hereby thank all the people that were involved with me during the process of this master's thesis.

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U Minho, CTUV Prague & SAHC master's for the support of the Consortium Scholarship 2023

ABSTRACT

The aim of the presented case study is the revitalization of the historic winery in Chlumčany by Louny, whose oldest buildings and cellars date back to the 18th century. The project focuses on two main aspects. The stabilisation and restoration procedures applicable to the damaged stone masonry structure with a degraded wooden roof (1) and the design of a new extension to the press building to meet the current requirements of the winery Willomena (2).

The work performed for the case presented included a building survey, historical and technical research, structural and material characterization, damage mapping, and material sample analysis. Based on the results obtained from the surveys carried out, restoration and strengthening procedures were proposed and their proper execution was described.

The design of the new extension was supported by an analysis of the methods of strengthening the truss structures, so that it would provide a structural stabilising element for the existing masonry building, while creating a new space for visitors to the winery. The structural measures implemented helped to distribute the loads from the damaged masonry walls to the new structure while providing additional support to the roof structure. The proposed solution concludes with the results of the structural analysis and a discussion of the importance and benefits of preserving historic buildings.

ABSTRAKT

Cílem předložené případové studie je revitalizace areálu historického vinařství v Chlumčanech u Loun, jehož nejstarší budovy a sklepy pocházejí z 18. století. Projekt se zaměřuje na dva hlavní aspekty. Stabilizaci a postupy obnovy použitelné pro poškozenou zděnou kamennou konstrukci s degradovanou dřevěnou střechou (1) a návrh nové přístavby budovy lisovny, tak aby splňovala současné požadavky vinařství Willomena (2).

Provedené práce pro prezentovaný případ zahrnovaly zaměření objektu, historický a technický průzkum, charakteristiku konstrukce a materiálu, mapování poškození a analýzu vzorků materiálů. Na základě výsledků získaných z provedených průzkumů byly navrženy postupy obnovy a zpevnění a byl popsán způsob jejich správného provedení.

Návrh nové přístavby byl podpořen analýzou metod zpevňování krovových konstrukcí, tak aby pro stávající zděný objekt představovala konstrukční stabilizační prvek a zároveň vytvořila nový prostor pro návštěvníky vinařství. Provedená konstrukční opatření pomohla rozložit zatížení z poškozených zděných stěn na novou konstrukci a zároveň poskytla dodatečnou podporu střešní konstrukci. V závěru navrhovaného řešení jsou uvedeny výsledky statické analýzy a diskuse o významu a přínosech zachování historických budov.

TABLE OF CONTENTS

1. INTRODUCTION

The aim of the project is to propose the revitalisation of Wilomenna winery, a local house wine producer located in Chlumčany, a small town in the Pilsen-ilj district, one hour southwest from Prague. The owners seek to renovate its facilities and create more space for new uses like a wine shop boutique and wine tasting experiences. Within the grounds of the winery the proposal focuses specifically on the stabilisation of the existing historic building and the structural design proposal of modification and extension of the historic pressing plant building that will house space for the new demands.

The study case presents a 2-storey masonry structure composed by a rectangular building with a base dimension of 7.00m x 17.50 m and a height of 4.9 m. The perimetral walls have an average of 0.5 m thickness made of opuka stone. A sedimentary rock typical of the Bohemian region (Czech Republic) that has been extensively used for stone buildings and decorative architectural elements from about 10th C. The roofing structure is composed by timber trusses and timber boards between them covered by eternity roof composed by asbestos sheets. This former pressing plant maintains nowadays trails of its past. The building's façade that was once covered by a plaster render , has now wear off and it shows interesting embedded details such as window frame openings filled with brick and other types of masonry along as other additions & subtractions made with different construction techniques. This features add some uniqueness and texture to the construction in a natural sense of belonging to the site and its history. Other valuable features of this building are the use of local materials, craftmanship of local builders and a human scale sense. All of this are desirable characteristics for a visitor to experience a local product in a traditional environment, which will be one of the main aspects to consider for the conservation and renovation proposal.

With the past of time and lack of maintenance, the deterioration of the plaster renderings that used to cover the masonry walls from the environmental agents, are now completely exposed and decayed. Opuka rock becomes high susceptible for damage from decay process such as freezing/thaw, salt crystallization and rising damp, which has led to the opening of several cracks in its east façade and humidity saturation of the masonry units and mortar joints at street level. Another factor related to the recently expansion of this crack are the vibrations caused by a viaduct construction in the surroundings of the area . The roof structure which is composed by timber trusses,struts and posts also present decay and damage elements related to high moisture levels, and biological attack.

One of the main aspects to consider regarding conservation of historical buildings is to make a differentiation between the historical elements of the building with the new structure and materials. Making an intervention between the consolidated elements and the new structure in graded timber and steel joints with steel plates. The new structure adds load bearing elements to distribute the loads of the pre-existent timber roof to the ground. This also opens the possibility of having bigger spans for open floor distribution with higher ceilings. The design of this structural system has the capacity to hold the loads of the existing wooden trusses and the glassing for the extension. The numerical model of the structure was made in Robot Autodesk static analysis, calculating self-weight , snow, wind loads and accidental factors. The main objective of this intervention is to ensure structural safety of both structures and to comply with regulations for holding a bigger amount of visitors and related services like bathrooms, parking space, circulations, etc. By increasing its original area of 110 m2 to 165 m2.

The design of the intervention is based on temporal shoring techniques for masonry buildings with partially collapsed elements, or in danger of overturning. To implement this, a design process of form fitting was implemented with a contemporary geometry that performs the structural needs with less material in timber and can hold bigger spans. The space enclosed by these new structures creates different areas; covered, open and semi open. Creating a bigger gallery with more open space were traditional building techniques dialogue with contemporary design in new materials.

Fig 1 : temporal shoring timber structures stabilizing damaged masonry structures

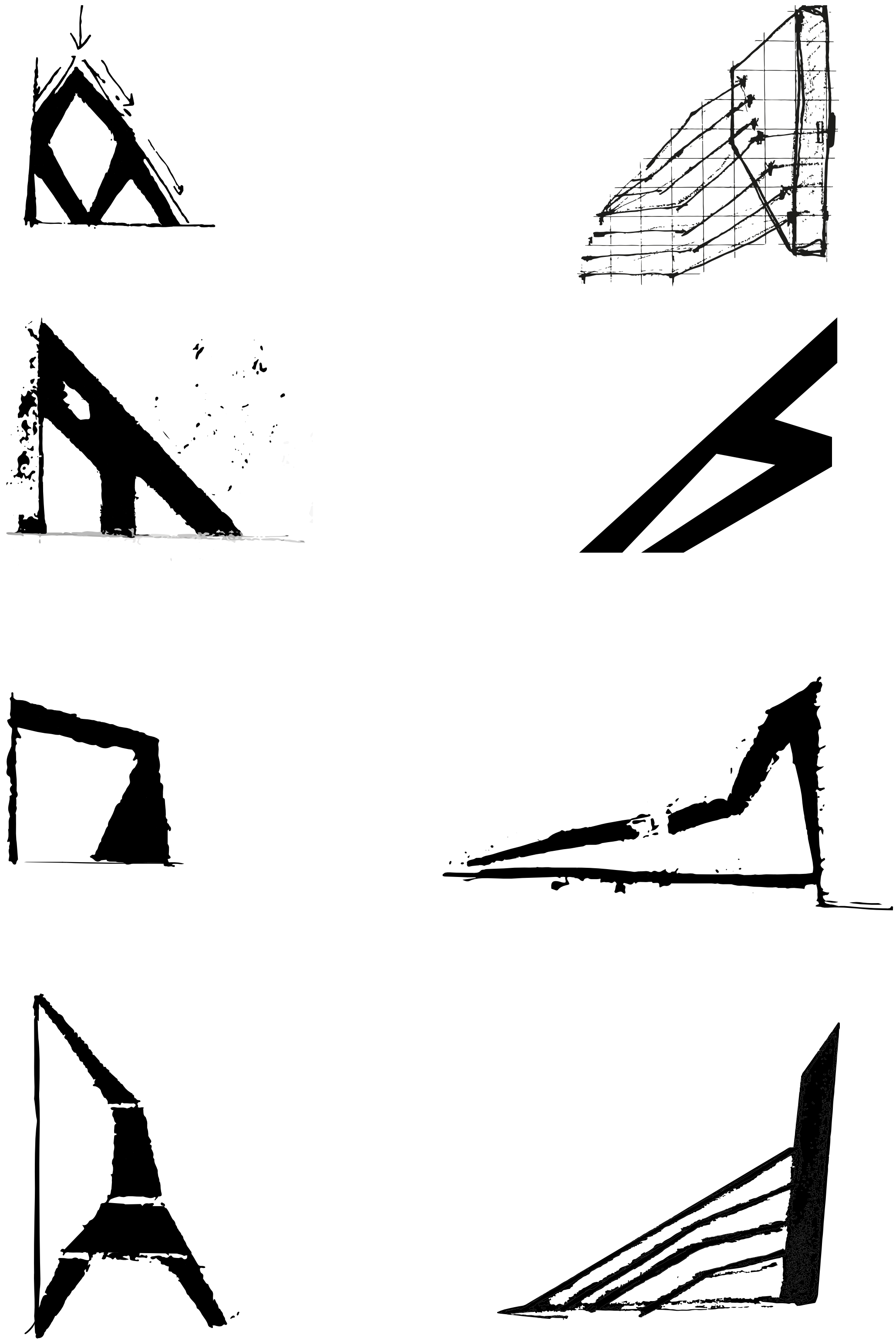
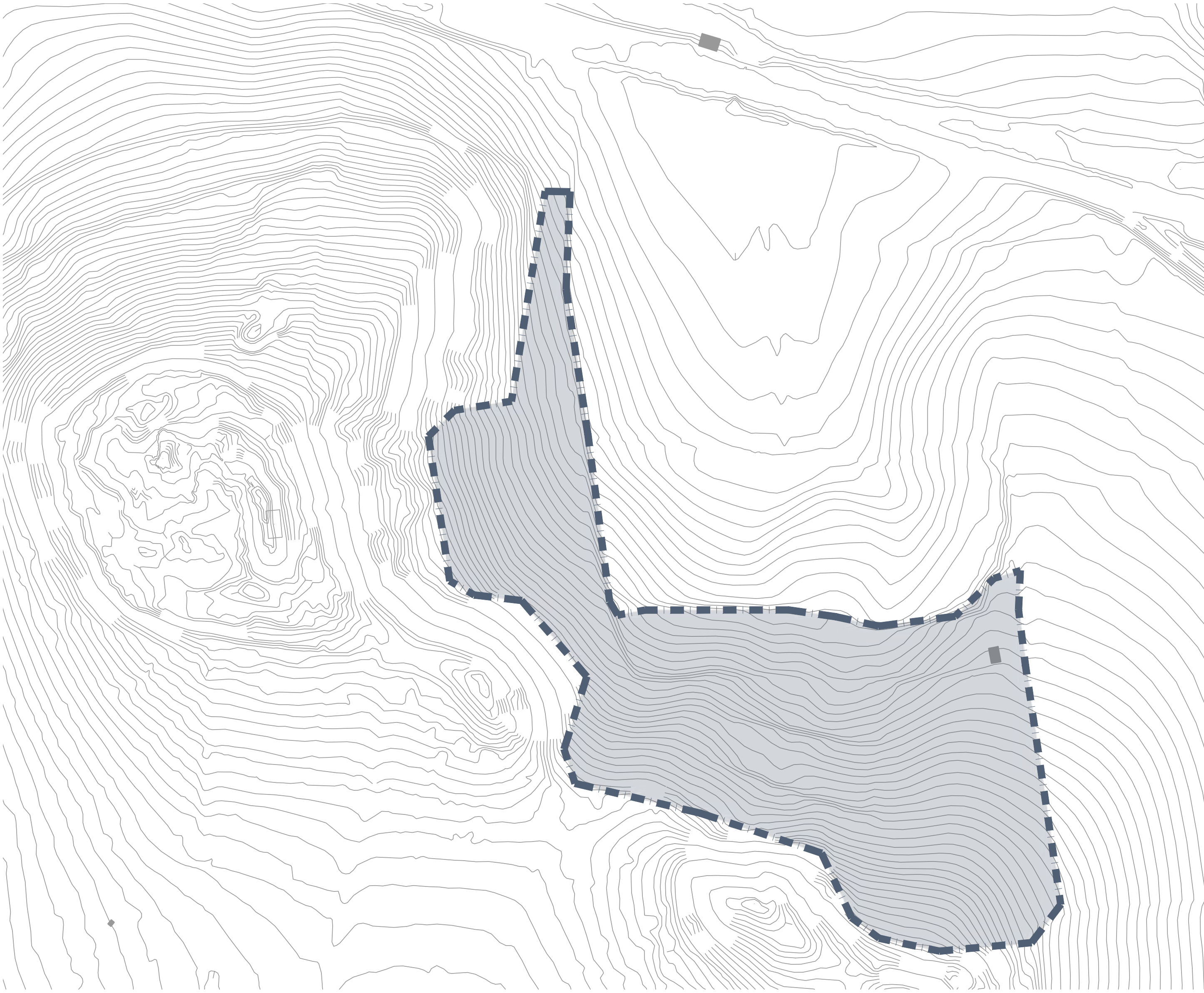


Fig 2 : form fitting study for transfering loads of an out of plane behaviour wall

2. METHODOLOGY

The proposed procedure and analysis are based on existing standards which deal with problems related to conservation and restoration of historical timber structures in Europe. ICOMOS which has adopted the "principles for the preservation of historic timber structures" since 1999, ISO 13822, the international standard "Basis for design structures, assessment of existing structures" and the Italian code. These standards and considerations used as a basis for the proposed methodology which considers aspects such as geometry of available data, material properties, numerical modelling, boundary conditions and applied loadings.
The following stages describe the development of the presented study case always taking into consideration ICOMOS principles .
-Documentation and investigation: gather of information about the history and alterations of the building during the past. Acquire understanding of the significance of the site and studied building, techniques and the skills used in its construction, regional characteristics and important events that lead to it's current state. Understanding of diferent principles for the preservation and reconstruction of historical buildings
-Diagnosis: site visits made in order to gain knowledge of the buildings geometry, measurements, visual inspectio on site survey, identification of decay and damage to determine the causes and its degree of conservation for future actions.
-Field research and laboratory testing: process of information about mechanical, structural and chemical material characteristics of materials that compose the structure.
- Architectural design: Interventions to be made in order to conserve the historic structure ,maintaining the historical authenticity and integrity with a design proposal for solving the current problematic along with the requiered needs of the project. This stage includes concept design from sketches, drawings, renders, perspectives 3d models and architectural plans.
- Structural analysis, assessment of the stability of the load-bearing structure. Taking into consideration the behaviour of the proposed structure and its components ; material properties, loads, supports and accidental factores were taken into consideration for the numerical model calculations made in Robot Autodesk software for static analysis.

1. THE SITE: Chlumčany u Loun.



Currently, the vineyard belongs to a small family winery called WILOMENNA. The Pod Chlumem winery was founded in 2019. It islocated in the village of Chlumčany u Loun. The headquarters consists of a warehouse and wine production facility, which is followed by a wine cellar and a pressing facility, where it is planned to create a tasting area for visitors in the future. The winery also includes vineyards in the vicinity of Blšanské Chlum in the foothills of the Český středohoří, in a non-traditional area where hops otherwise rule. This place was not chosen by chance, the town of Louny and the surrounding area was historically a wine town, when it was especially famous for wines from the Tramín variety (once called Brynšt). In addition, this location has an exceptional volcanic subsoil that gives the local wines unique sensory properties, especially an exclusive taste with an appropriate earthiness. The vines are planted so that they can take root more deeply and thus obtain more minerals from the volcanic bedrock.

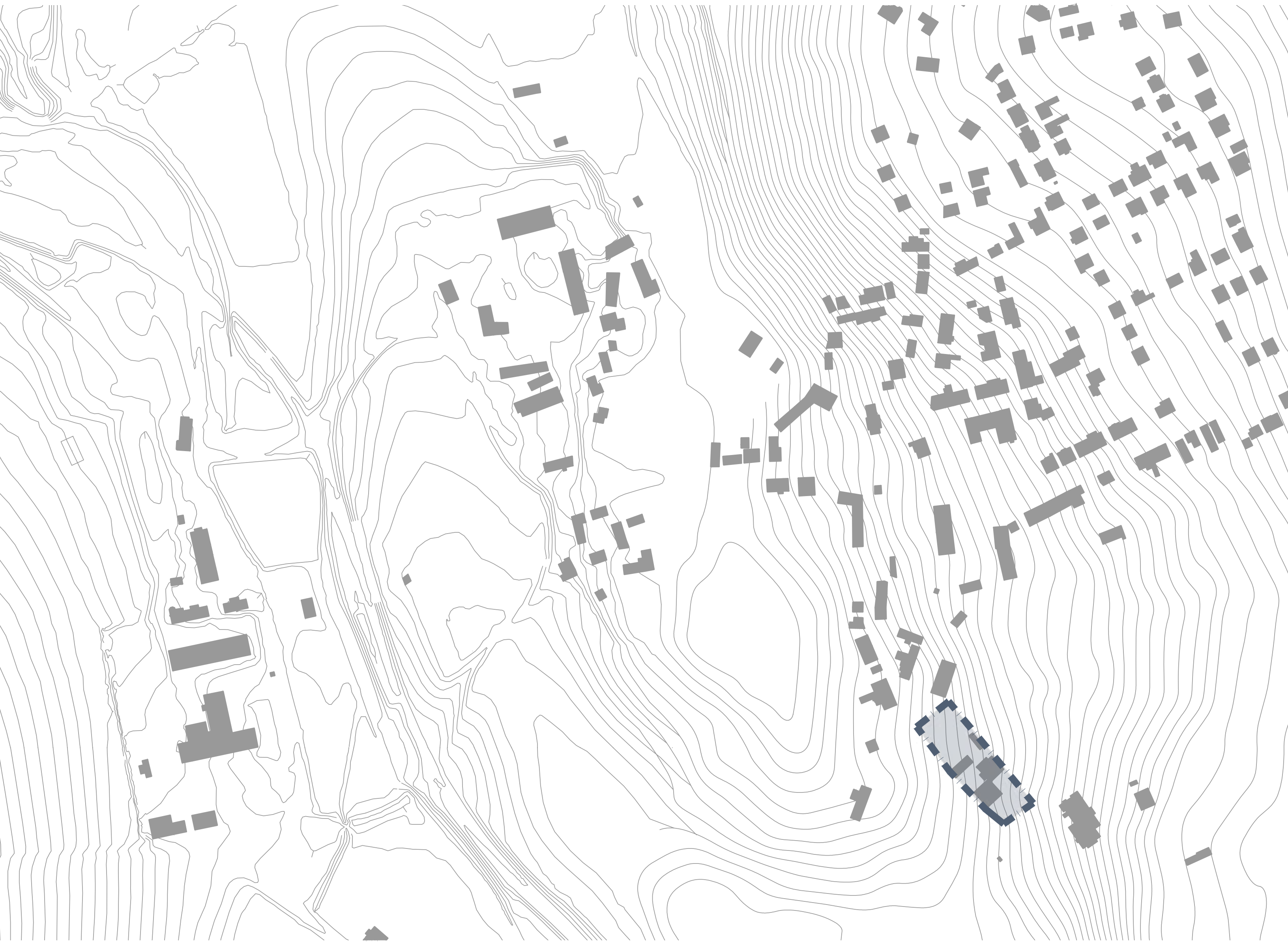


Fig 3: Curve map ofChlumčany highlighting Vineyard lands and Willomena facilities.

3.1. History & urban developement

The earliest mention of the village dates back to 1316, when Vikart the Vladyka appeared at the provincial court of Chlumčany as a witness in a legal case with a manor house, usually represented by a small fortified building. The actual appearance of the village in the pre-Hussite period can only be partially approximated. It is not certain whether there was already a fortress, which was not mentioned in writing until 1506, but, given the owners' long-standing called "of Chlumčany", it undoubtedly existed earlier. It is still commemorated by the local name "Na brance" and several worked stones set into the walls of the former Schwarzenberg court. Apart from the fortress of unknown form, the dominant feature was the parish church, dedicated to St. Clement and administratively belonging to the Slánský deanery.

The first name known parish priest was the priest Bartholomew. In the Middle Ages, it was very common for a village not to belong to a single superior, but to different owners took turns in the possession of different parts of the village. In the case of Chlumčany, the lack of the situation was somewhat unclear until the Hussite wars. The first documented owner was the aforementioned Vikart of Chlumčany in 1316.In the period of the Hussite wars and the subsequent normalisation of the situation under King George of Poděbrady reports about Chlumčany are very scarce. The turbulent and turbulent times always gave the opportunity to excel for capable personalities. One such figure was a member of the Vladyc family of the owners of Matyáš, also called Louda of Chlumčany.

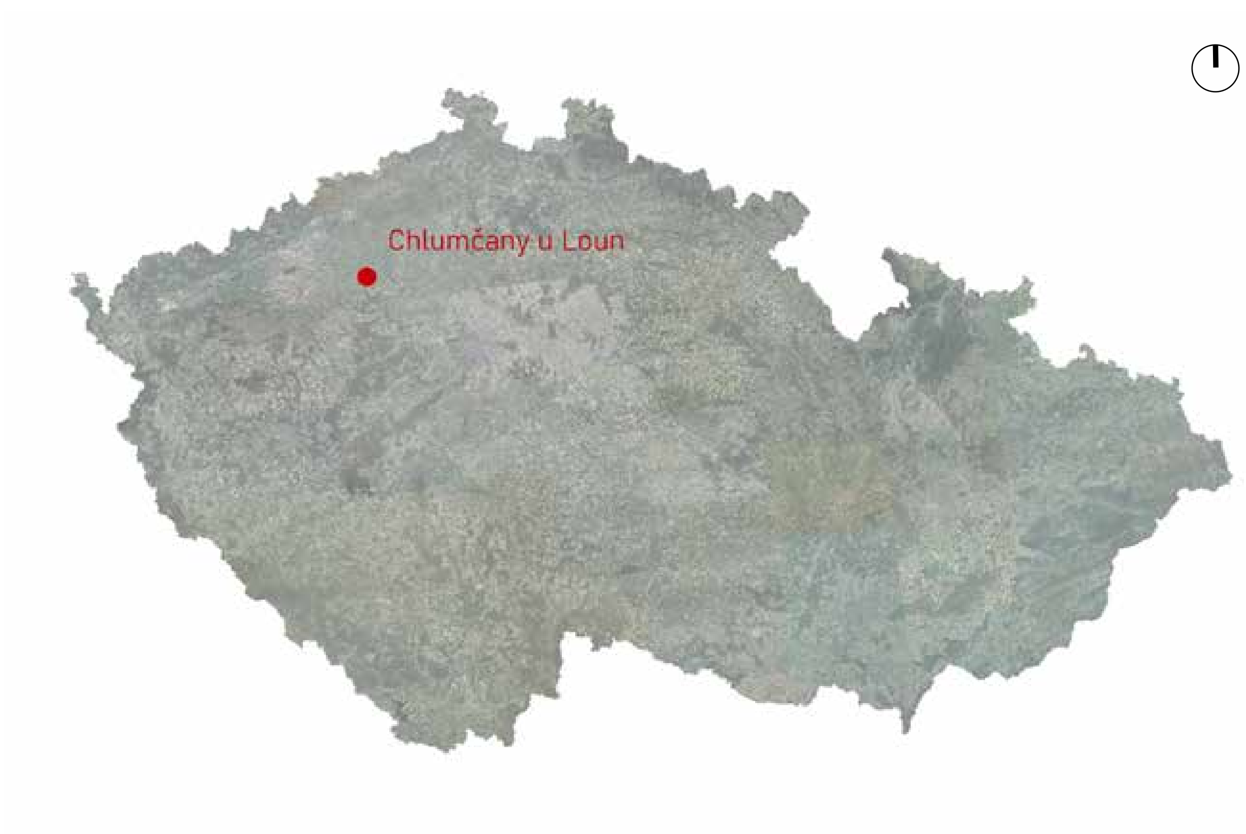


Fig 04: Satelite Map of Czech Republic

His significant contribution to the victory of the Hussites at the Battle of Vitkov in 1420 brought him not only the acquisition of the house of the Black Lamb in Prague's Old Town, but above all the prominent place in the camp of the Hussite radicals.In 1525 Chlumčany came under the administration of the town of Louny and its officials. A quiet time
without serious war shocks favoured the economic development of the village, where around the middle of the 16th century, a wine press was established, equipped with appropriate storage facilities. The vineyards were
mentioned in a purchase contract of 1525, which, without specifying the vineyards, refers to the Mount Chlum and the salary derived from them.

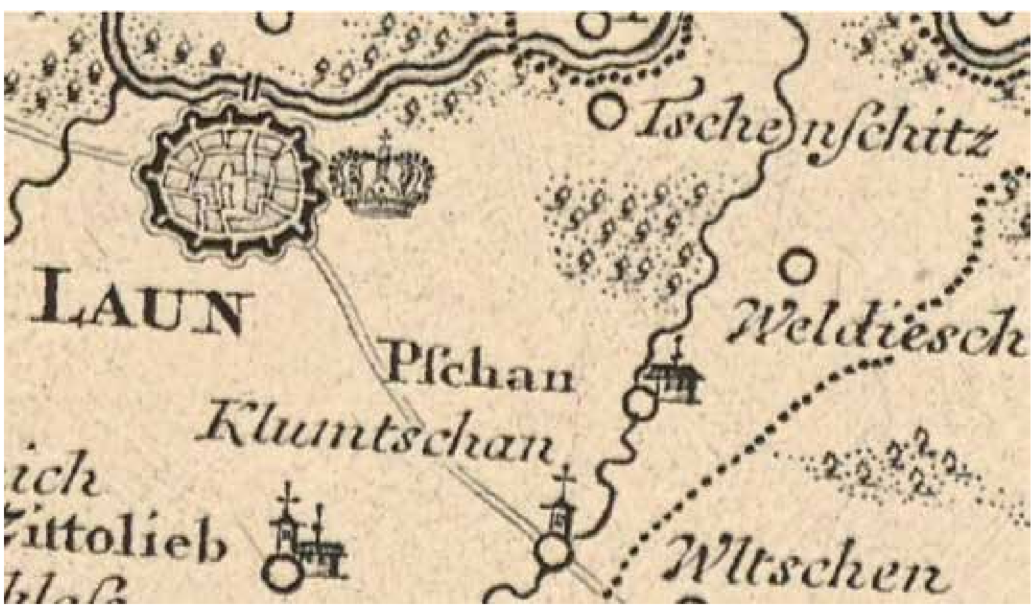


Fig 5 : Kluntschan mention on Mühler's map of Bohemia 1720.

The year 1547 brought another change of ownership to the village. After an unsuccessful resistance, the town of Louny against King Ferdinand I., Louny suffered severe punishment and, among other things, had to surrender to the king all fourteen villages, including Chlumčany. However, they did not remain in the king's possession for long, for they were immediately bought by Shebastian of Veitmil and sold in the same year 1549 to the six brothers Kuneš of Lukovec. In 1557, Albrecht Kuneš of Lukovec as the sole owner, sold the village to Countess Veronika Šlíková of Holejč, owner of the nearby Toužetín. The rapid change of various superiors continued. In 1583 he acquired Chlumčany together with the Toužetín manor was acquired by Jan of Šelmberk, after whose death his remarried wife sold the village in 1605 to Charles the Elder of the Hrušk family of Březno. Thus Chlumčany came under the administration of the estate of Cítolib and despite the change of owners, they remained connected with it until the 1920s.

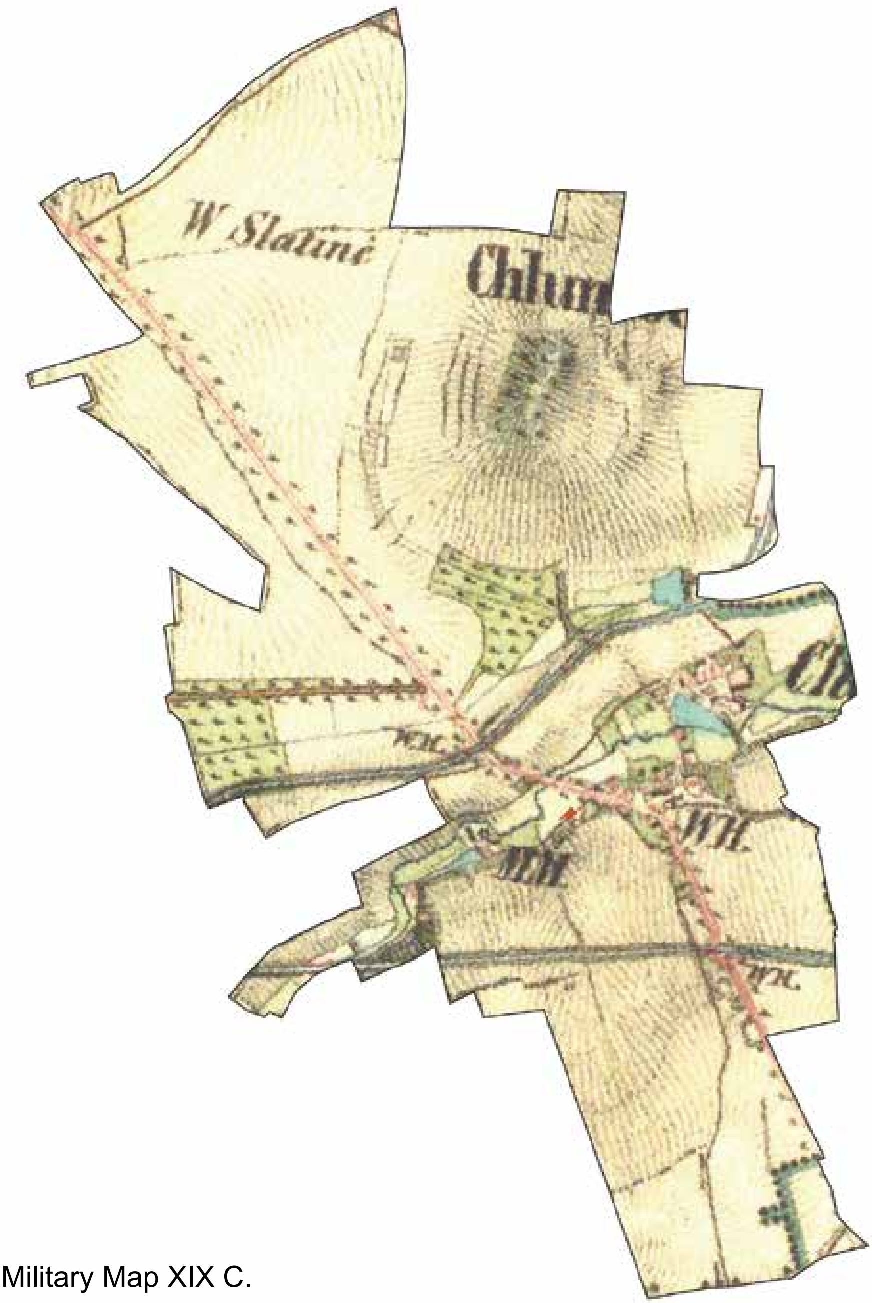


Fig 6: Copy of a Military Map XIX C.

From the middle of the 19th century Chlumčany grew so much that the municipal councillors started to consider building a school. The persistent efforts of the municipality to obtain a permit bore fruit and in 1908 classes began in the new school building. A big change for Chlumčany was the land reform, which gradually took place since 1921, when the remaining land was parceled out. The construction of public buildings continued after 1927 the municipality started building a water supply system and a public lighting and in the second half of the 1930s the telephone was introduced. During the First Republic, the development of the village reached its peak, and the wide range of trades and services. In the 1930s there was a blacksmith's shop, a car workshop, a petrol station, a small locksmith shop, a shoemaker's, a tailor's, a saddler's and upholsterers, a cotton and knitwear shop, a linen mill, a barber shop, two consignment shops, a grocer's and two tobacco shops.

Fig 7: Copy of a Cadastral Map 1950

The normal life of the village did not stop even after the occupation of Czechoslovakia and the creation of the Protectorate in March 1939. During the war, a municipal house was built, used for the purposes of the post office and municipal office, but the village was in debt and with the worsening wartime the lack of basic necessities of life was strongly felt. With the approach of the Germans retreating from the areas occupied by the Russian army.
The school in Chlumčany was confiscated for their accommodation in February 1945 and gradually inns and vacant apartments throughout the village. The dramatic period of the last days of the war in Chlumčany culminated on May 6, 1945, when the six-member National Committee was formed and took over the administration of the village. Chlumčany's location by the road proved to be disadvantageous during the war, as several times the village retreating German troops passed through the village and there was a danger of a clash.

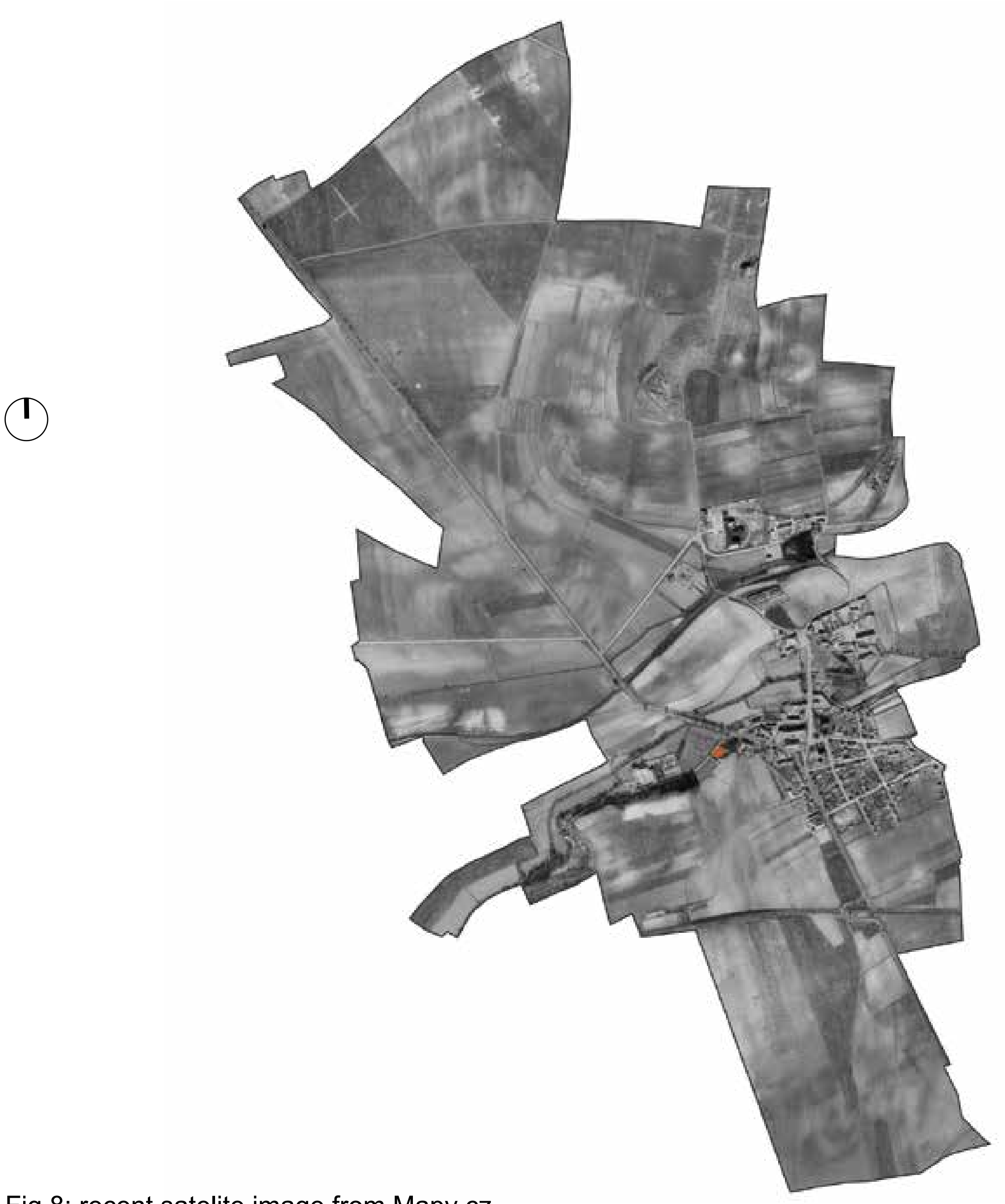


Fig 8; recent satelite image from Mapy cz

The end of the war came in the early evening of May 7, when Russian tanks eliminated the remnants of German resistance and entered the village. After the situation calmed down, life quickly returned to normal. The local national committee headed by its chairman, J. Barta, took over the administrative agenda and began to work on eliminating war damage and injustices. The second half of 1945 brought a significant decline in the number of 40 families left Chlumčany in addition to the return of refugees from the Sudetenland, mostly to the border areas. In 1947 there were 11 trades in the village, of which 2 car workshops, 1 blacksmith's, 3 taverns, 1 grocer, 3 tailors and 1 baker. After the takeover by the Communist Party in 1948, rapid changes in the economic system came, from the village was most affected by the law on unified agricultural cooperatives of 1949. In Chlumčany, a preparatory committee of the JZD was established in 1950 and the establishment took place two years later.

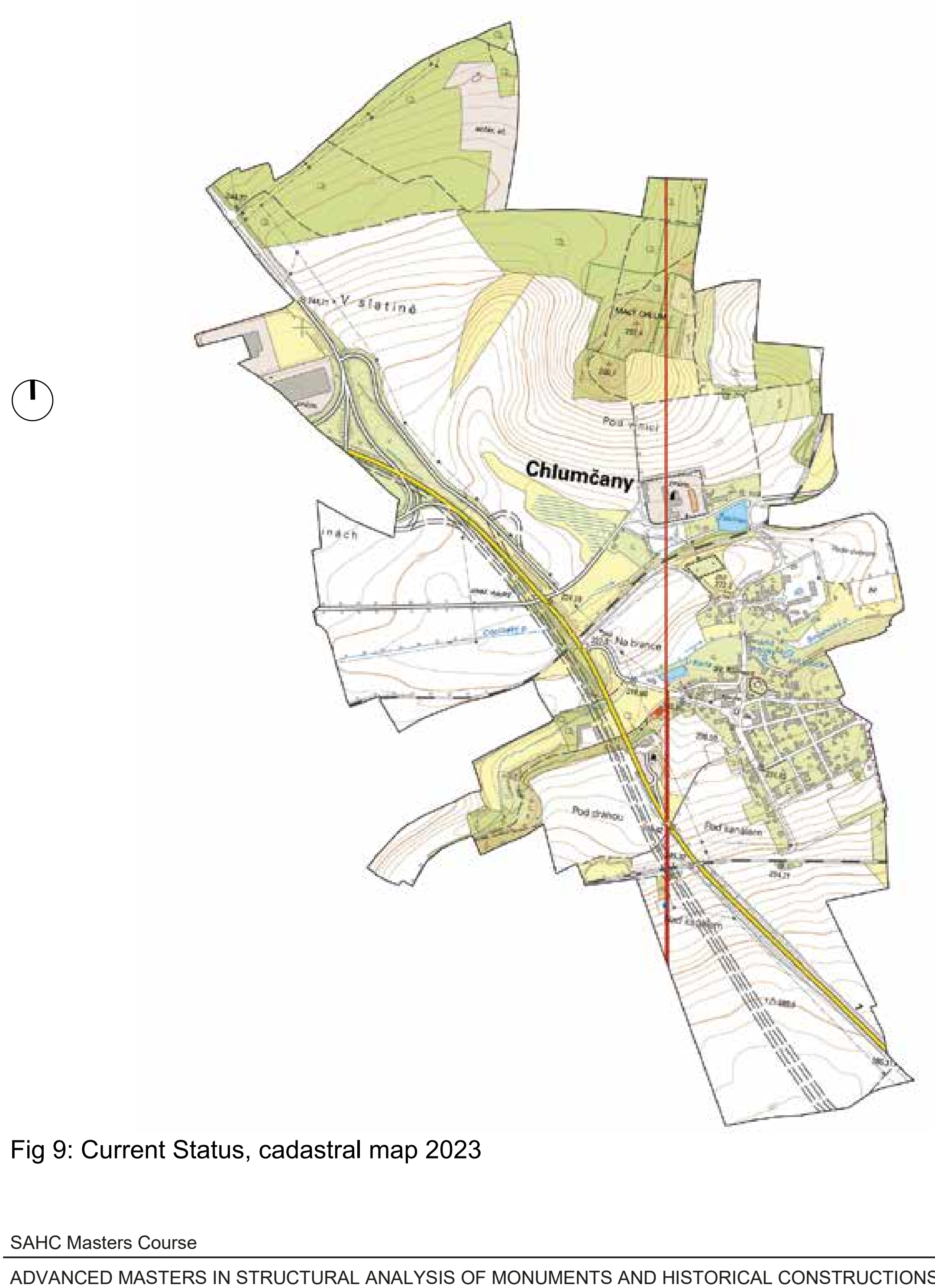


Fig 9: Current Status, cadastral map 2023

3.2 Origins of the vineyards

The oldest known report about the manor vineyard under the Chlum hill is in purchase contract of 16 March 1525, by which Countess Mičanka of Klinštejn and Roztok sold her inheritance, the village of Chlumčany, to the town of Luna. In the contract, among other things, the Chlum mountain with vineyards and vineyard land. At that time she reached the vineyard below Chlum had reached 12 barrels and 7 barrels of wine had been purchased.
The town of Luna did not enjoy the ownership of Chlum for a long time. In 1547, after the suppression of the rebellion of the Bohemian Protestant estates and towns against Ferdinand I.
Luna was punished along with other rebellious towns. On 8 December 1548, Ferdinand sold the confiscated village of Chlumčany to Šebestián of Vajtmile for 2,100 kop. The emperor annexed the Chlumčany vineyard to the Luna hospital, to feed the poor people. In the purchase contract of 3 May 1569, Václav Kuneš of Lukavec sold the village of Cítoliby, a share in Chlumčany was also mentioned. In 1605, the estate of Cítolabská became the property of the Hruska family of Březno. The vineyards under Chlum are again mentioned in the relevant contract, where it also mentions the wine press and cellars in Chlumčany. Back in the early Thirty Years' War ,there were vineyards in Chlumčany. This is evidenced by the entry in the chronicle of Pavel Mikšovič from May 5, 1625: "In the spring of 1625 there were in the town of Louny and everywhere. In the trees, grafts, vineyards, forests, there were many of them....in the woods and forests. They ate almost everything in the woods and woods. Many of our neighbours from vineyards picked them up and burned them, but then more and more of them grew up in the vineyards."

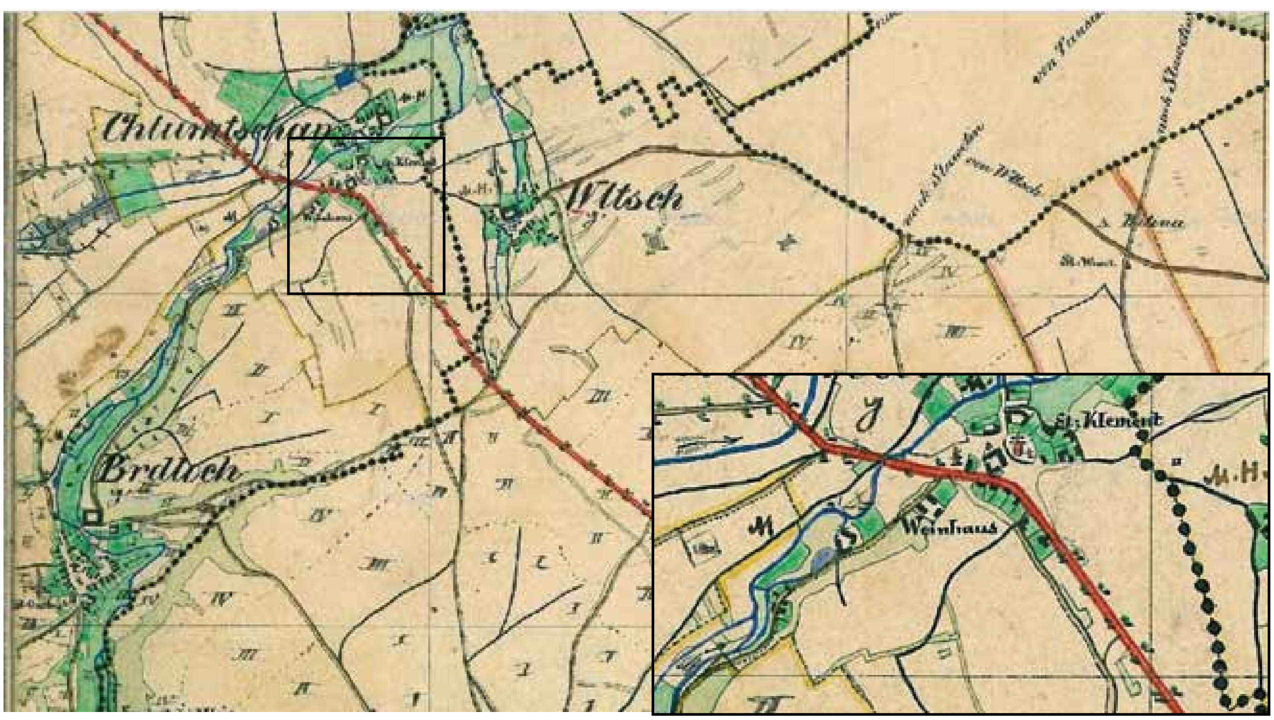


Fig 10: Map of cultures 1837-44. Nové Strašecí district

In the later years of the Thirty Years' War. especially with the Swedish pillaging, our country suffered terribly. Chlumčany, situated on the land route to Prague, was destroyed and depopulated by foreign troops. The vineyards and fields became desolate and there were no more for several years. After the Thirty Years' War there was a great shortage of labour, and when the authorities put someone on a deserted farm, there was no need for tools or to cultivate the fields.
It was only Count Arnošt Pachta who experimentally left one of the vineyards under Chlum to replant it. This vineyard is mentioned in the purchase contract of 1676, which states: "That Kashpar Volf, a peasant from Chlumčany, has a meadow next to the manor field, where you go to the vineyard..." However, the vineyard was not long-lived, it lacked experience. The conscious Czech winegrowers languished in exile, while the vineyards died.
When Baron Jakub Wiemmer acquired the estate of Cítolib in 1798, he established a vineyard under Chlum, but again without success. Further information about the vineyard in Chlumčany comes to us in correspondence between Prince Josef Švancenberk and his headquarters in Cítolib. In a message dated 13 July 1804, the directorate of the Cítolabi estate proposed to Švancenberk and asked for his consent to put the Chlumčany hill to establish a vineyard. The proposal described the favourable conditions for the cultivation of vines, noting that wine had already been grown in the region.

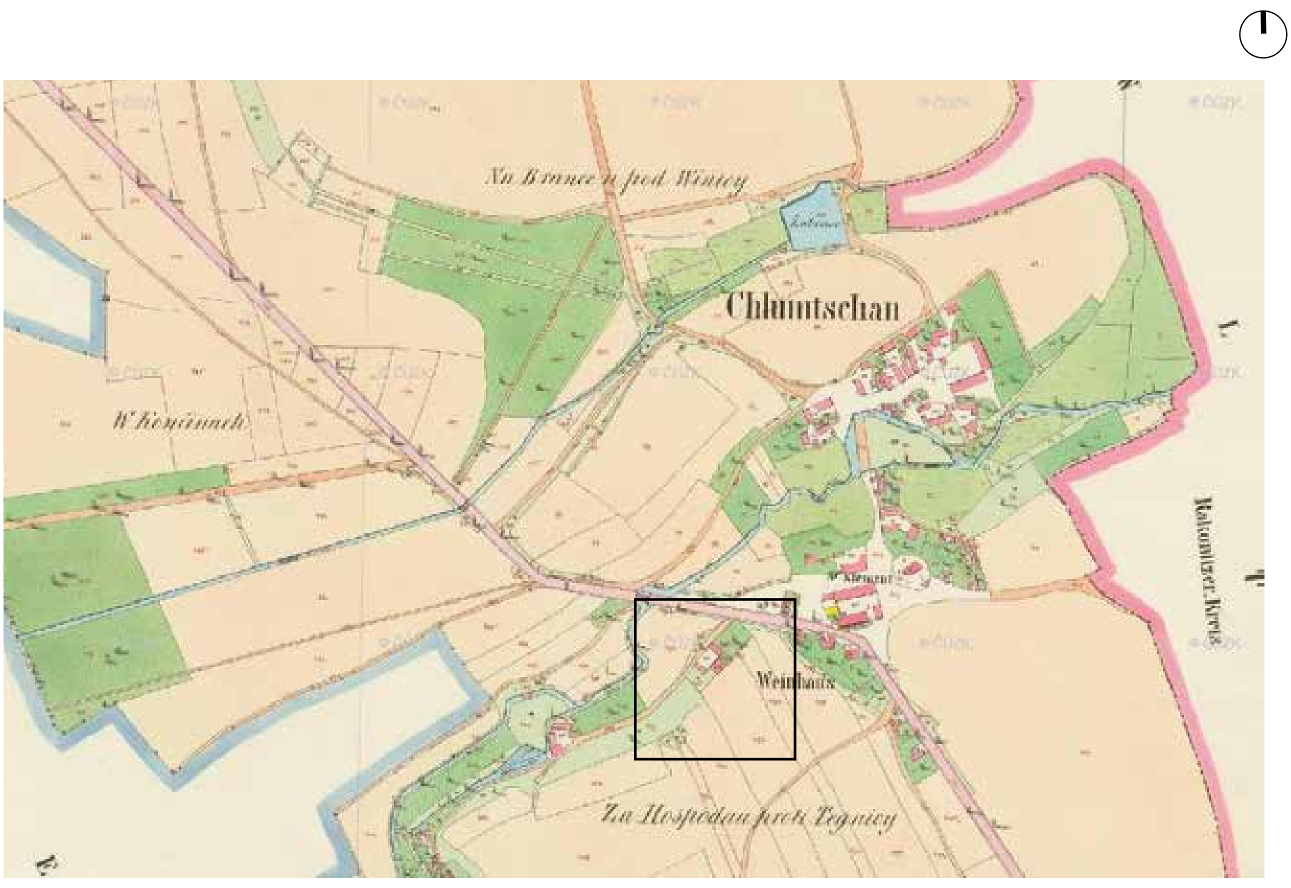


Fig 11: Imperial compulsory imprints of the stable cadastre 1841

Švancenberk had no objections. Seedlings of burgundy vines were brought from Mělník,
14 kop of bushes and 157 kop of seedlings. A bunch of shrubs was worth two gold 45 kreutzers and 1 seedling for 4 kreutzers. Five years later, in 1809, the first harvest is also mentioned - three buckets of wine. In 1810 also three buckets, in 1811 even seven buckets and in 1812 twelve buckets. In 1813 the harvest from the vineyard is not mentioned. Just at the time when the grapes were ripening, the Russian army was stationed under the vineyard near the manor sheepfold. The soldiers plucked the grapes and burned many of the vine poles. In later years, the wine harvest was probably increasingly worse due to lack of care, and this was the fate of the vineyard under Chlum was decided. Švancenberk did not want to invest money and closed the vineyards. he vines planters were transported to Lovosice on 3 April 1818 in six furrows. The news of the cancellation Švancenberk was informed of the vineyard's closure on 12 August 1818. Since, it has not been cultivated on a large scale in Chlumčany, only the name "Under the Vine" has been preserved.
It has been 155 years since the vineyard under the Chlumčany hill was closed. According to
the decision of the State in 1958, the glory of the wine-growing tradition was restored by Lounsko and established a vineyard under the Chlum hill in Chlumčany, which expanded every year. Planting is carried out according to modern experience. By modern methods and careful tending, each year they harvest better and better results. The vineyard must continue to be well looked after.

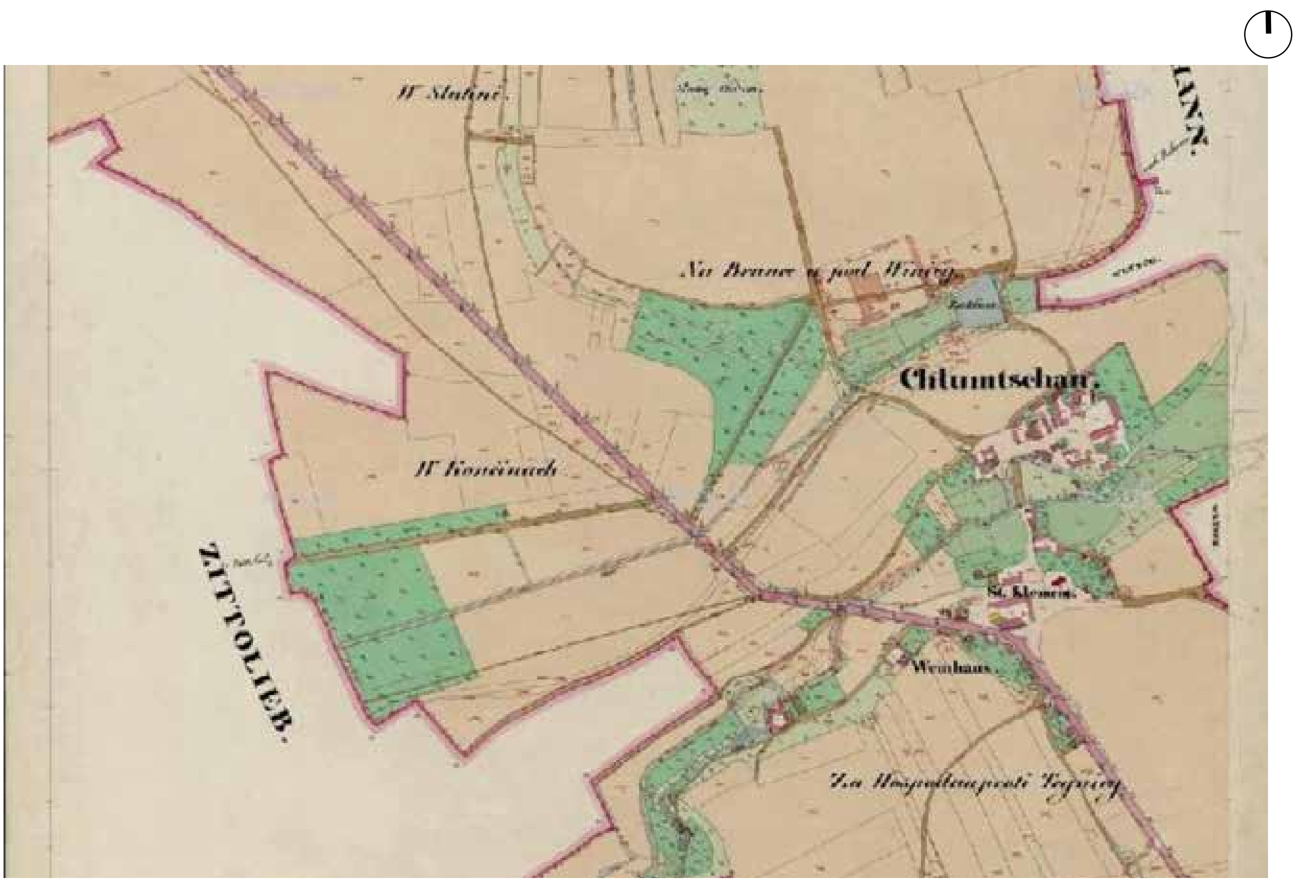


Fig 12: Original stable cadastre maps 1840 , Bohemia region.

4. CURRENT STATE

Wilomena grounds

The result of the previous historical research lead to t he formation of the studied pressing plant and the facilities of the winnery in the plott that now conforms the Wilomena winnery. The proximity to the main road makes it very accesible but also implies certain disadvantages like influence of vibration, noise and visual impact. On the other side it has a privileged orientation to the vineyards that are located in the north hill of the plott facing the winnery. The production house or factory has space to hold the wine production. The cellars are another unique feature of the site. An underground vault made in brick , where the products are stored with the adequate temporate. It sits adjacent to the owners house. This compact layout around an open courtyard has the potential for the revitalization of the grounds within the same compromised space already in function.

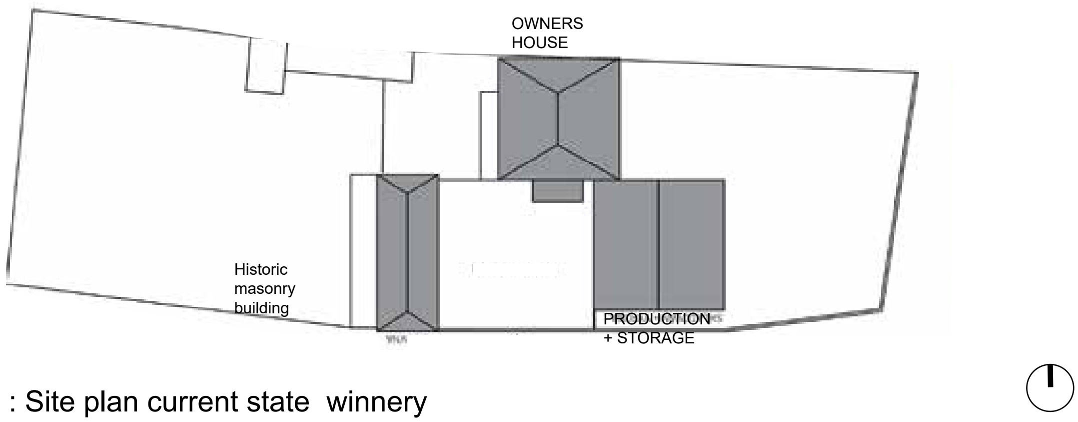
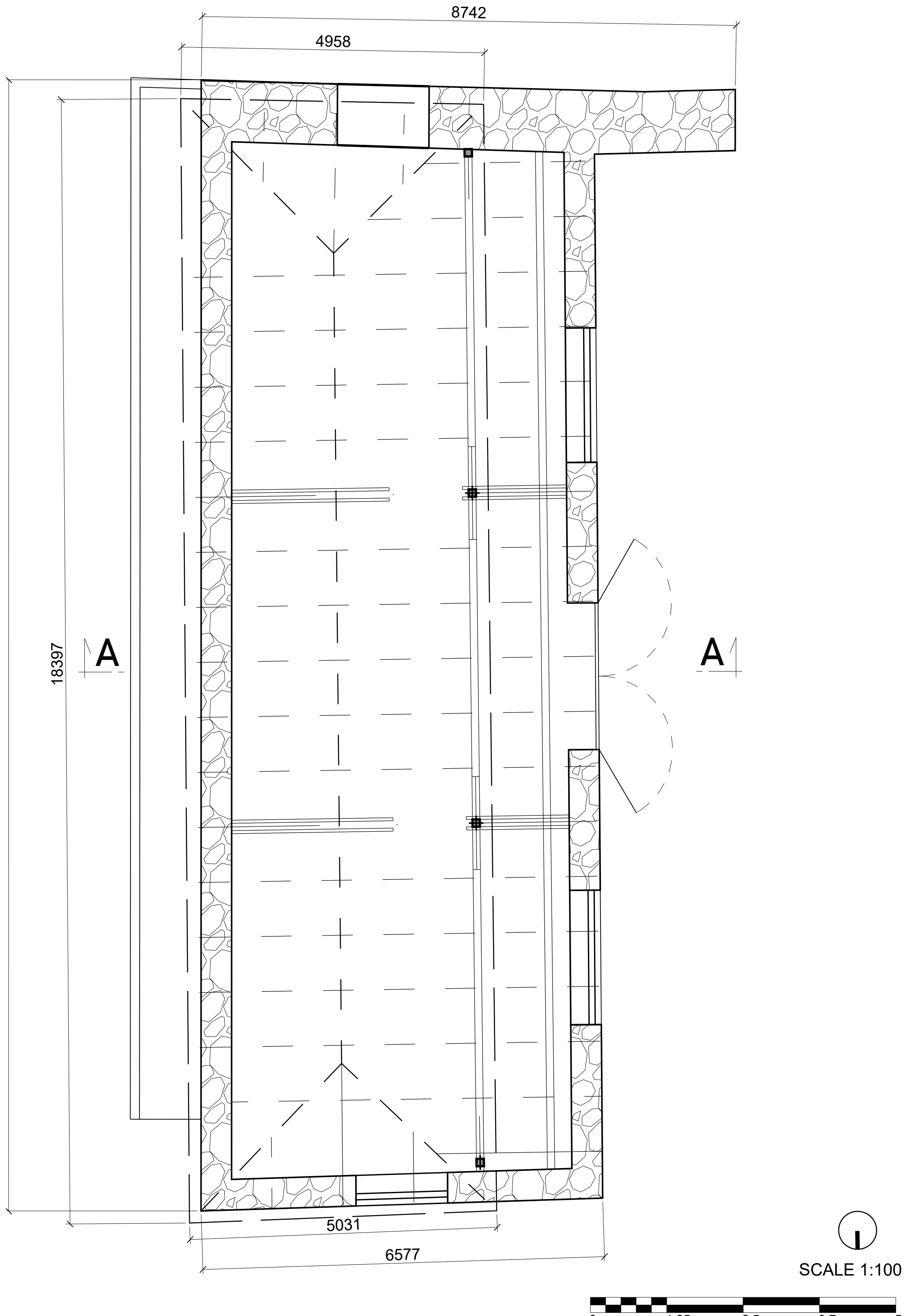


Fig 13 : Site plan current state winnery

Fig xx : Current Cadastral map of Chlucany with aereal photo overlapped.

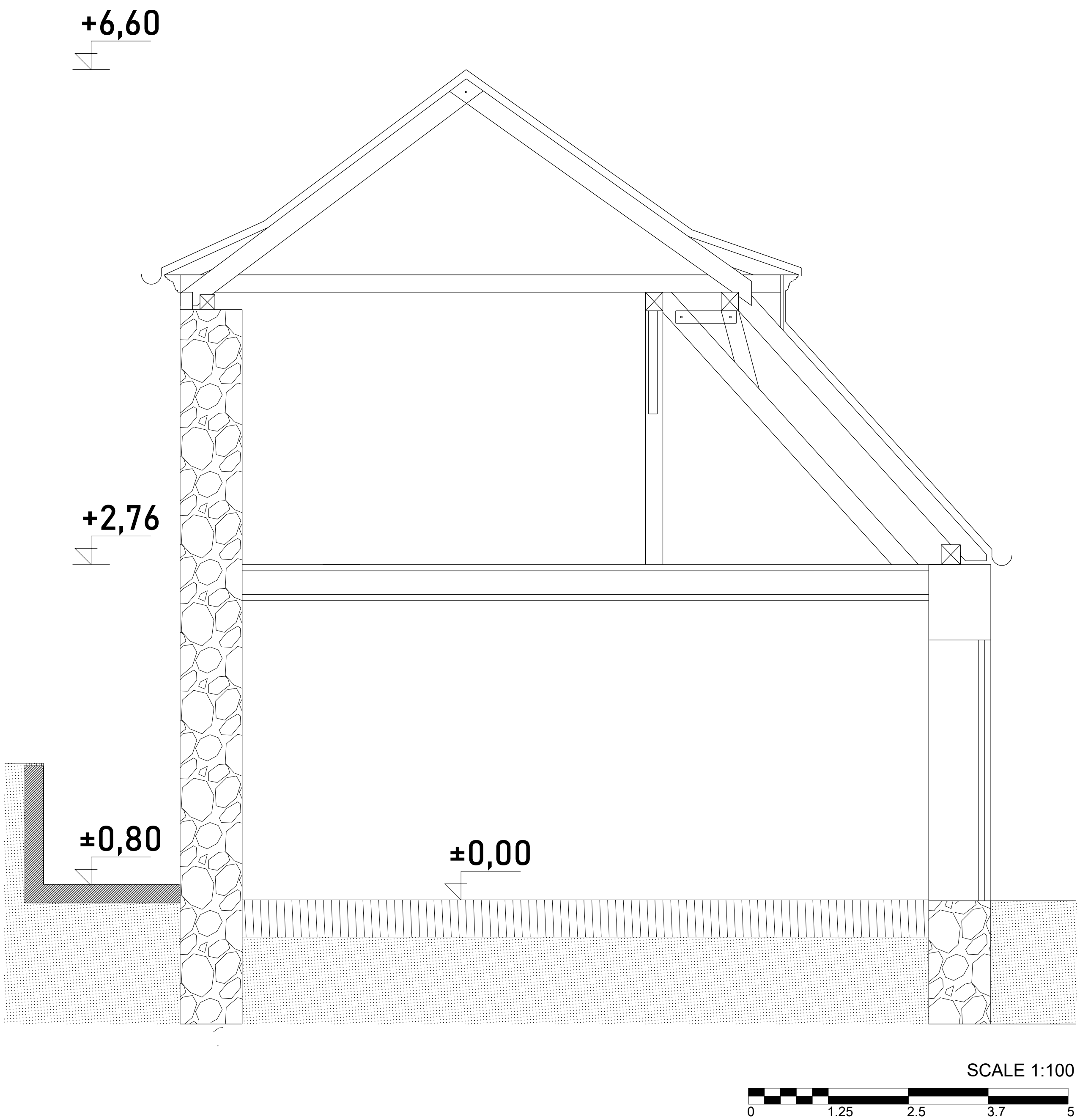
4. CURRENT STATE
Masonry building

Ground Plan
GP-01



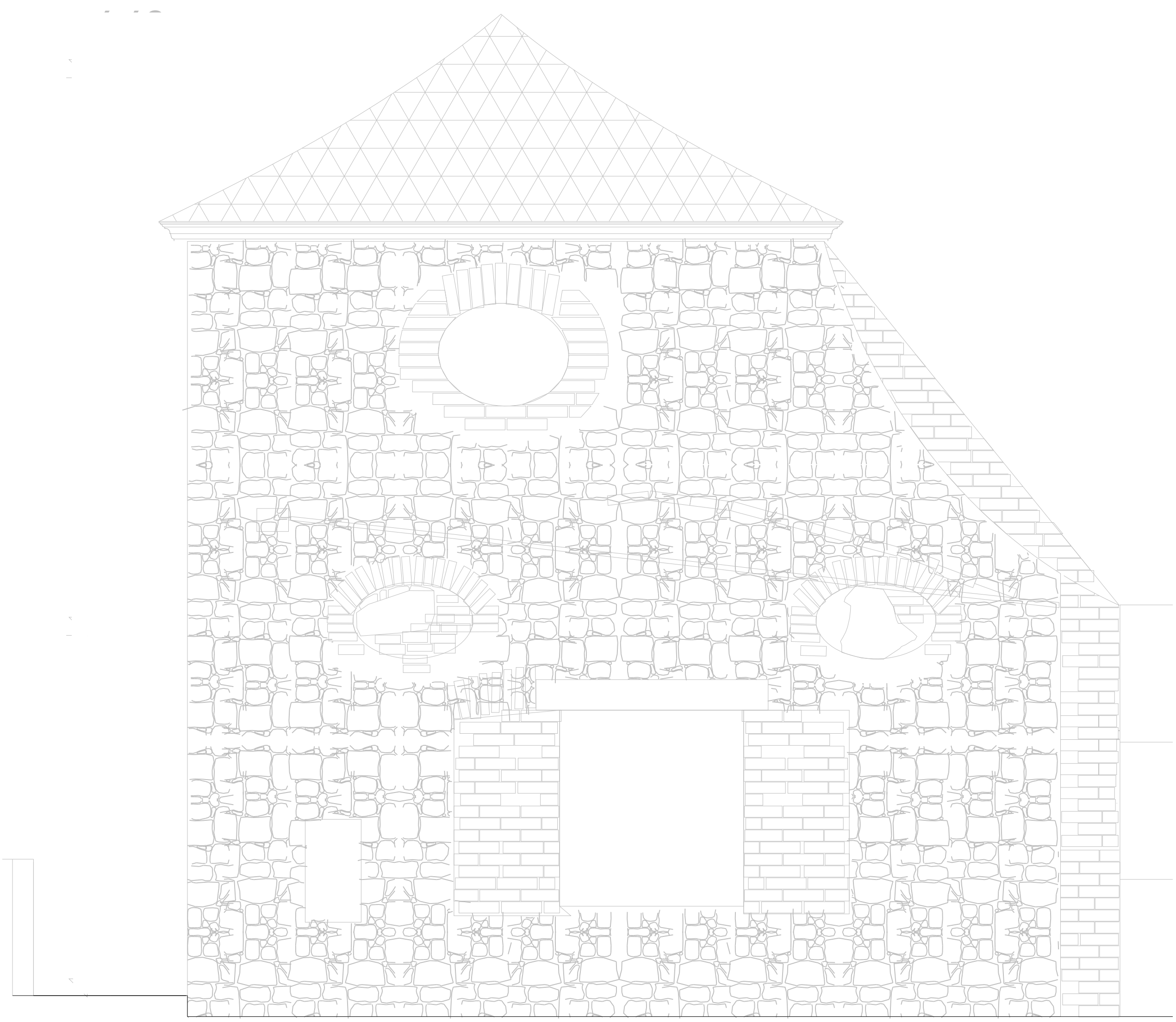
4. CURRENT STATE
Masonry building

Transversal section
TS-01

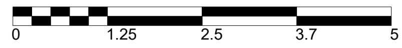


4. CURRENT STATE
Masonry building

North Facade
FN-01



SCALE 1:100

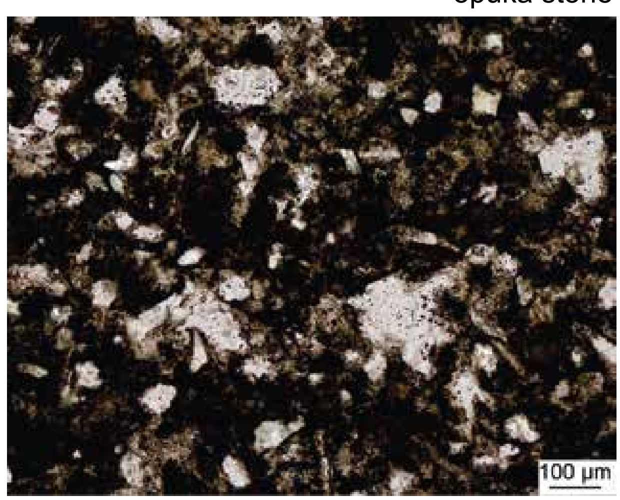


5. MATERIAL CHARACTERIZATION
Masonry : Opuka stone

The masonry of the historic building is made of quarry stone - limestone. For most of its lifetime it's probably been plastered over, but by the end of 2022,the plaster was removed from the exterior facades and left the masonry exposed. From the analyses carried out, it is clear that the masonry has a low moisture content (around 5% by weight) and common salts are present. Nitrate and ammonium are probably associated with agricultural use of the building and the source of the chlorides is most likely to be comming from the adjacent dirt road.
The historic fabric of the masonry is bonded with lime-clay mortar. This is quite extensively degraded. As for the lime used, it is
given the location of the building and the historical petrological context, it´s most most likely to be from the Džbánská opacca.(nearest quarry).
Bohemian Central Highlands The Bohemian Central Highlands are part of the Podkrušnohorie region. The geomorphological unit covers an area of 1265 km2. A large part of the geomorphological unit of the Bohemian Central Highlands is today a protected landscape area (1063 km2) thanks to the presence of rare steppe and forest-steppe communities and unique relief. It can be divided according to the Elbe River into two sub-units - the Vernerice Central Highlands - right bank and the Milesovské Central Highlands - left bank. There are 5 national nature reserves, 8 national nature monuments, 12 nature preserves and 18 natural monuments in the Bohemian Central Highlands. Pedology and opossum mining Since soils are not the same everywhere, they are divided and categorised by many features. In the local area, brown parendzina is predominantly found on the opuka. The most important influence on the mineralogical composition of the local soil is the sandy loam, which was formed by the consolidation of sedimentary clays (a mixture of clay and limestone) with a minor admixture of sandy material. This soil is characterised by a large number of fragments of parent rock in the upper layer of the horizon. The opaca, which is the local parent

Figs 15,16 Macro samples of opuka stone

Fig 17: Microscopic picture showing composition of opuka stone

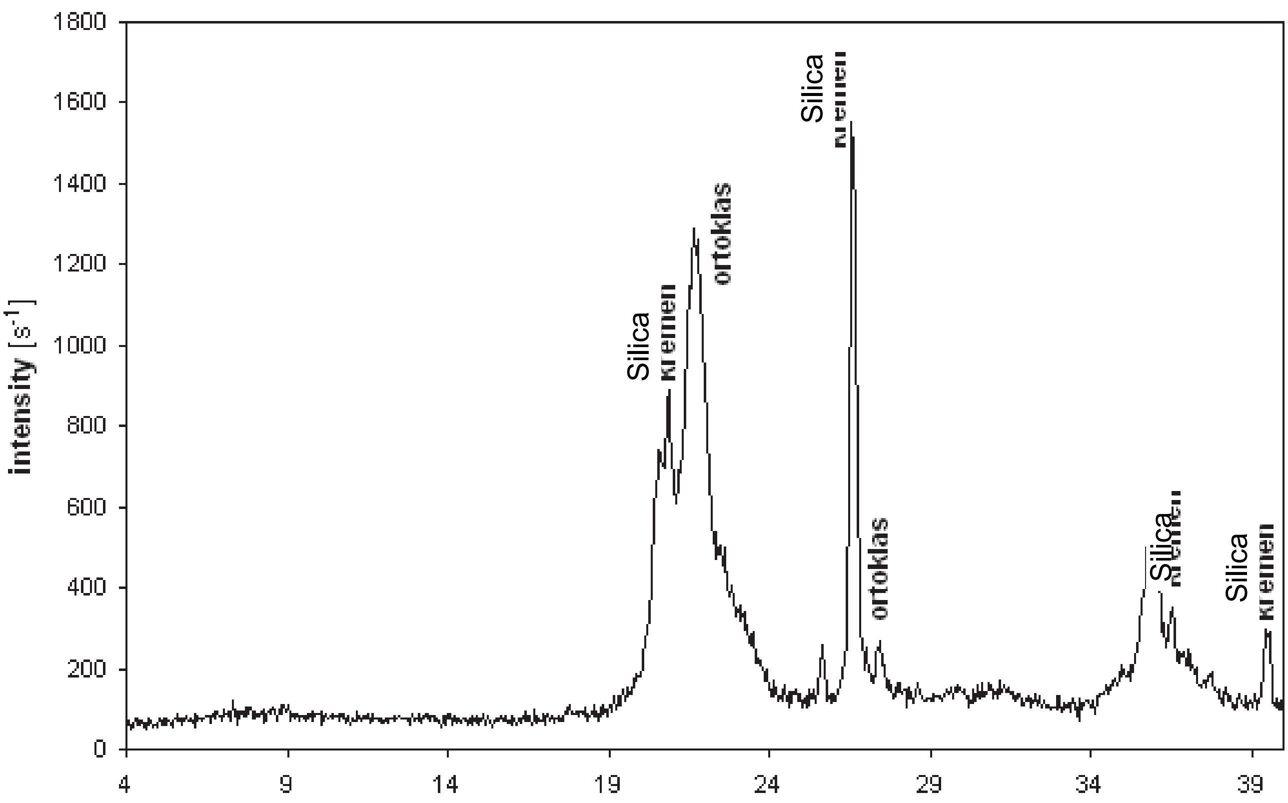


rock, comes from the Lower Turonian. The old opaca quarry was one of many quarries for high quality building stone. These quarries were established under the Austro-Hungarian Mining Law, which allowed anyone to quarry on their own land for their own use (a number of smaller quarries were established, the remains of which can be found near this nature trail) and allowed their owners to sell building stone (e.g. Kádner Quarry, which is about 100 m south of this site).

Parameter	Stablished value	Unit
Density	1170	kg/m3
Density	2320	kg/m3
Open porosity	47.5	%
Total porosity	49.5	%
Absorbency	15.5	%
Compressive strength	12	Mpa
Bending strength	3.3	Mpa
Resistance to abrasion	69.5	mm

Table 1 : Mechanical properties of the stone obtained from Třeboc quarry.

Fig 18: Natural Opuka stone in Třeboc quarry.



Graph 1 : Diffractogram-Phase composition of sample.

Salinity & Ph in masonry

As a further analysis, other tests were conducted in order to obtain the amount and type of salts in the masonry. As the building is located on a slope below a field in a rural development, it was assumed that there would be nitrates, ammonium and chlorides. For the measurements it was necessary to take a sample of the studied wall to prepare the lab sample. The analysis was made with dried samples (6A and 6B, in sample mapping), both which were previously measured for moisture content. It was used 2g of each sample, adding 100 ml of distilled water and left for 5 hours in an ultrasonic bath. (Fig xx) After this, the tests were performed individually for each sample. Sample 6A , became cloudy during the ultrasonic bath, probably due to industrial dyes, and so the tests cannot be considered conclusive. The ph of the masonry was measured Ph = 7 - neutral.
Nitrate:For nitrate content, it was first made a visual test for nitrate by the color of the test paper, which was positive. After it was proceeded to a more detailed test using sulfuric acid and other impurities in the spectrometer. The determined value was of 7.8 mg/l.
Ammoniak:The amount of ammoniak was evaluated using EPA 350.1 test and spectrometer. The resulting value is 1,25 mg/l. The critical value is not within the standard, but it was noted that ammoniak should not be present in the masonry at all.
Chlorides:The chloride content was determined colorimetrically by staining of the sample and by comparison with the colour chart. It was determined a value of 20 mg/l.
Sulphur: Sulphates were assessed by the colour of the test paper, but there was no obvious change and so the sulphate value was set at 0 mg/g.

	Content mg/l	Content mg/g	Degree of salinity
Ammoniak	1.25	0.06	Doesn't appear
Nitrate	7.8	0.39	Low
Chlorides	20	1	Increased
Sulfates	0	0	-

Table 2: shows mg/l values of salinity in stone

Degree of salinity of masonry	Salt content in mg/g of sample and in percent by weight					
	Chlorides		Nitrates		Sulphates	
	mg/g	% mass	mg/g	% mass	mg/g	% mass
Low	< 0,75	< 0,075	< 1,0	< 0,1	< 5,0	< 0,5
Increased	0,75 až 2,0	0,075 až 0,20	1,0 až 2,5	0,1 až 0,25	5,0 až 20	0,5 až 2,0
Hight	2,0 až 5,0	0,20 až 0,50	2,5 až 5,0	0,25 až 0,50	20 až 50	2,0 až 5,0
Very Hight	> 5,0	> 0,50	> 5,0	> 0,50	> 50	> 5,0

Table 3: Results were evaluate according to the standard ČSN P 73 0610 Salinity in masonry

Fig 19: Ultrasound bath

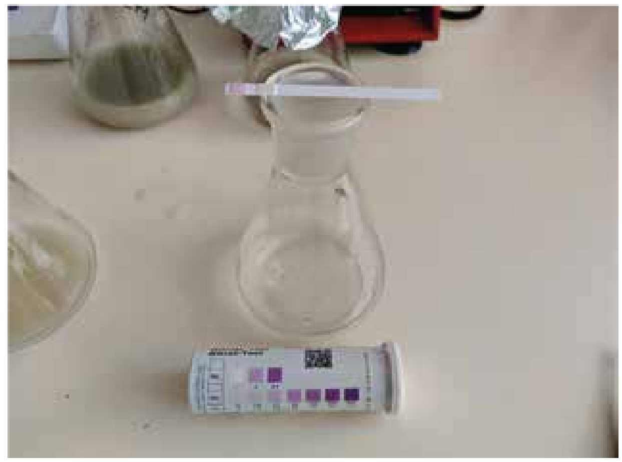


Fig 21: Ultrasound bath

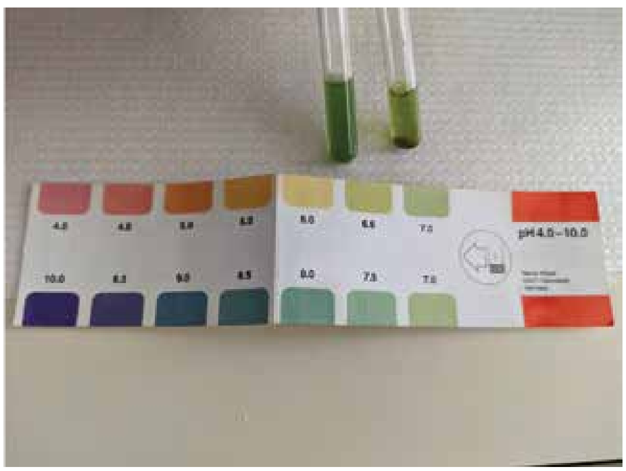


Fig 22: Meassured Ph

Fig 23: Meassured Ph

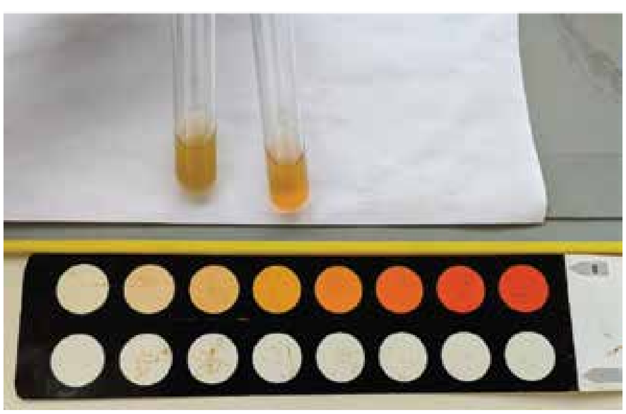


Fig 24: Chloride Meassurement

Masonry Quality Index

Determination of residual strenght of masonry

Determining the residual strength of masonry is relatively complicated and it will always be a certain idealization of the complex structure of piecework, gaps and the binder. For design purposit has been chosen to determine the MQI (Masonry Quality Index), as a guideline, giving a visual indication assessment a reasonably accurate prediction of the strength of the masonry. The method is based on the determination of partial factors taking into account the condition of the masonry. It can be determined whether the walls are made according to the "rules-of-art" by evaluating certain parameters. If "rules-of-art" were followed, it is expected that compactness and monolithic behavior are ensured. The following procedure is explained according to Borri et all, 2020.
For computation of MQI value following parameters need to be considered:
- conservation state and mechanical properties of the units (SM),
- units dimension properties (SD),
- the shape of the units (SS),
- wall leaf connections (WC),
- horizontal bed joints characteristics (HJ),
- vertical joints characteristics (VJ), and
- mortar mechanical properties (MM).

Each of the mentioned parameters is evaluated as fulfilled, partially fulfilled, or not fulfilled for three types of loading: vertical, in-plane, and out-of-plane. Once all the parameters are determined, the proper equation needs to be chosen.

$$MQI = r \times SM \times (SD + SS + WC + HJ + VJ + MM)$$

$$MQI,V = 1 \times 0.8 \times (0.5 + 1.2 + 1 + 0.2 + 0.4 + 0)$$

$$MQI,V = 2.64$$

$$f_{md} = 1,2113\ e \wedge (0.1698\ MQI\ v)$$

$$f_{md\ med} = 1,6841\ e \wedge (0.1572\ MQI\ v)$$

minimum compressive strenght value :
f_{md}= 1.91 MPa

mean value of compressive strength:
$f_{md\ med}$ =2.55 Mpa

Fig 25: 1x1 square of opuka masonry wall

Material Properties

Humidity

The moisture test to be performed on historic masonry is to measure the moisture content.
The first part of the study was a visual assessment, that didn't resulted in significant conclu-tions,the walls at first glance show no signs of moisture, salt or mould. Further ,samples were taken of the masonry from the areas shown on the following drawing made with orthophoto on April 18, 2023.This samples were only taken from the exterior, due to the fact that the interior plaster was mostly intact.
The brickwork was carefully broken away using a mortar and pestle, and was stored in pre-marked sealed containers, which we wrapped in an airtight bag. Afterwards all the samples were weighted and placed them in the dryer at 105°C for 24 hours. After removal from the oven the sam-ples were weighed again and calculated the mass moisture content using the next formula :

wh= (m-md)/md*100.

The results of the humidity at each location are given in Table H1. According to ČSN P 73 0610 Waterproofing of buildings - Table H2 it was observed that in most part of the masonry the moisture content is low, but in specific areas of the masonry there is also
elevated moisture content . Based on this values its posible to conclude, that the moisture is caused by contact with the soil, due to the fact that the values decrease from the bottom to the top. The areas with highest moisture content is at the base strip where the wall its in direct contact with the ground.

Table 4 : Weight comparison between samples extracted from studied area.

Sample	1A	1B	1C	6A	6B	6C
Total weight m (g)	22.06	28	27.23	32	30.25	25.22
Weight after drying ma (g)	21	26.76	26.03	30.31	28.67	23.94
Weight moisture Wh (%)	4.85	4.63	4.61	5.57	5.51	5.37

Table 5 : Waterproof of buildings according to Czech Technic Norm ČSN P 73 0610

		w_h	<	3,0 %	Very low humidity
3,0 %	≤	w_h	<	5,0 %	Low humidity
5,0 %	≤	w_h	<	7,5 %	Humidity increased
7,5 %	≤	w_h	<	10,0 %	High humidity
10,0 %	≤	w_h			Very High humidity

Fig 26: Sampling stone with chiesel.

Fig 27: Drilling in joints for mortar samples

Fig 28; Borehole depth measurement

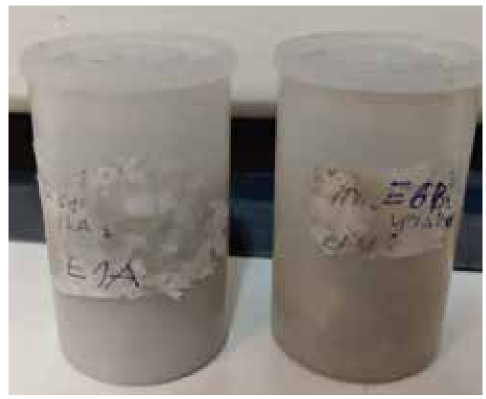


Fig 29: Storage of the sample in airtight container

Fig 30: Distribution and weighing

Fig 31: Drying of samples

5. GEOMETRICAL SURVEY
5.1 VISUAL INSPECTION

The masonry is not in bad condition and there is no risk of imminent collapse. Nevertheless, there are a number of failures. The most serious are a set of cracks located in the north-west corner of the building. The cause is thought to be rotation or uneven settlement foundation joints of the gable wall. This may have been contributed by inappropriate drainage design (running along the north wall of the building), insufficient depth of the foundation and also the substantial increase in traffic on the adjacent road due to construction work of the new motorway bridge in the vicinity of the area in question (particularly frequent passage of heavy motorized equipment in the immediate vicinity object).
Cracks run through the entire thickness of the masonry and their width varies between 10 and 37 mm on the exterior side and 4 to 28 mm on the interior side. The widest crack is under the crown of the north wall of the building where it is 69 mm wide.

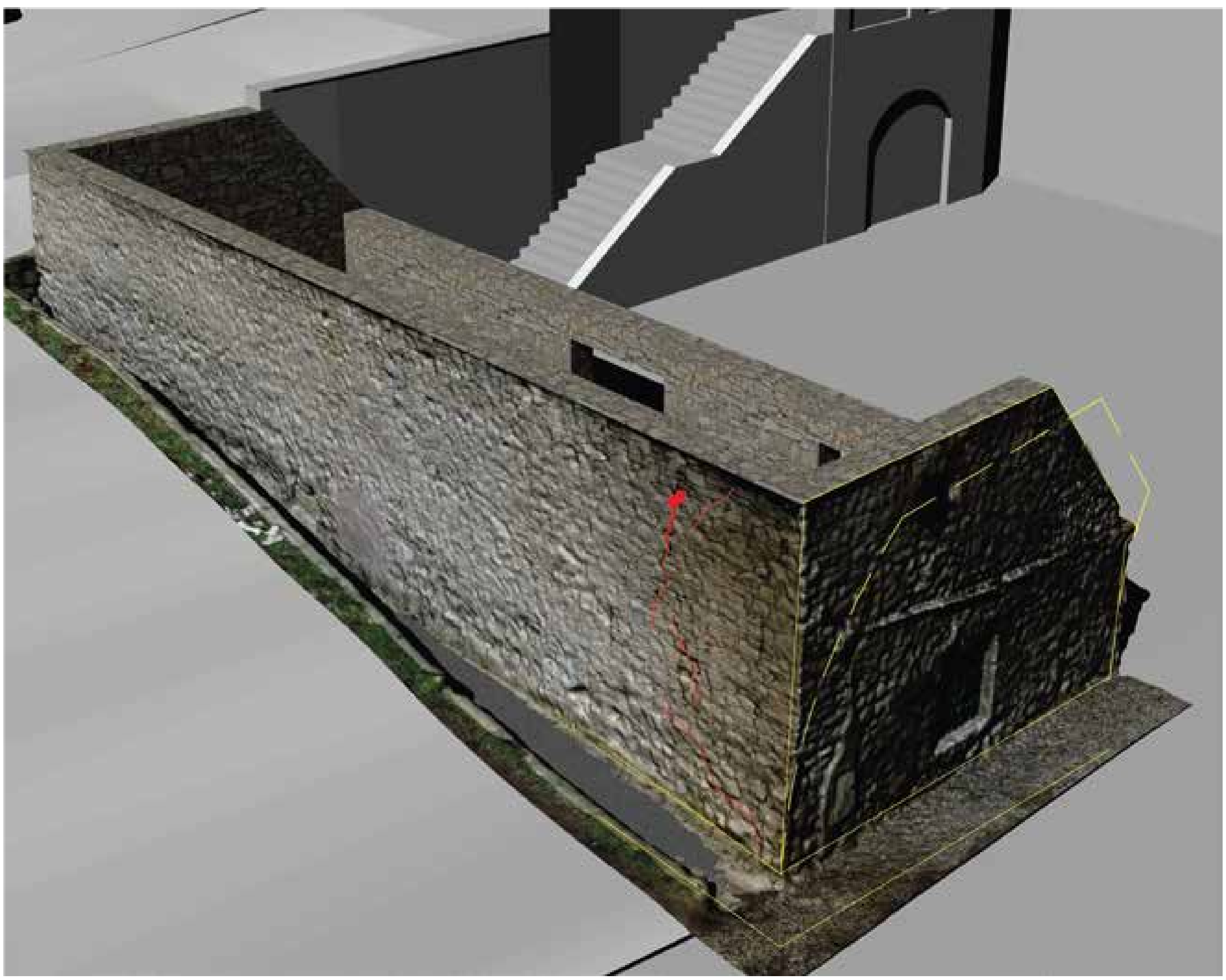


Fig 32: Structural failure diagram made with photogrametric model of masonry building.

Fig 33: West facade is mainly covered by eternite roof with biological attack of lichee and moss.

The existing eternite roofing cover is composed of a double sloped gable roof , which it’s made of asbest and concret sheets, which have been proven dangerous for human health.This cover is now eroded by the environement, leaving it in bad conditions.Therefore it needs to be replaced, this aspect is one of the main concerns about the project, due to the importance of it.
On the west facade , the opuka stone wall has experienced recent crack openings, that according to the owners ,they appeared recently during the construction of a viaduct in the proximities of the site. This facade also has some deterioration of the opuka stone due to raising damp of the soil next to it therefore it is necessary to consolidate and strenght this wall.

Fig 34: East masonry wall shows cracks in its colindance with the street and slope.

Few remains of original plaster on South Facade. Biological growth of lychee and moss over the Eternite roof

Fig 35 :South Facade

Darkened masonry strip due to moisture saturation of opuka stone is causing cracks and fractures on the Opuka stone

Fig 36: North Facade

5.2 DAMAGE MAPPING

Damages observed in the exterior transversal facades of the masonry walls include deterioration of opuka stone ocasioned by diferent reasons like raising damp and freeze & thaw cycles.These are observed at the base of the north facade on the adjoining part with the grass slope. Another visible characteristic are the previous interventions made with diferent materials. For instance the brick filling that was used to cover the original openings of circular windows and others.
Low quality concrete mortarts and grouts were used to fill cracks and gaps.Also used to hide electrical instalations that are visible from the street level. There are few remains of the original plaster renders, which are only visible in the South facade.The most serious damage in this two facades is the weathering and decay of the opuka stone as well as its original mortar joints, that had been washed out by natural agents due to lack of any waterproof treatment or maintenance.

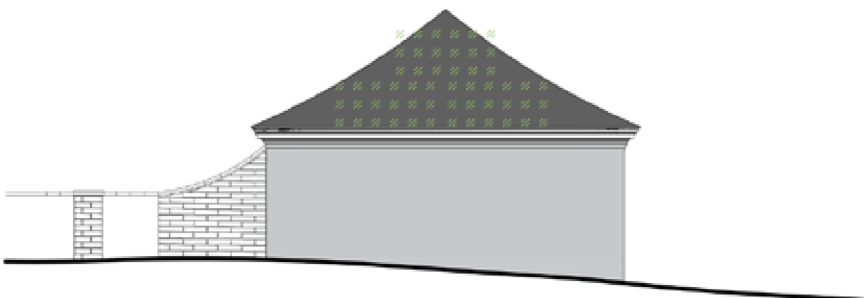


Fig 37: South Facade

Material Legend

Fig 38: North Facade

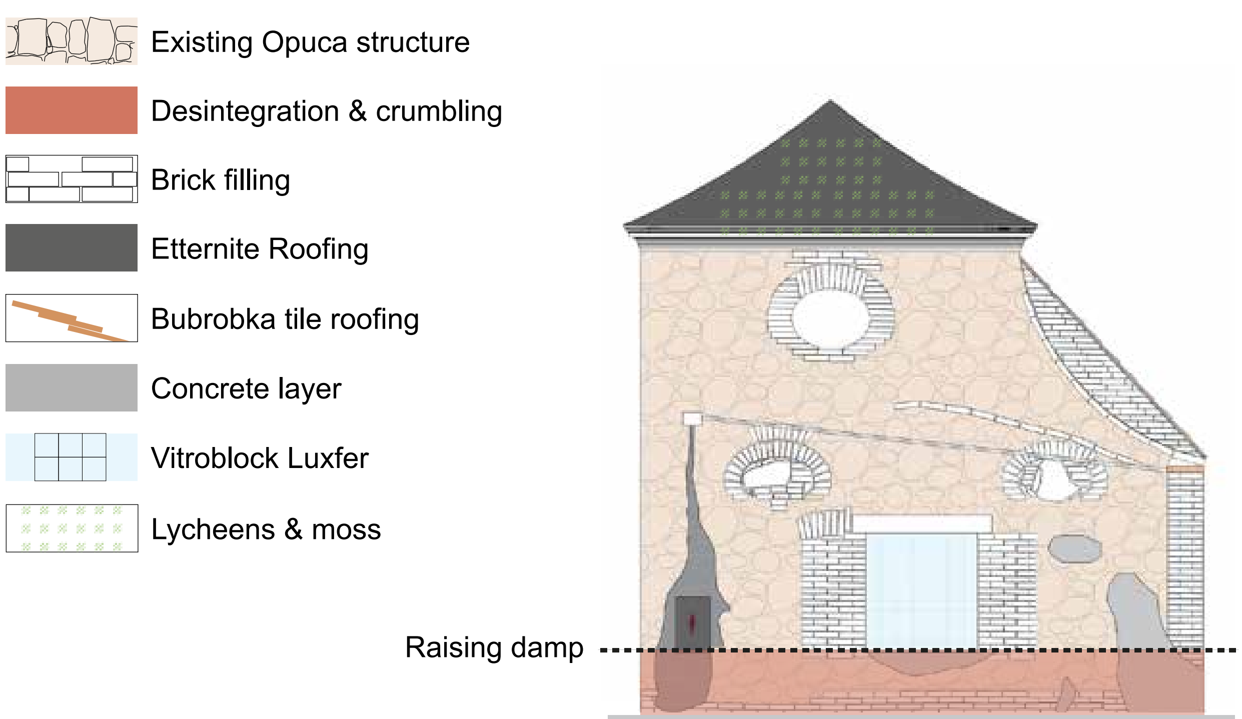
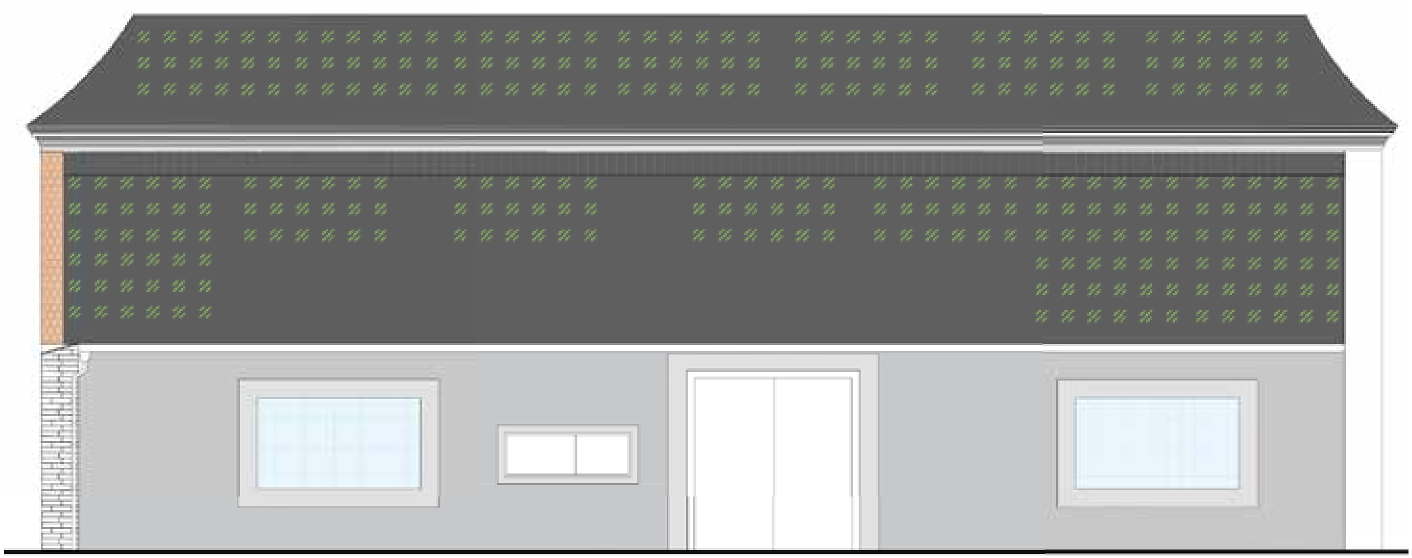


Fig 39: East Facade



Material Legend

Existing Opuca structure

Original plaster render

Brick filling

Bubrobka tile roofing

Etternite Roofing

Cracks & fractures

Lycheens & moss

Vitroblock Luxfer

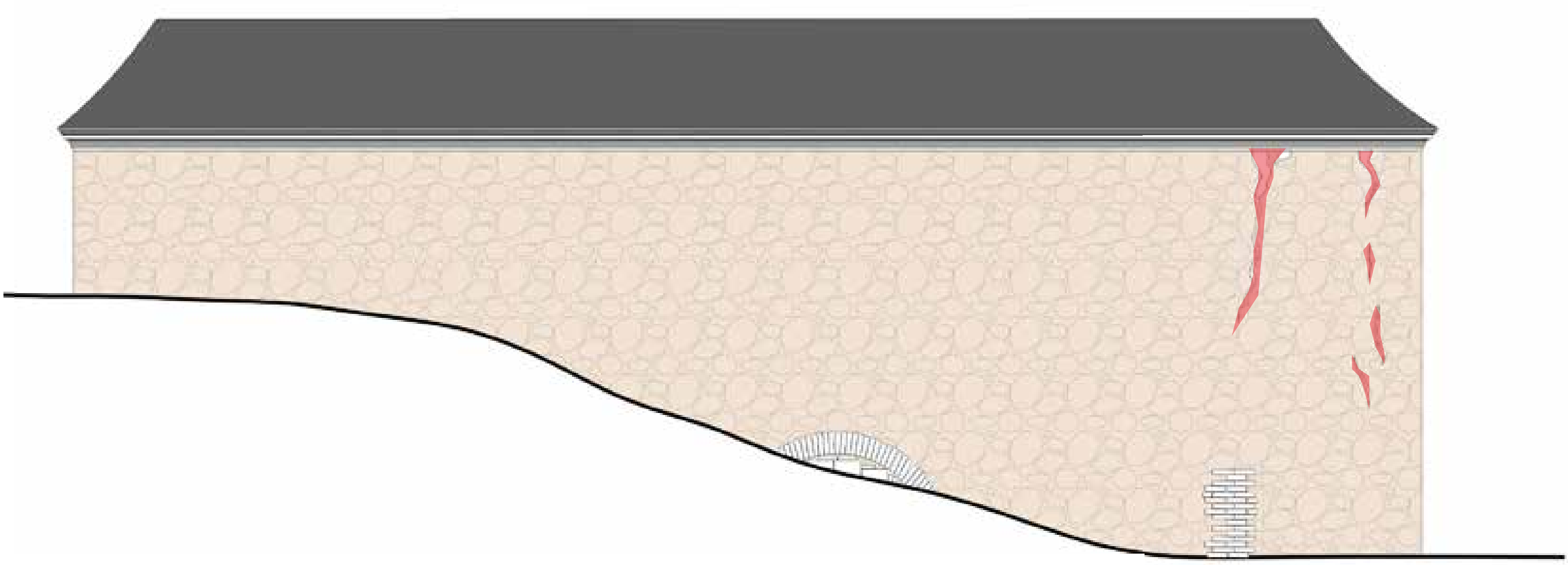


Fig 40: West Facade

5.3 DIAGNOSIS

The interior inspection and diagnosis of the north facade shows at ground level the original plaster renderings with some good level of preservation.At the upper level in the attic, the former window leaves open space to environmental agents to enter the structure and weather the stone. For this reason all of the plaster renderings in this level are now gone, leaving the masonry walls exposed. This inside face shows crumbling and weathering of stone due to humidity saturation of the rock.The cornice detail of the timber roof is splitted due to moisture saturation,swelling and srhinkage of the wood exposed to the sunlight.

Another interesting feature apreciated in the North Facade is the Bubrobka tiles placed along the right upper edge. Used in order to avoid water penetration in the thickness of the opuka wall. This traditional roof system is made of fire based clay units that resemble the shape of a beaver's tail, hence the name of it. There are also minor cracks and fractures that appear at the base of the facade.

Fig 41: Circular opening from interior

Fig 42; Cracks & fracture

Fig 43: Cornice detail

Fig 44:Former circular window

Another disadvantage of eternite roofing is its relative brittleness and porous surface.This results in a greater amount of moss, lichens or salt blooms that are visible in all of its outer surfaces. There is also moss growth in the edge of the masonry walls that are in contact with the exterior eternite sheets.

Fig 45: Moss growth in joints between masonry walls & eternit sheets

Fig 46: Different color & texture interior and exterior plaster renders

Fig 47: Degraded Eternit roof by biological colonization

Fig 48: Former chimney shaft

5.4 RECOMENDATIONS

Waterproofing of historic masonry buildings is an important measure to consider in the renovation and maintenance of the structure. With the following mapping of results obtained ,it is observed that in most of the top pareas of the masonry the moisture content is low, but in the bottom part of the masonry there is elevated moisture content. Based on the obtained values, it can be conclud-ed that the moisture is caused by contact with the soil. Observing that the values decrease from the bottom to the top, and having the highest moisture content at the point where the wall is in direct contact with the ground.

Having in consideration that the results of the conducted test were only made in a specific wall out of the whole structure, it's important to mention that when working in the structural design , the results will be averaged in order to use a valid / permited value for the mechanical properties of the material, like compressive strenght or bending capacity. This range of values are the results of the academic & scientific approach to support or validate the values that will be inputed after for the structural analysis.

Having analyzed the previous information it's important to adopt diferent measures for the renova-tion project, for instance ventilation of the floor and masonry foundations with , air canals and mechanical separation of the rear wall from the direct contact with the slope. Also it is important to remove salt cristalization in the masonry. In order to do so, th first step is to restrict water access, which transports soluble salts with it and previously stated which techniques can be used.

The next step is the removal of crystalized salts from the masonry. Since the salinity values are not high in this case and in the case of increased salinity are only the chlorides, which are more soluble.A sufficiently effective method in which the masonry is exposed should be desalination wraps, a well-effective mixture is a combination of pulp, bentonite, pumice and Ajatin (in a 1:1:8 ratio), recommended to be applied at least two cycles (2nd cycle in a 2:1:8 ratio)

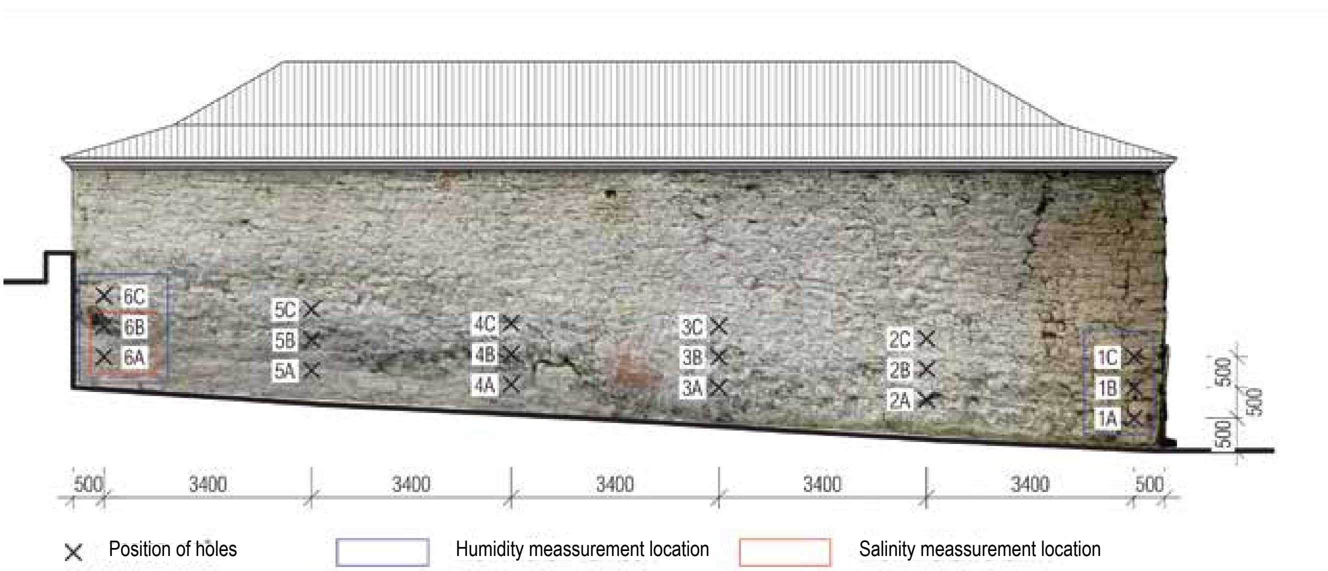


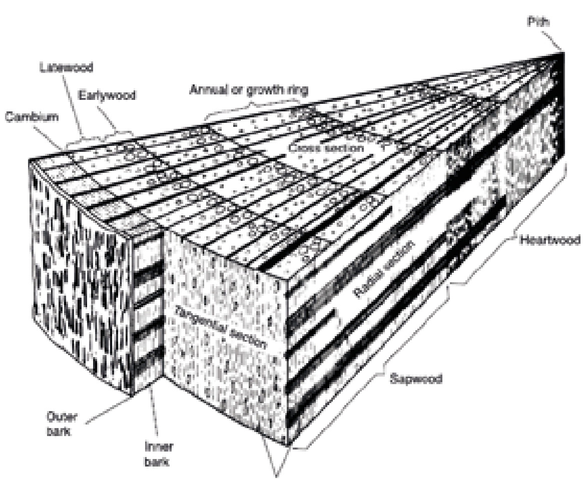
Fig 49: Mapping of samples taken of stone and mortar from masonry wall in East Facade.

5.5 TIMBER

Wood species , *spruce picea*

Wood is a natural anisotropic material which characteristics vary with the direction, wood species, their structure, moisture content and defects. Within the tree, there are diferent regions with different properties, most of the twigs and branches of the crown are sapwood. The core of the trunk contains the older cells that are closwer to the pith. This is refered as heartwood, which in many species has a darker colour than sapwood, which is more durable. There are two main divisions for the classification of trees , softwoods, located mainly in the northern temperate zones, and hardwoods , which ocur both in temparate and tropical regions.
Considering research on the site on which the study case is located and also by visual inspection the Species of wood used for the construction of the timber elements is *Spruce*.
This species is widely distributed throughout continental Europe. The large tree usually has a straight, cylindrical trunk and grows to a height of about 30m (up to55 m), with a large diameter of about 60 cm (up to 1,5 m). Regarding its appeareance ,the colours range from creamy white to light yellow and to red-brown. Heartwood is not distinct from sapwood. Spruce is straightgrained with thin and regular texture.The wood is soft, low in weight and has medium density, it also has good strength properties.There are various typical uses for spruce wood, for structural end uses, indoors and outdoors, thus it is the most important building and construction timber in Europe. It is also used for decorative plywood, decorative veneer, domestic flooring, factory flooring, general carpentry, interior construction, joinery (external).

Fig 50: Diagram of a section cut from a five year old stem of a hardwood.



Physical characteristics	
Density (at 12 % moisture content)	441 kg/m³
Total longitudinal shrinkage	0.3 %
Total radial shrinkage	3.6 %
Total tangential shrinkage	7.8 %
Equilibrium moisture content	
(20° C/37 % rel. humidity)	7.0 %
(20° C/83 % rel. humidity)	16.4 %
Mechanical characteristics	
Modulus of elasticity under bending	12500 N/mm²
Modulus of rupture under bending	77 N/mm²
Tension strength	95 N/mm²
Compression strength	44 N/mm²
Brinell hardness perpendicular to the fibres	44 N/mm²
Janka Hardness	1.6 kN
Nail withdrawal strength in	
N per mm depth and mm diameter	5.5 N/mm²
Natural durability and treatability (according to EN 350-2)	
Fungi	Class 4 – poorly durable
Dry wood borers	susceptible
Termites	Class S susceptible
Treatability	3-4 poorly or not permeable

Table 6: Spruce Picea characteristics: European Wood Species & their characteristics

When considering the specific species, the distribution of historical constructions varies significantly in terms of location and time. The predominant species used in historical constructions across Czech lands from the 15th to the 18th century was fir. Starting from the early 16th century, spruce utilization became less common and began to dominate in the latter half of the 19th century, particularly at the expense of fir and oak. Timber constructions are found at elevations ranging from 136 to 1019 meters above sea level (asl), with a median elevation of 353 meters asl (standard deviation=133 meters). It is observed that, both the highest constructions (only 4 above 900 meters asl) and the lowest ones (7 below 150 meters asl) were primarily made of fir and spruce. The spatial distribution of timber construction sites for each specific tree species directly correlates with the altitude (Fig. xx). Since altitude is indicative of other natural conditions like climate and soil, each tree species exhibits a distinct spatial pattern. The spatial analysis of fir deviations reveals that fir was prevalent in historical constructions, particularly in the eastern part of the Czech lands (Moravia/Silesia), while its presence in buildings in the western and central parts of the country is less significant. This can be attributed to the less frequent occurrence of spruce and pine constructions in Moravia/Silesia until the 17th century. Spruce constructions are widely spread across the western and central parts of the Czech Republic, while they are rare in the eastern part . The average elevation of all spruce constructions is 394 meters asl, which is the highest among the four dominant species. Clusters of spruce constructions can be observed in highlands, sub-mountains, and mountain regions, especially from the 17th century onwards.

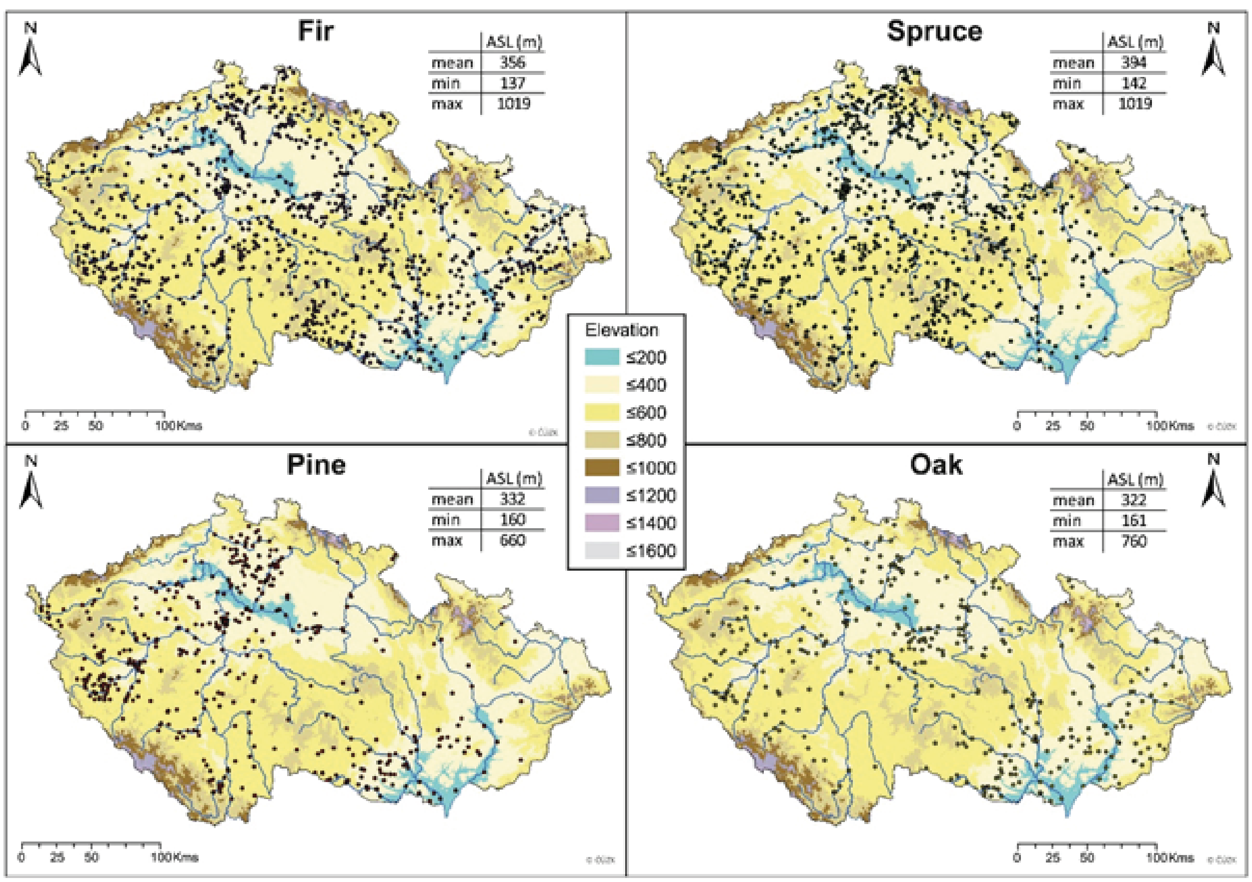
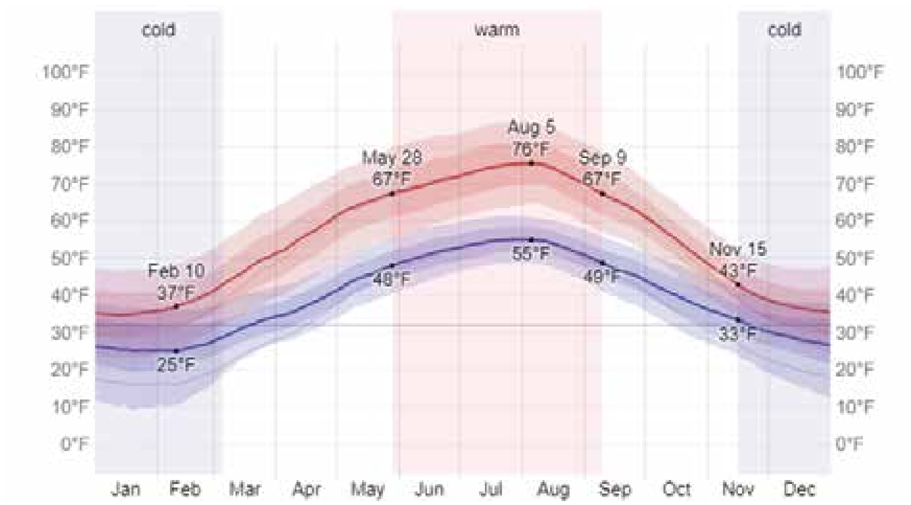
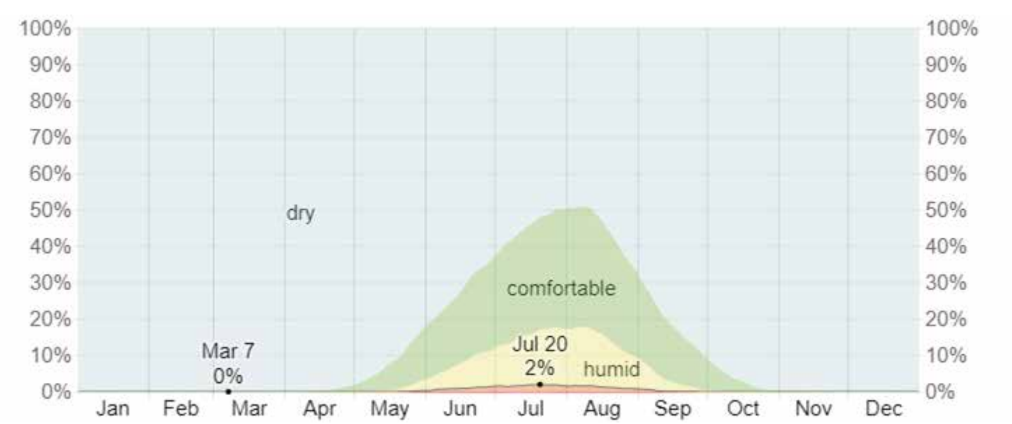


Fig51 .Spatial distribution of fir, spruce, pine, and oak constructions in Czech lands in the 1400–1900 period with tables showing minimum, mean and maximum elevations (ASL) of the sites.

To conduct a complete “Performance assesment” it is necessary to understand various factors that relate with the service life of a building, which is the period of time after the instalation during which a building and its parts meet or exceed the performance requirements (ISO 1586-1:200). Some of this factors can be damaging caused by biological, chemical or physical agents,reused timber elements that come from former structures, change of use or alterations in timber structures. And if there is or not a maintenance plan of the existing building. For this reason its important to make several inspections in order to obtain all the information needed regarding this agents.During this inspection the wood performance was observed taking into account mechanical properties , hygroscopic, durability and functionality.
Climate factors can affect the performance over time. This exposure to the environemental agents can lead to cracks, fungal decay, moisture content.There are three scales of climate exposure:
The first one is the Macroclimate; which considers the general climate of the region or town , where the building is. The weather in Chlumcany has a a warm season of 3.4 months from May 28 to september 9, with an average daily high temperature above 67 F. The hottest month of the year is July. The cold season last for 3.7 months from November 15 to March 5, with an average daily high temperature below 43 F. The coldest month of the year is January.



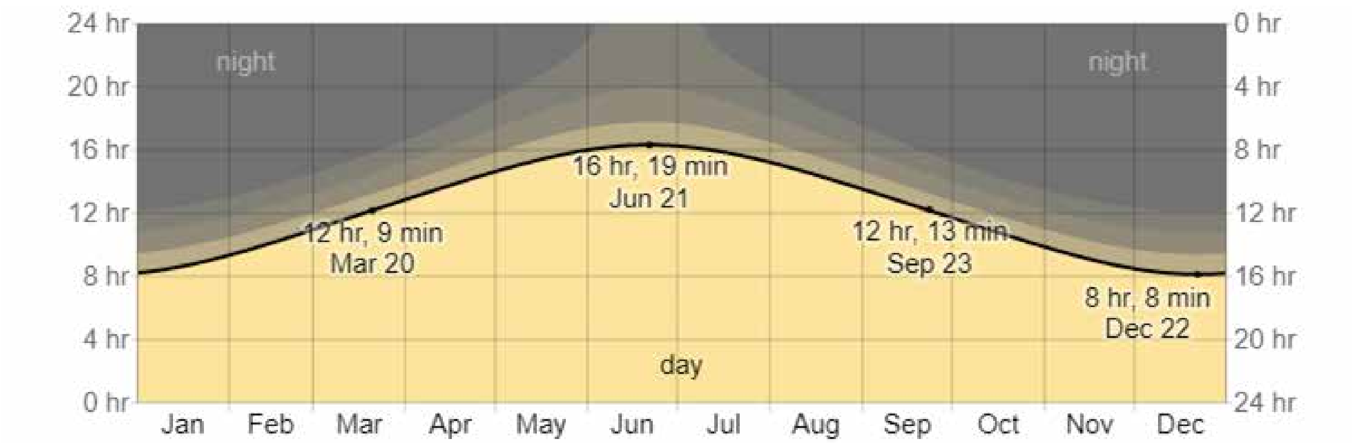
Graph 2 : average high and low temperature in chlumcany. WeatherSpark.com



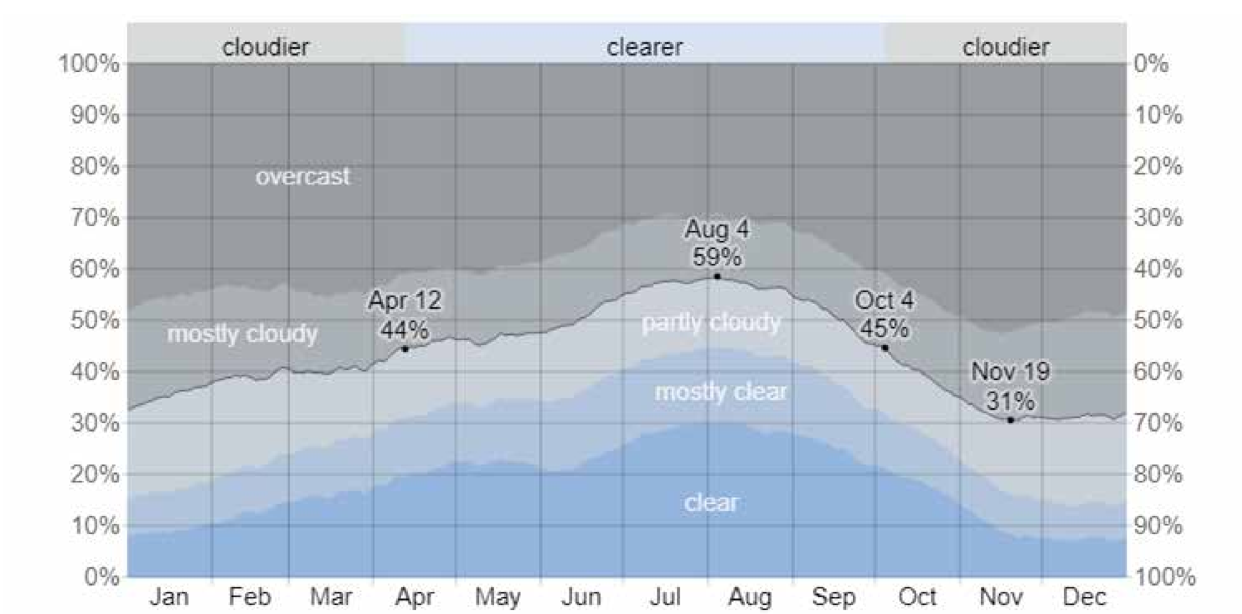
Graph 3: The perceived humidity level in Chlumčany doesn’t vary significantly over the course of the year, staying within 1% of 1 % throughout the year.

The hours of sun and length of the days varies extremely over the course of the year. The shortest day which is in December 22 last 8 hours with 8 minutes. While the longest day in June 21 has 16 hours, 19 minutes of daylight. However, the Pilsen district has practically half of the year with a cloud cover wich starts from October 4 and last for 6.2 months, ending around April 12. Reason for which the exposure to hours of light is significantly reduced to a half of the average,
The precipitation levels considers a wet day one with at least 0.04 inches of liquid precipitation.

Graph 4: Hours of daylight and twilight in Chlumčany.



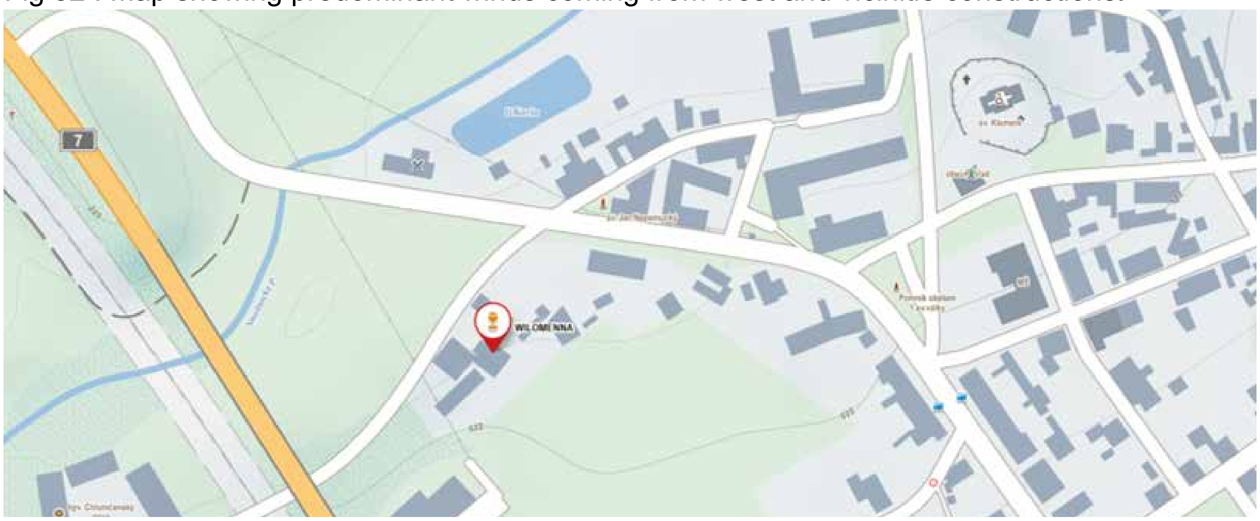
The wetter season last 4.0 months from May 6 to September 5, with a greater than 28% chance of a given day being a wet day. The month with the most wet days is June with an average of 10.9 days with at least 0.04 inches of precipitation. While the dry season takes place from September 5 to May 6 , being the dryest month February with an average of 5.6 days with at least 0.041 inches of precipitation.



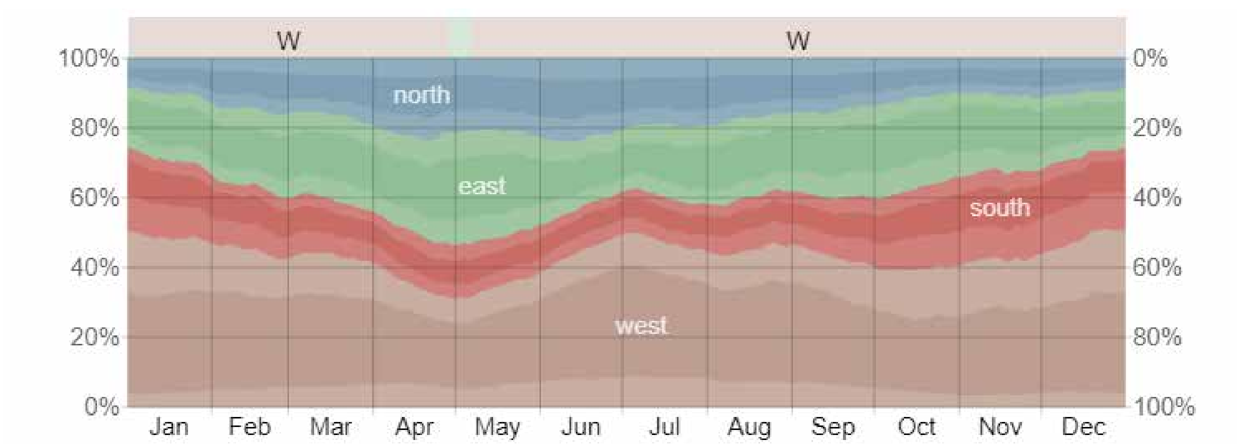
Graph 5: amount of clear and cloudy days in Chlumčany.

The second enviornment exposure studied is the Mesoclimate, which studies the vecinity of the building and / or timber structures, which are not disturbed neither by wood properties or by the geometrical features of the building and/ or timber structures. The winery is situated in a rural area surronded by crops and sparced residential houses. The exposure to wind its considerable to the predominant winds coming from the west direction, where the high road is located and there are also no other constructions to block this side . For this reason the project propose to incorporate trees in the main courtyard, both to provide some protection from the predominant winds and also to make a visual blocking towards the highway.

Fig 52 : Map showing predominant winds coming from west and vicinitie constructions.



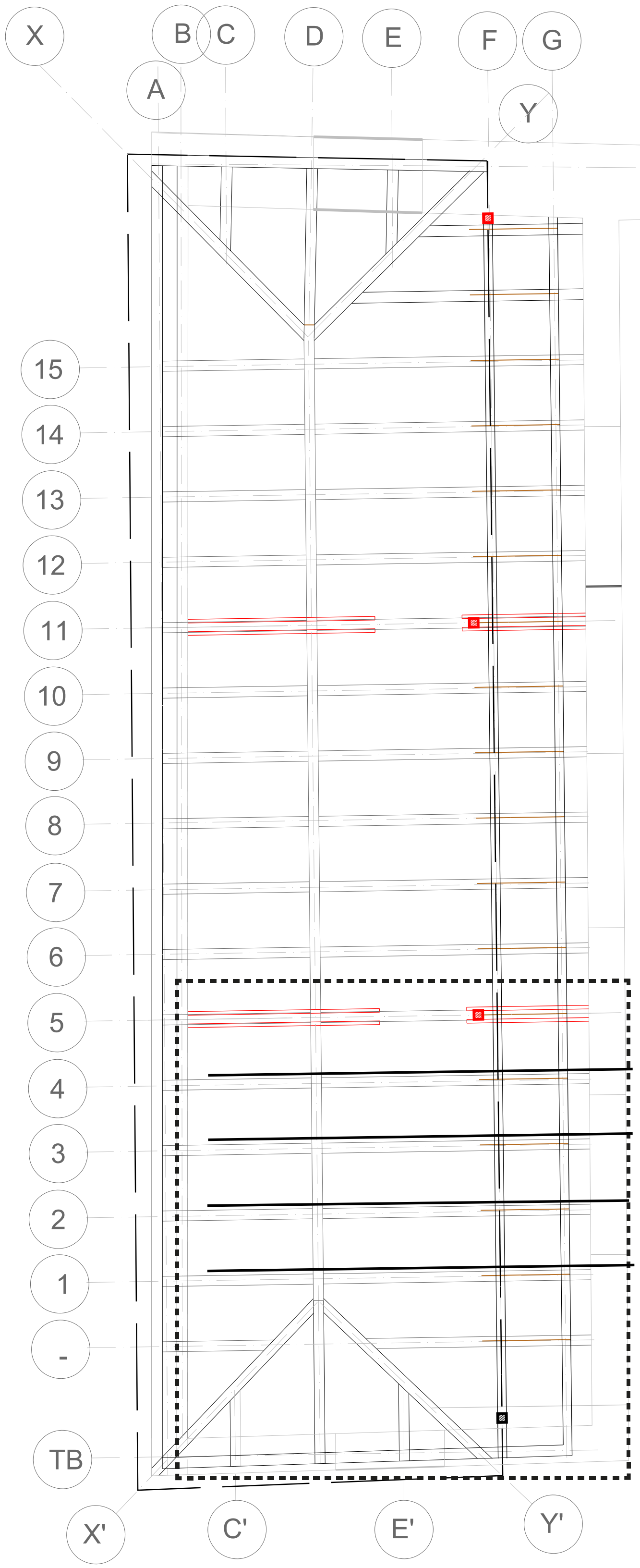
Graph 6 : Predominant West Winds direction in site are evaluated in structural analysis.

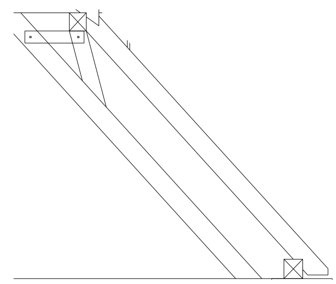


For this level of exposure its also imoprtant to consider the emplacement of the building in the site, which is adjacent to a small slope of grass with a small ditch of aprox 1 width, diged in order to separate it from the soil and the humidity of the sloped terrain. Nevertheless the masonry walls have experienced raising damp from the soil, absorving in its first meter , causing the deterioration of the opuka stone, but also compromising the levels of moisture of the timber members, due to capilarity phenomenon in rocks.

5.6 GEOMETRICAL SURVEY

Ceiling Plan CP-01





Wood strut

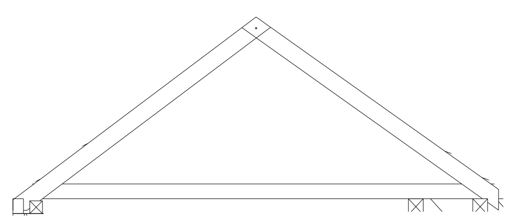
North section of roof

Maped trusses

Wood struts

Woodboard walls

Timber posts



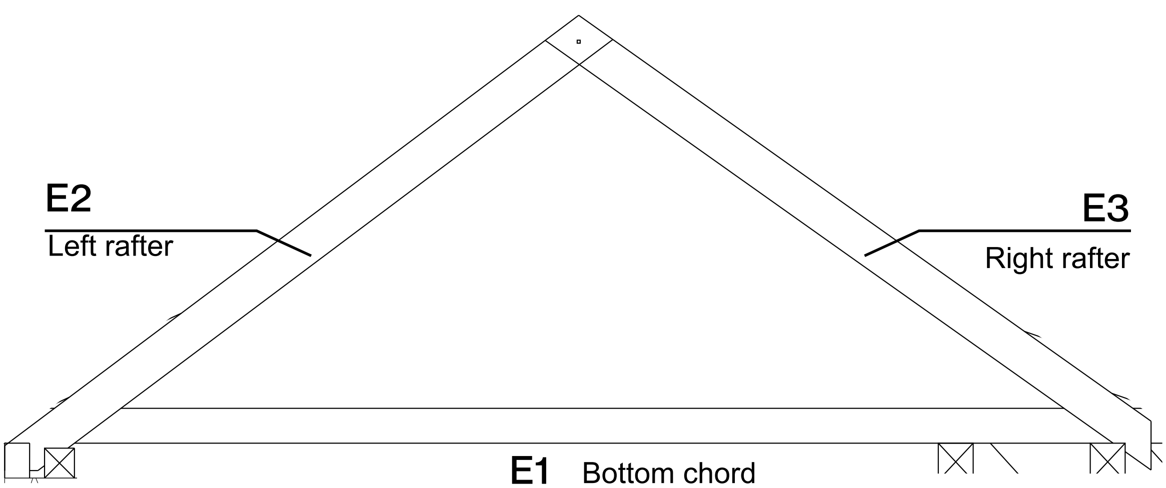
Truss type A

5.7 VISUAL INSPECTION

The roof structure is composed by 15 simple wood truses along the longitudinal section located at every 90 cm from separation. They are joined by nails and interlocked cutted joints. This trusses rest on the left side on two beams (A & B) that are supported on the top of the masonry wall.
On the other side this trusses rest on the wood struts, this bring the loads down of the ceiling to the masonry walls. There are two partition wood board walls that divide the second floor marked in red. Two inclined beams (X & Y) at the end of the sides of beam C , that conect with the corners of the rectangular perimeter in order to create the slopes of the roof sides. The other small beams(C,B / 1,2) help structure this triangular frames to the the edges (beams 1& 6)
Most of the trusses type are in a considerable salvage state of conservation. It present from moderate to sever damages in their members such as cracks, biological attack ,interventions with new timber members and repairs made with sealings and polyurethane.The trusses were coded by its diferent members in order to have a better understanding of the localized damage.
The wood struts , vertical posts and partition walls were found in a completely degradaded state by humidity and insect attacks. The posts are not longer comoplying with any function and so for this reasons they will be removed completely.

Further studies in the type of insect attack should be performed to prevent the spread of them in other wood members.

Fig 53:
First section of timber roof, facing north



TPA: Elevation : Truss type A

5.8 DAMAGE MAPPING

Trusses A1 - A3

Visual inspection and pathology assesment is the first diagnosis for a complete material characterization of all the timber elements in the studied roof system. As shown in the ceiling plan CP-01, there are a total of 15 trusses type for which the first sectionof of the roof trusses were inspected. Presenting moderate to severe damage , represented in a color mapp of degree of damage.
Truss A2 & 4, where the most severe damage is found on the corner points of the rafters. This points should be intervened with metalic conectors embeded in the joints.Further studies of the mechanical behaviour of the joint should be performed to dictaminate the specifications of the elements.
Truss A2 presents a long crack in the upper section of the element. This represents a posible future expansion or splitting in this section of the member. Reinforcing with U steel profiles can be incorporated along its lenght as a posible solution to stich this crack. An adecuate resistance test with a screwdriver or a rod penetration test should be performed in order to know the depth of this soft section and derive its actual resistance.
Truss A1 shows some minor damage on its front face caused by acidity provoked by organic fecal mater of peagons and xilophagus attack that are penetrating inside the wood. Insecticide should be sprayed and/or inyected in this areas depending on the exact insect species that is eliminated.

Severe damage   Moderate damage   Low damage   Section replace

Fig 54: Truss type A North section with damage mapping

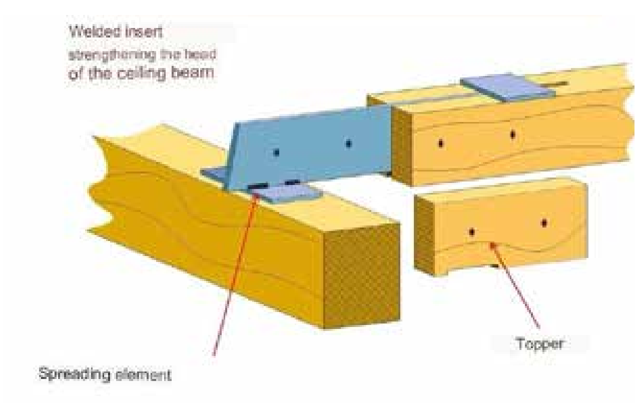
5.9 RECOMENDATIONS

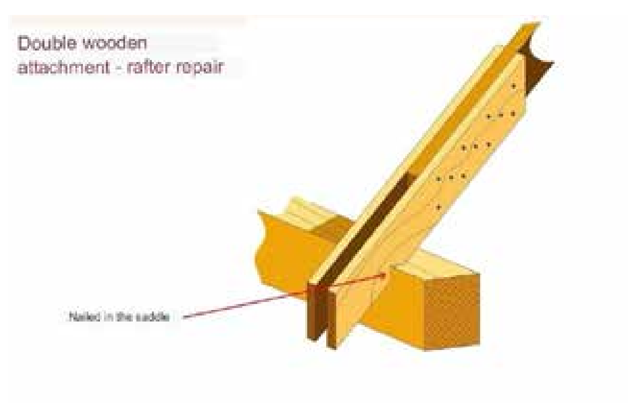
Rehabilitation of wooden structures can be carried out by direct strengthening of individual elements (by means of prosthesis, extension, height extension, application of carbon fibres, anchoring into a steel bracket, etc.), by their indirect strengthening (by supporting, lightening, etc.) or by strengthening of structural units (by coupling in the form of wood - wood, wood - concrete and other load-bearing systems, by tightening with steel rods, etc.). This chapter focuses on the methods of prosthesis, attachment and anchoring to steel brackets, which arerecomended in the rehabilitation of the ceiling and timber trusses.
The rehabilitation of timber members or parts with damage or undersized elements and parts of the structure must be strengthened in order to restore their functionality. The rehabilitation intervention must be organized in the following steps:
- Diagnosis of damaged wood and damage mapping in elements.
- Sterilization of rotten and wood-damaged wood,
- Restoration of wood properties (durability, strength, moisture sorption, etc.) by impregnation with preservatives,

The restoration methods recomendes for the wooden elements and the whole structure are prosthesis, bolting and anchoring to steel brackets.

Methods of strenghtening

1. Increasing the cross-section: by Insertion and height extension.
2. Application of carbon slats or carbon fibre mats.
3. Replacement of damaged wood in the element with sound wood of same species or similar
Lapping - joining a healthy part of the element with a timber or steel lap (repairing the rafter head),
Anchoring - insertion of the sound part of the element into a steel bracket (repair of the ceiling joist header).
4. Replacing (or supplementing) the damaged timber in the element with sound timber or other material while maintaining its original cross-section:
Prothesizing (carpentry and beta-methods,
Sealing,impregnation with a strengthening substance (e.g. epoxy resin).





Figs 55-56: Examples of corrections

6. ARCHITECTURE PROPOSAL

The project is developed from the revitalisation of Wilomenna winery, a local house wine producer located in Chlumčany, a small town in the Pilsen-ilj district, one hour south west from Prague. The owners seek to renovate its facilities and create more space for new uses like a wine shop boutique and wine tasting experiences. Within the grounds of the winery the proposal focuses in detail on the stabilisation of the existing historic building and the structural design proposal of modification and extension of the historic pressing plant building that will house space for the new demands.

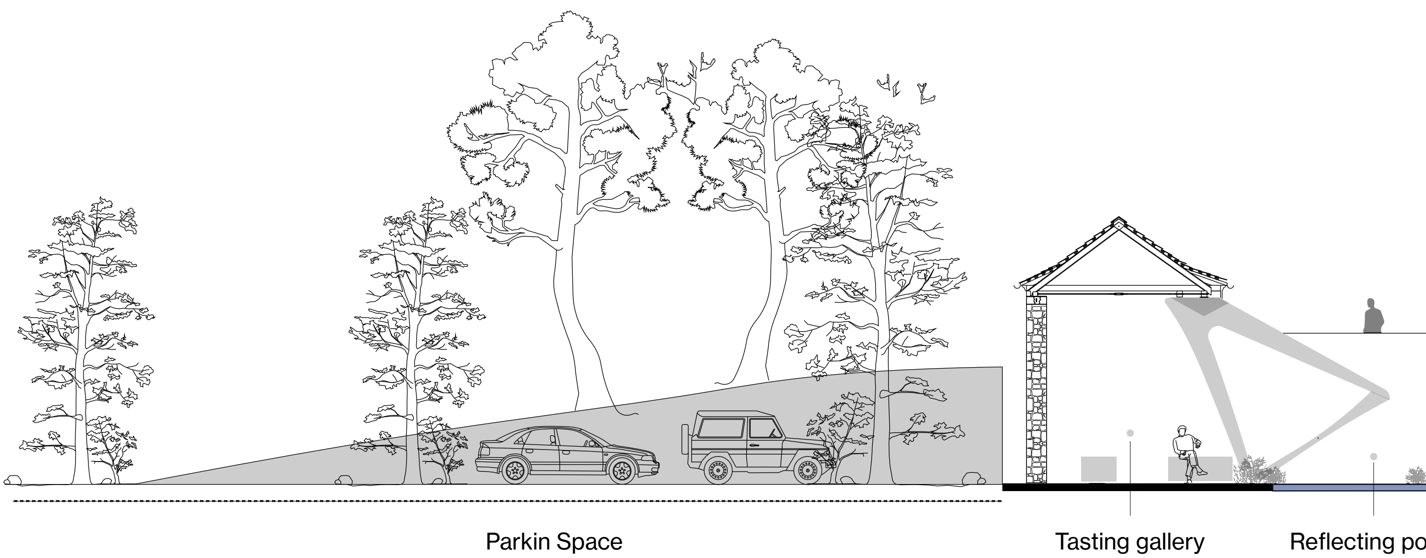
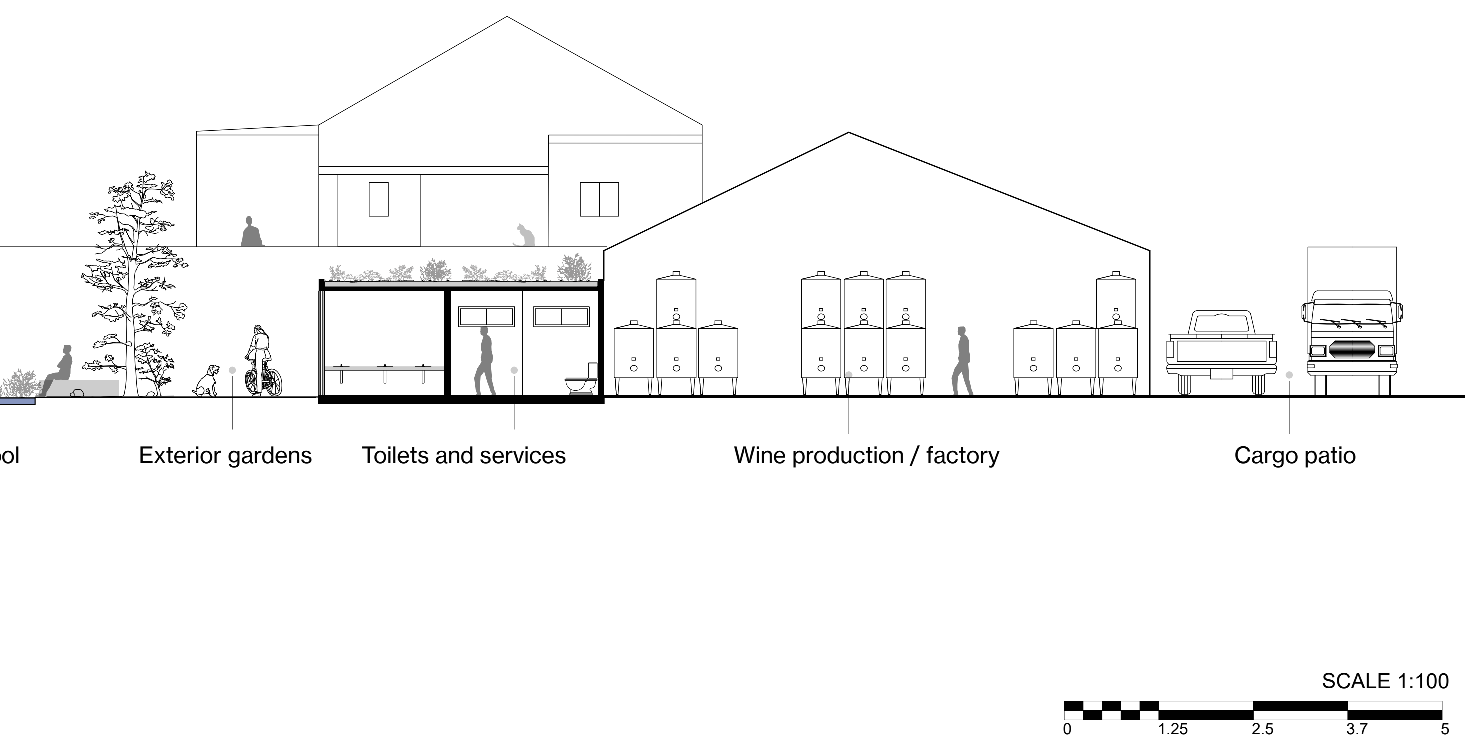


Fig58: Section of the Project
Wilomena Winery

The design of the intervention is based in temporal timber shoring techniques in masonry buildings with damaged elements, after a seismic event. In order to implement this , a design process of form fitting combined with structural analysis , resulting in a contemporary geometry that performs the structural needs with less material in laminated timber that can hold bigger spans. The space enclosed by these new structures creates different areas ;covered, open and semi open. Creating a bigger gallery with more open space where traditional building techniques dialogue with contemporary design in new materials.



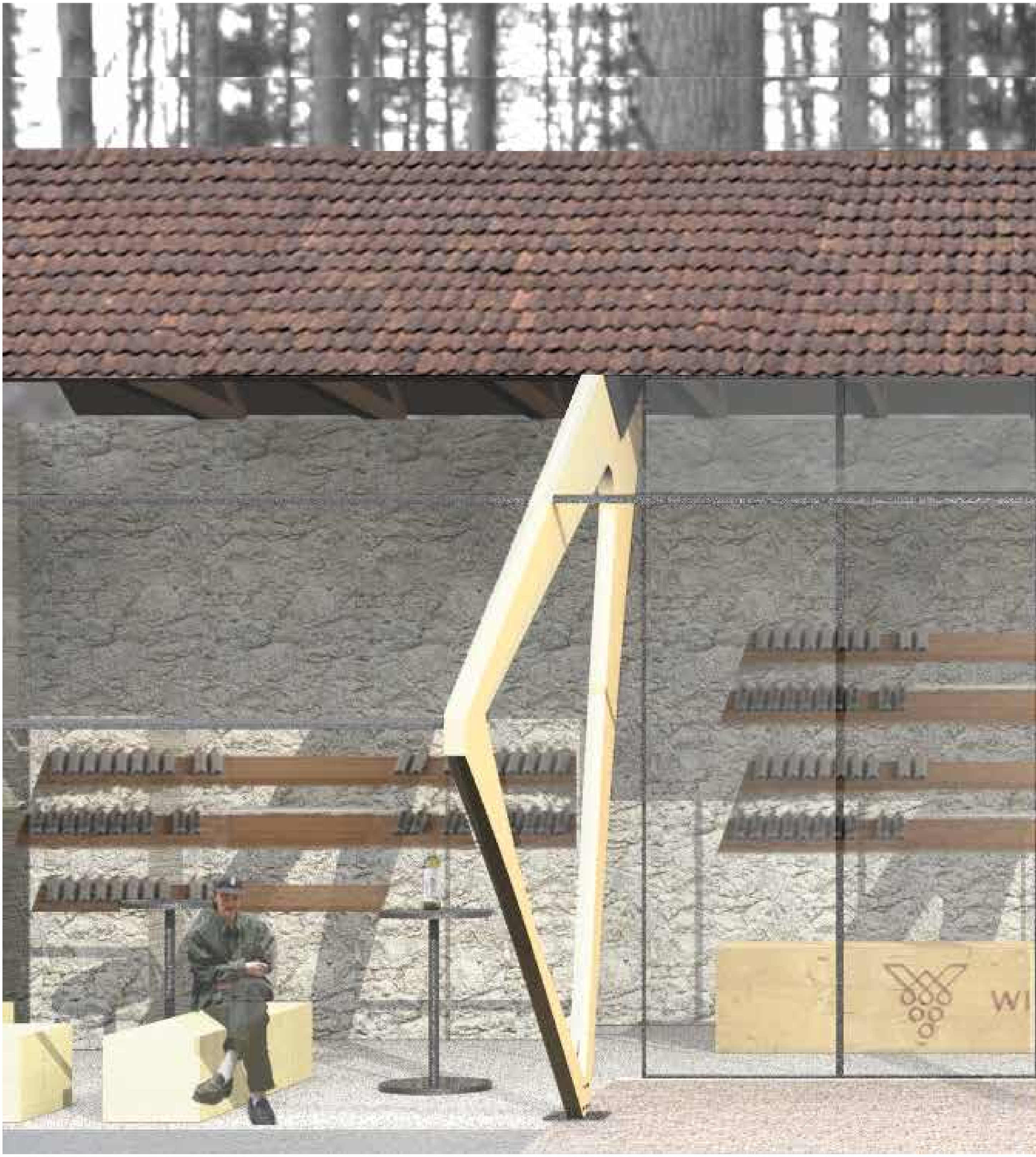


Fig 59: Exterior perspective main entrance


LOMENNA

SITE PLAN PROPOSAL

Table 7

Area distribution			
Space	#	m2	# visitors
Wine shop & gallery	1	24.3	8
Private lounges	4	38	20
Toilets	2	44.6	7
Storing space	2	22	
Outdoor gardens	3	169.8	
Hardscape pavings	1	107.3	10
Parking space	5	10.5	51
Cellar	2	44	10
Wine production	2	26.14	
Total		486.64	35

Fig 60: Site plan Willomena grounds

LAYOUT & SPACE DISTRIBUTION

The project incorporates the pre existing masonry structure as the wine tasting gallery and shop which opens up to the inner courtyard.Through landscape and hardscape design ,these exterior spaces conects the whole project with the other facilities (cellar, wine factory and toilets).
This exterior landscape brings light and view to the gallery and also enhances outdoor activities for visits during the summer enriching the wine tasting experiences at Wilomena.

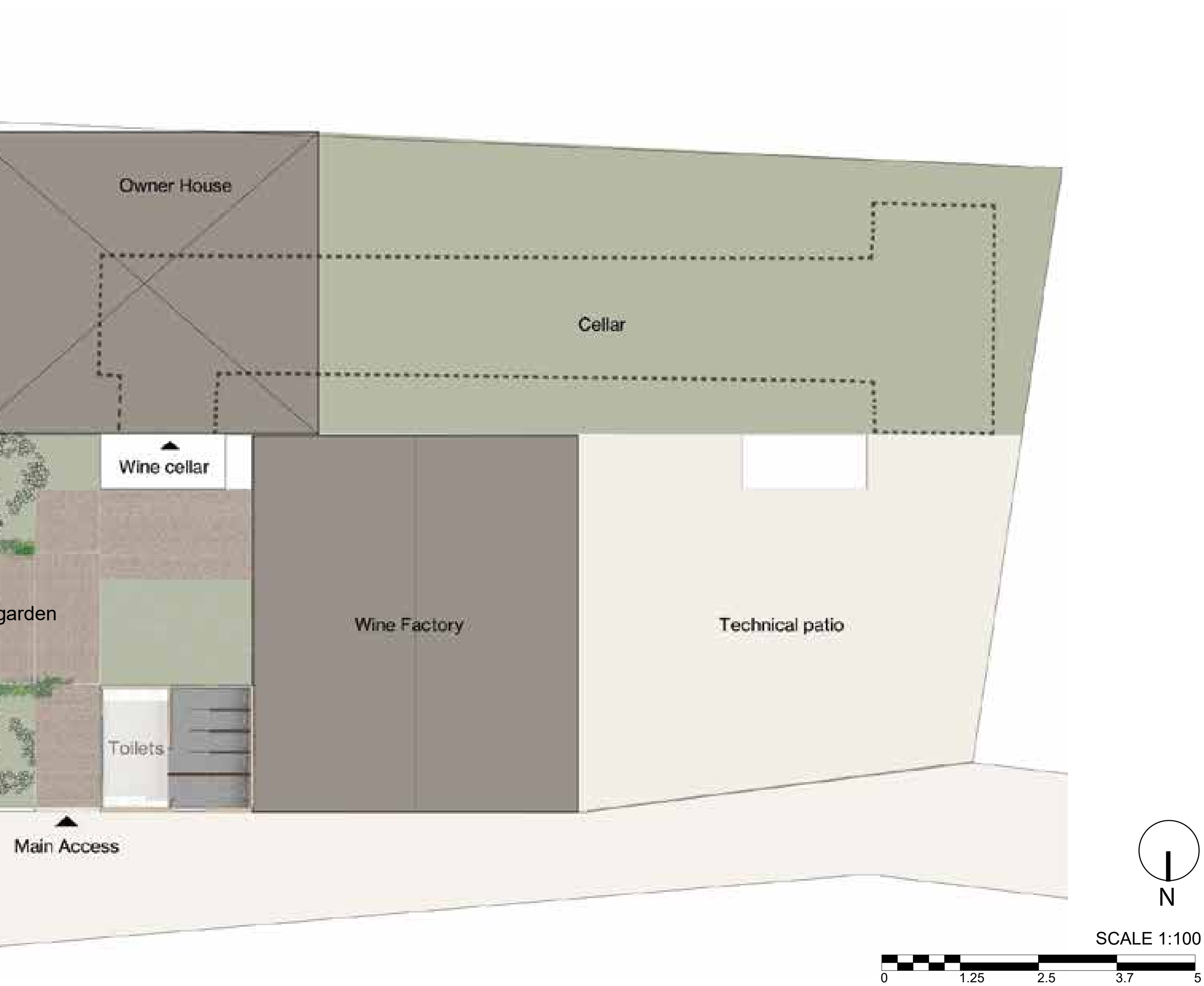


Fig61: Interior perspective of wine gallery & shop

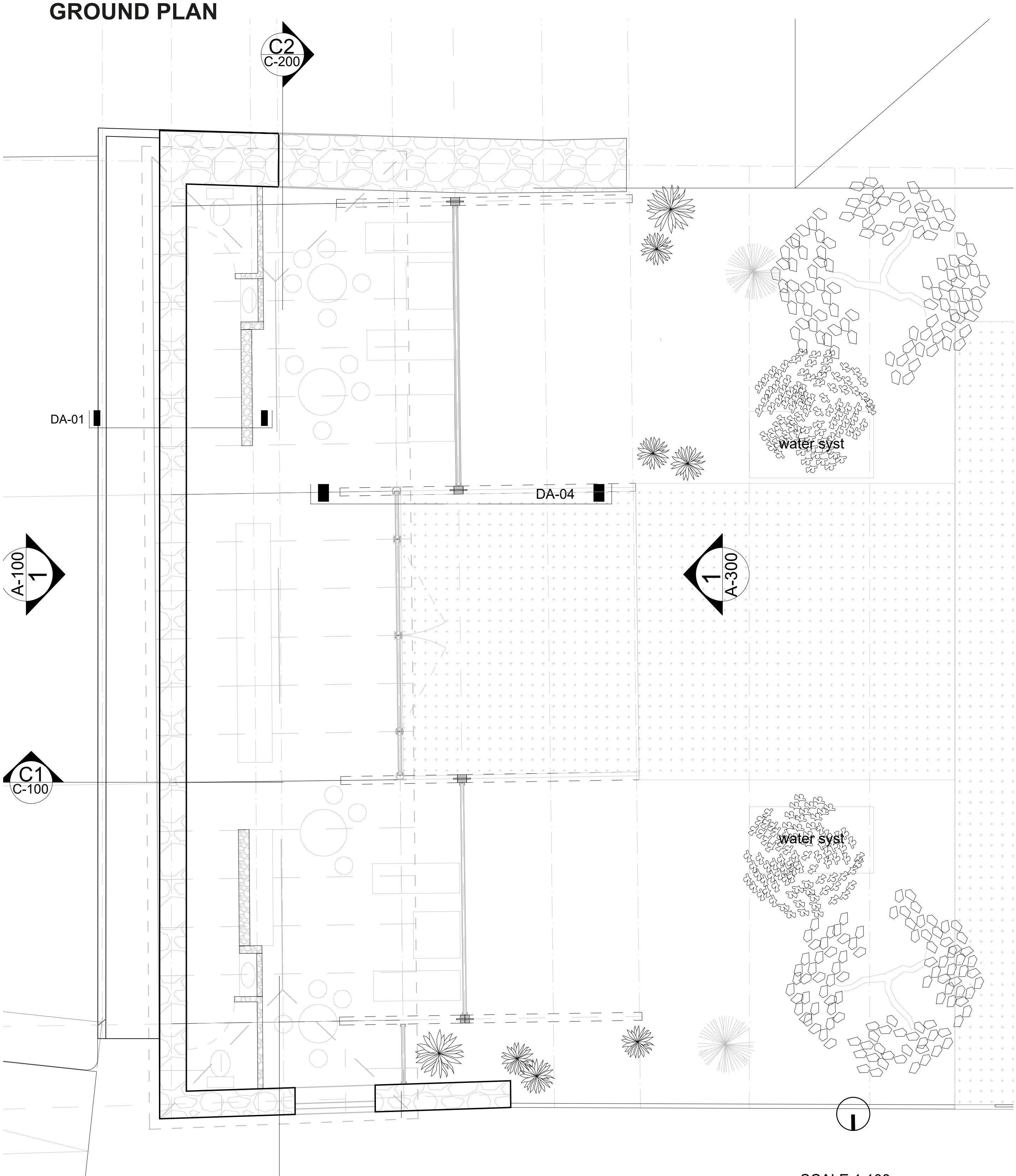
7. ARCHITECTURE PLANS

The proposal for the winnery includes the wine tasting shop & boutique for wine tasting and the services needed for the new capacity of visitors , toilets, parking space and others. The main porpouse of the study case focus mainly in the masonry building ,which is in a dilapidated and unstable state, so it will be strenghtened and repaired with diferent techniques that will be discussed further. The project develops around the masonry building , which opens up with the help of the new structure to the outdoor courtyard.This patio plays with water and vegetation at the base of the extension, creating a landscape to contemplate from the wine tasting gallery. Also by designing a series of stone pavements for paths and reunion points will help conect all of the facilities in one same hardscape

WSP-50
SITE PLAN showing masonry building and facilities

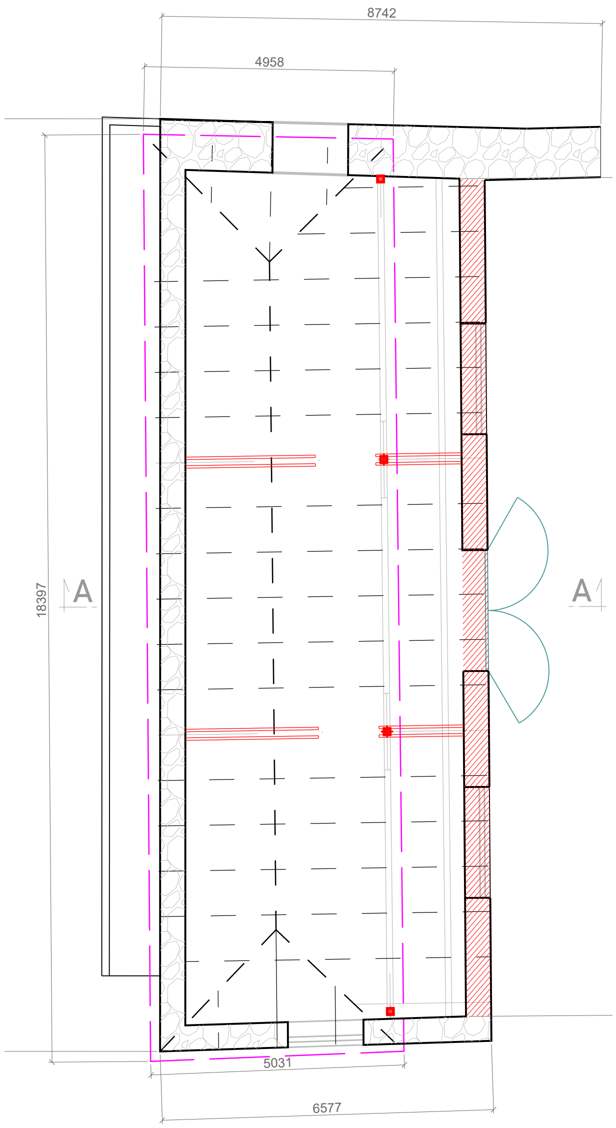
SCALE 1:50
0 1.25 2.5 3.7 5

GROUND PLAN



PA-100 Ground plan of masonry building

DEMOLITION PLAN



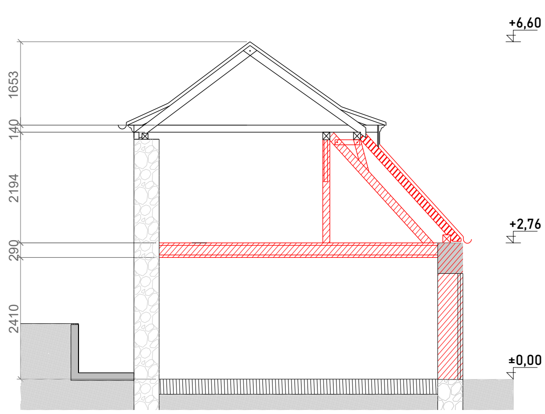
The design of the extension reuses the original timber roof , which in the scope of this study is of value and worth conserving for heritage salvage and reduce costs of building , due to the fact that creating a new roof would imlpy more costs. For this reason only the deteriorated and unsalvage timber elements will be removed like the wooden floor that is destroyed by insects. Regarding the roof the truss system has some wooden struts that carry the loads down to the masonry walls. This elements are also highly deteriorated at its base when they touch the walls. For this reason the design of the extension takes into consideration this problematics and solves it with the following actions.

1.Removal of the deteriorated wooden floor to create a gallery with much height.

2.Demolition of the wall adjacent to the patio to bring light and view to the interior of the building.

3.Design of a new timber structure that carries the truss system down to new foundations, and also that can create a bigger span than the previous one. This progresive design acts as an element that can be structural but also creates extra inner space to the building that will be used for visitors to have private spaces to enjoy the wine tasting experience.

Original plan and section
of masonry building with demolitions.



Stabilized masonry

Masonry demolition

Timber element removal

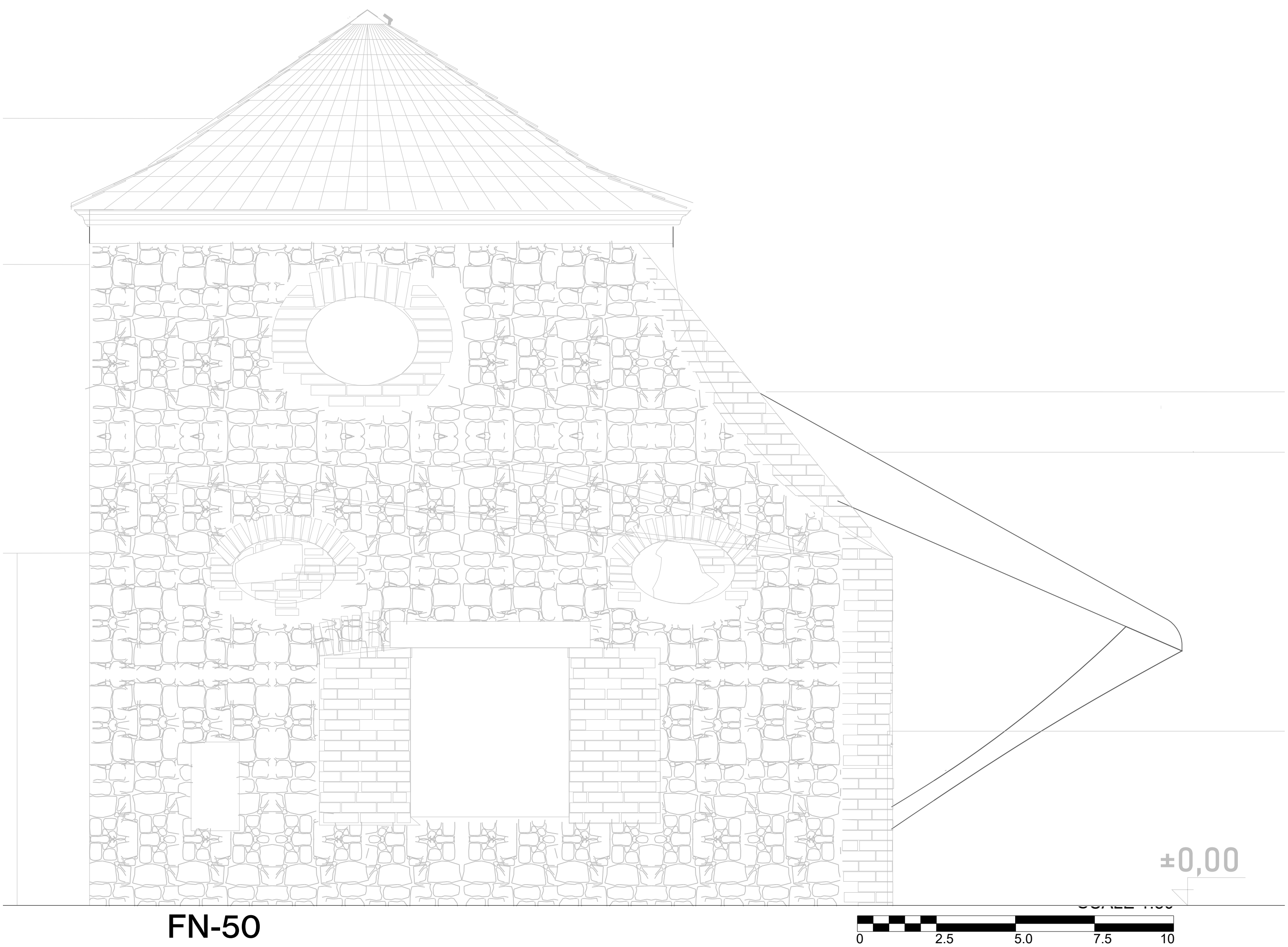
Conserved timber element

D-100

SCALE 1:150

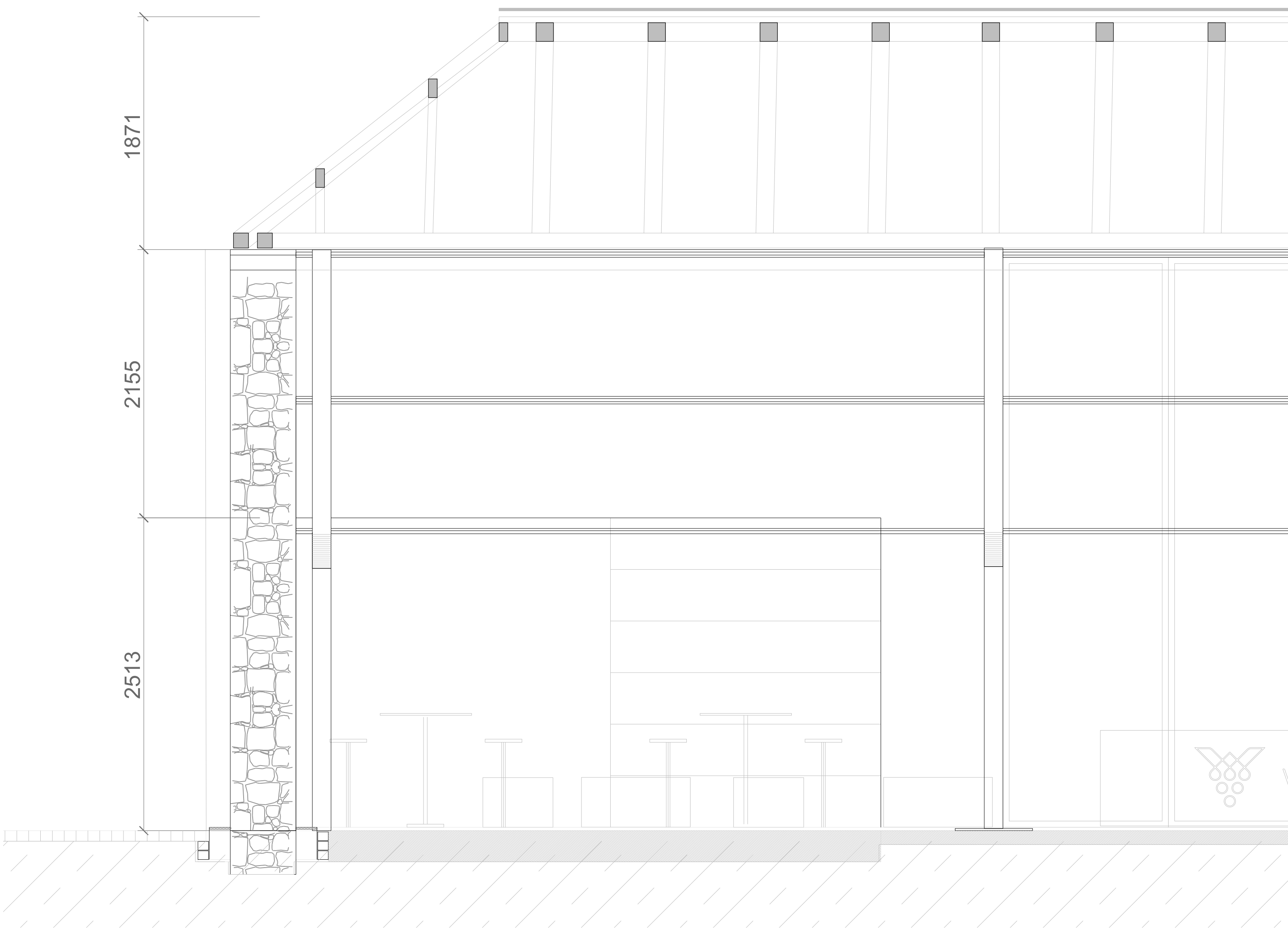
0 1.25 2.5 3.7 5

FACADES

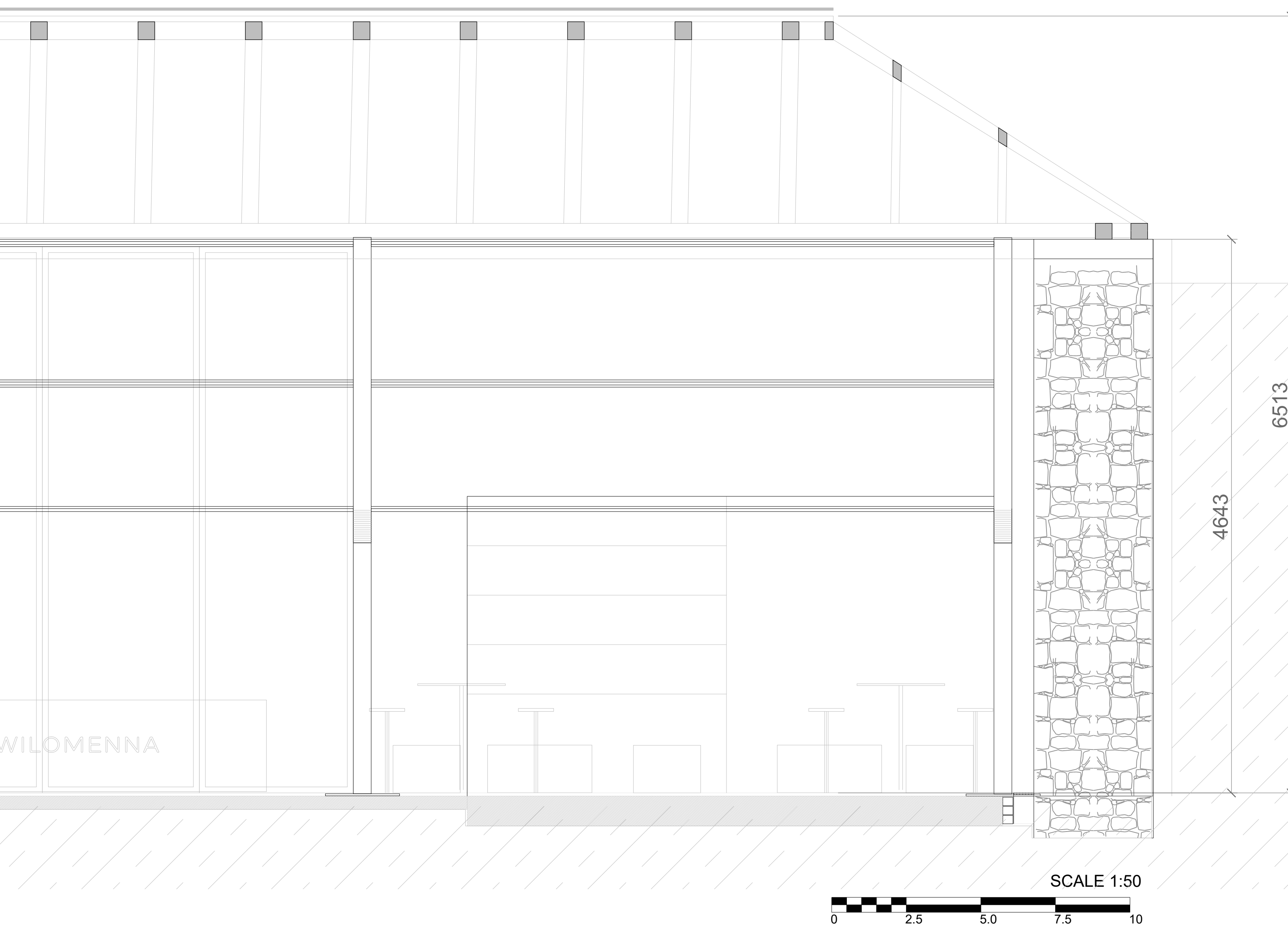


FN-50

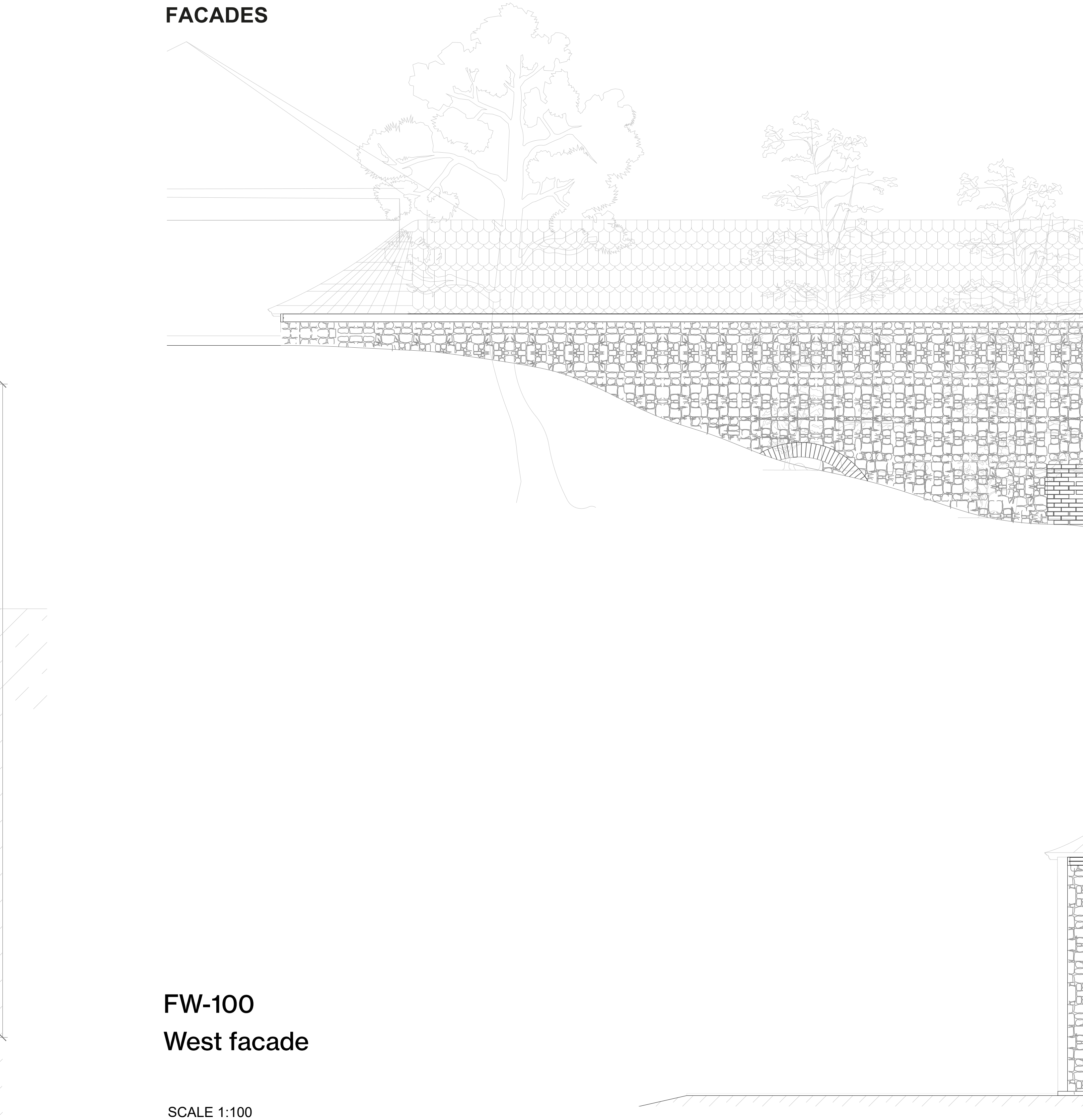
LONGITUDINAL SECTION



CL-50


WILOMENNA
4643
6513
SCALE 1:50
0
2.5
5.0
7.5
10

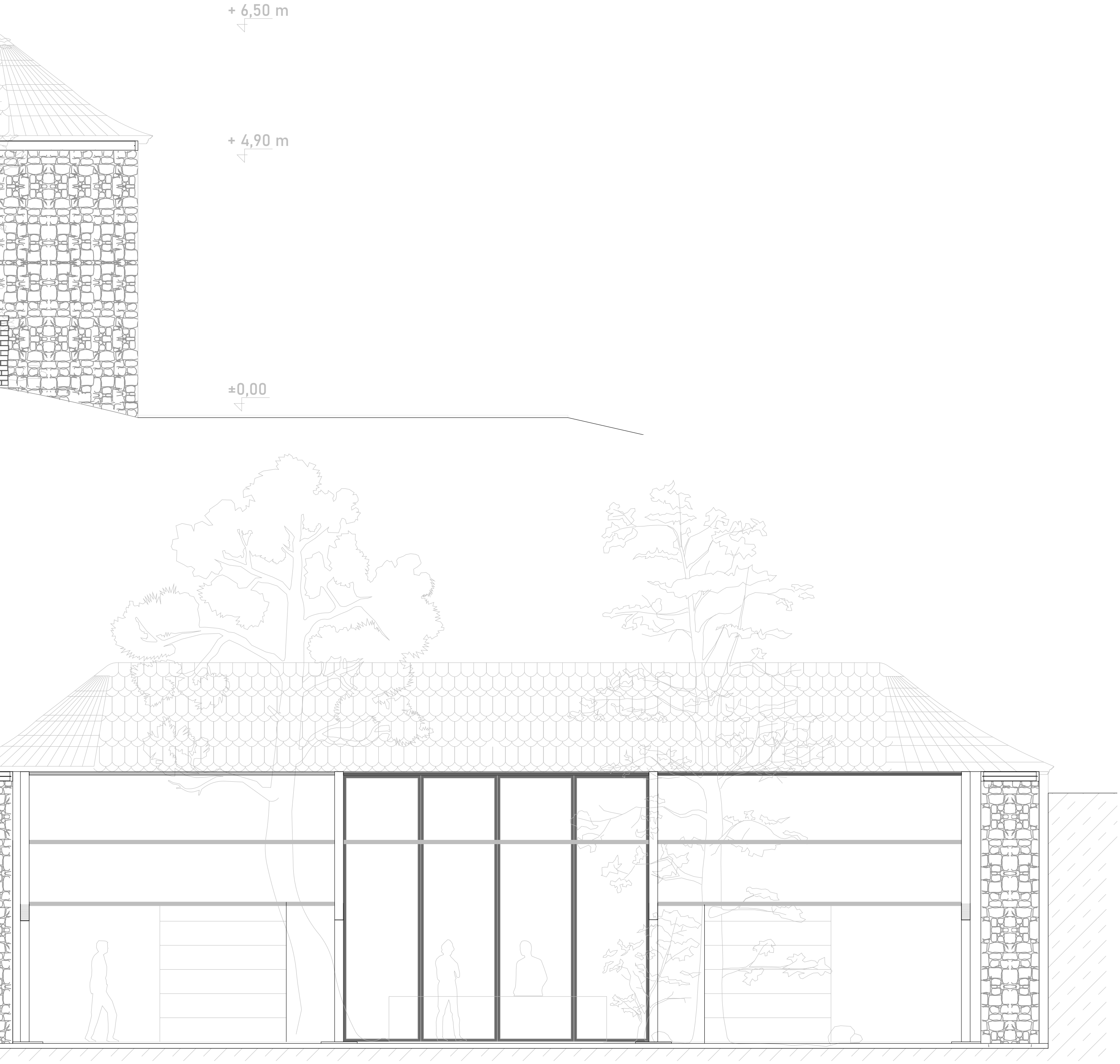
FACADES



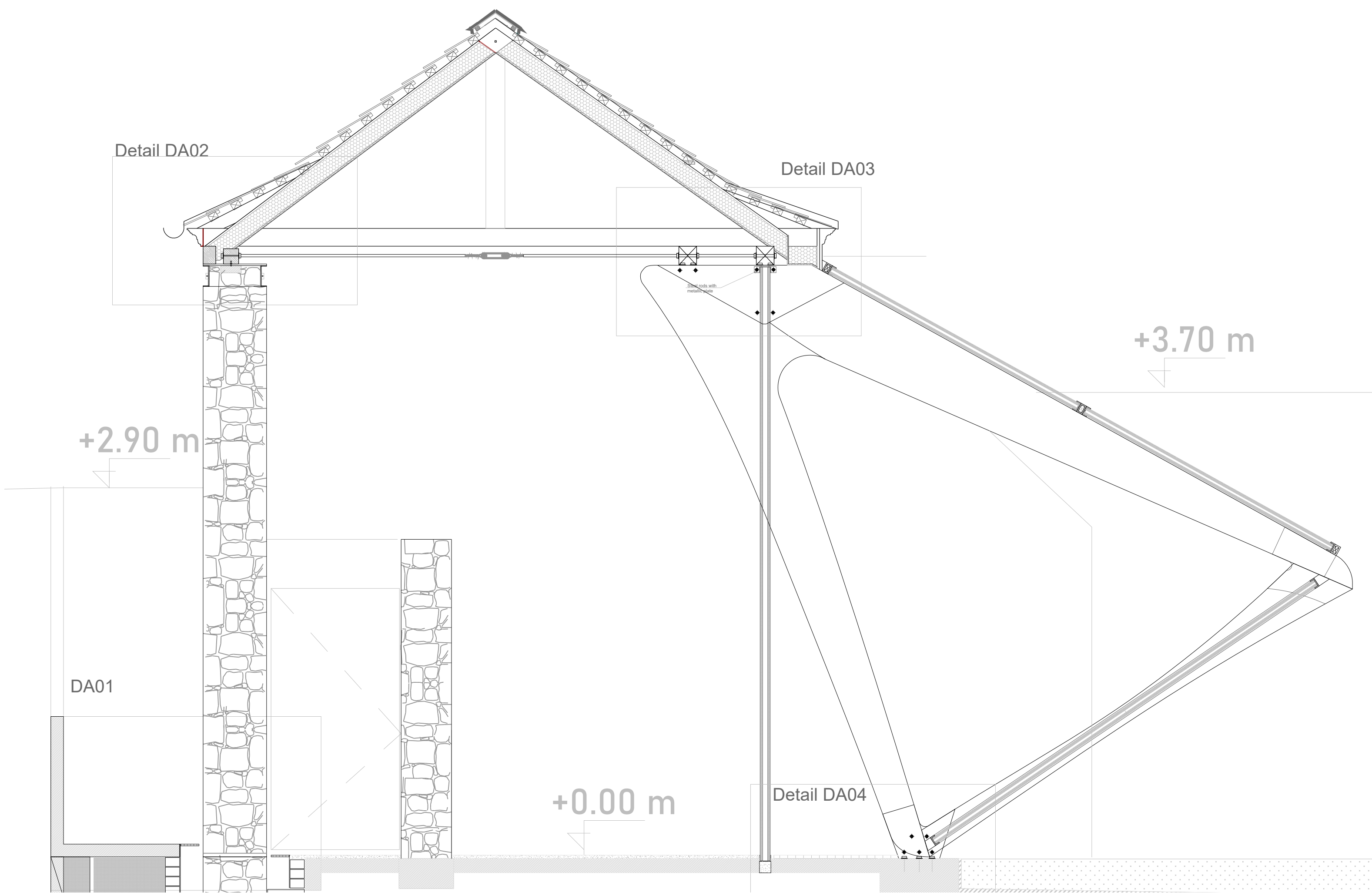
FW-100
West facade

SCALE 1:100
0 1.25 2.5 3.7 5

FE- 100
East facade



TRANSVERSAL SECTION



CT-50

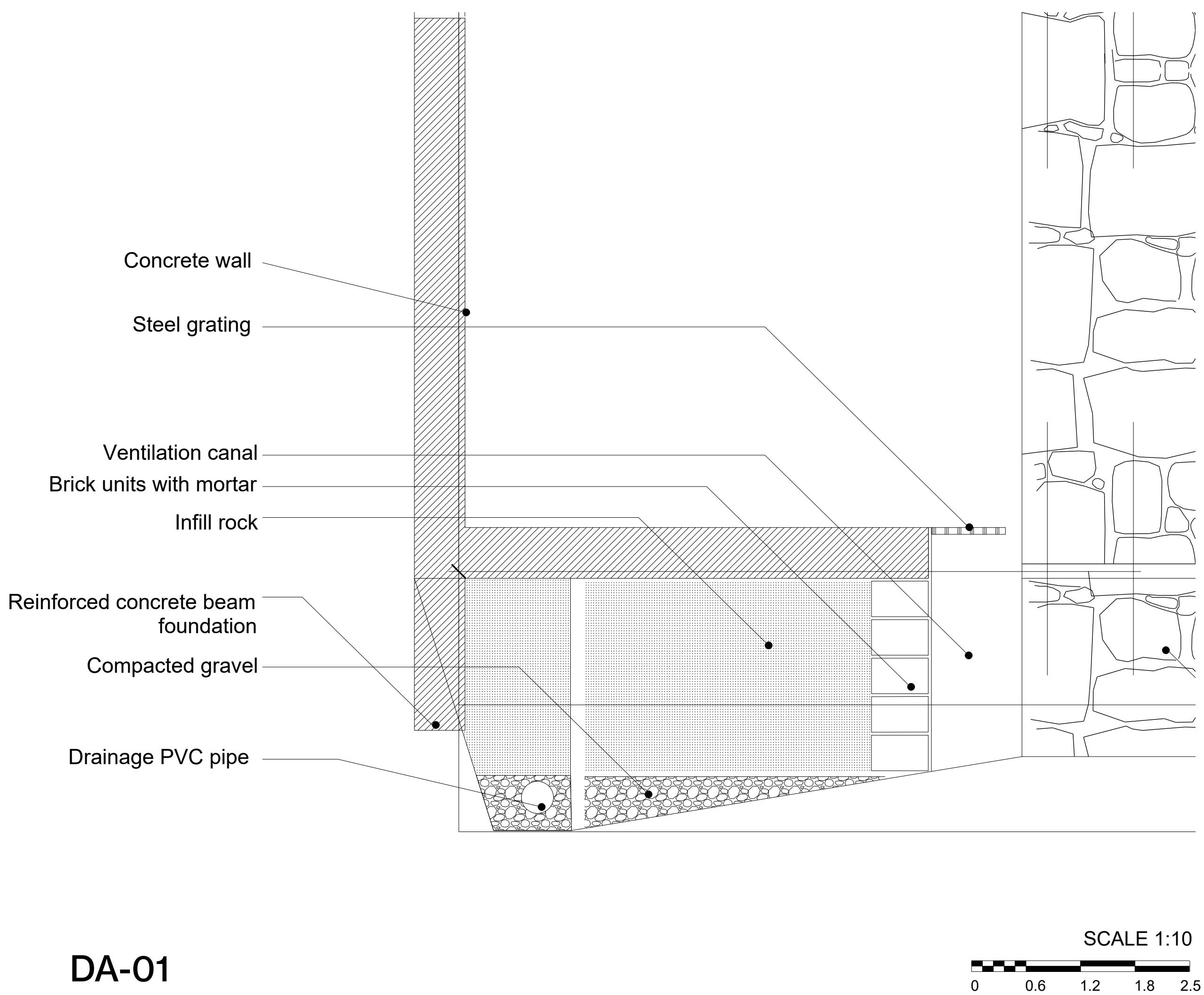
SCALE 1:50

0 2.5 5.0 7.5 10

Arquitecture Detail 01
Masonry Foundations

The perimetral opuka walls have masonry foundations from 30 to 40 cms below ground level. This buried stone is now damaged due to rising damp of underground water table. Therefore it is necessary to implement a passive ventilation technique which consists in making air ventilation canals along the perimetral walls. This air ducts will avoid the direct contact between the masonry stone foundation and the water from the soil in its surrounding.The channel is based over a small concrete template and built with brick units binded with mortar and a waterproof layer of hydraulic lime.

It is also important to consider the pre existing adjoining ditch which will be reinforced with a concrete beam as a base, that will help settle the pre existent wall over diferent types of infill, gravel and soil that will be poured underneath this concrete wall in order to drain the accumulated water around the masonry walls and foundation. On the inside of the building the ventilation allows the pass of the air through open steel gratings and a dilataion gap that is left so the materials can contract and dilate without creating any tensions or streesses in the walls.

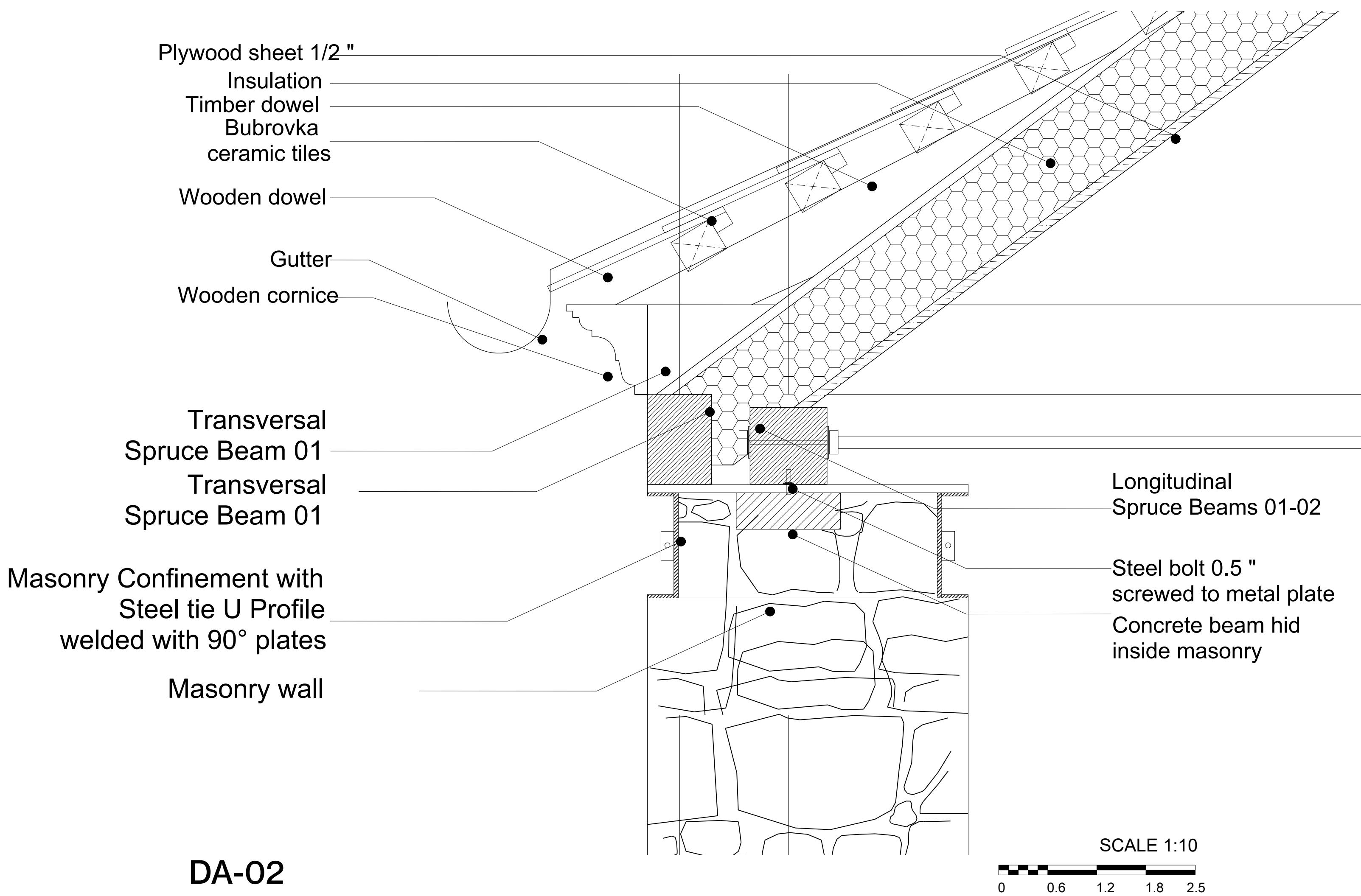


DA-01

Arquitecture Detail 02
Timber roof with masonry wall

The top part of the masonry walls needs to be stabilized due to material loss and degradation of the opuka stone, which throughout the years without any maintenance, has left an uneven degraded surface of stone and rubble.
This masonry confinment belt of 17 cm of height, is made by a U Steel profile on both faces of the wall anchored in the corners with steel plates. Along with repointing and grouting techniques within the masonry structure. This ties compact the opuka masonry walls from both sides , creating a stable and leveled element that acts as a beam where the timber trusses of the roof will be resting.

Bubrovka roofing it's a traditional Czech clay based tile system that is supported on wooden-batten that run along the longitudinal section of the main timber trusses. Underneath the Bubrovka system there are two plywood sheet that hold from both sides the insulation layer composed of a light polyestiren foam. The pre existen spruce trusses rest over two timber beams ,that run along the entire lenght of the wall connected with a dowel tail joint.



DA-02

Timber truss system

The pre existing roof has a simple timber truss system .The supporting structure of the roof consists in two timber spruce beams. In the bottom part, the beams are fixed by anchors that are properly attached to the confined masonry belt *. This beams have a small gap between the masonry surface provided by a waterproof mesh that keeps away the humidity from the structural wood element. The extension of this beams over the perimetrall walls create a cornice ,complemented with an inclined element called flange , which its attached to both extremes. This element gives a second inclination to the bubrobka roofing system, that ends in the gutter. The woodenbeams should be properly reinforced at the top part by means of wood boards nailed from the top down with the specified inclination.

Fig 63: Simple wood truss system with and without flange

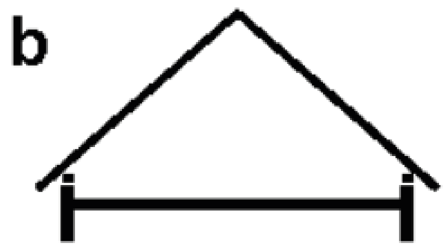
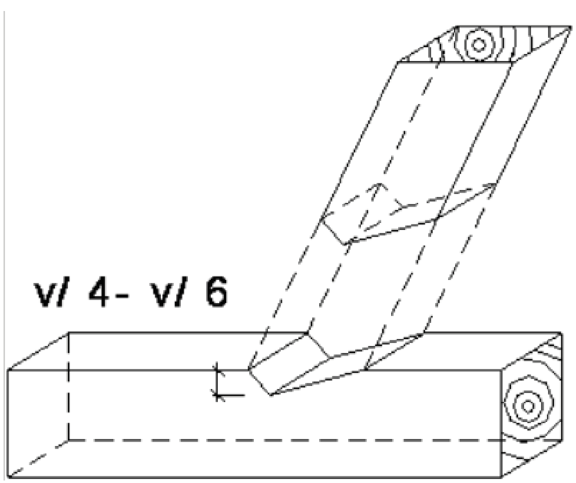


Fig 62 : Dovetail joint or front notch



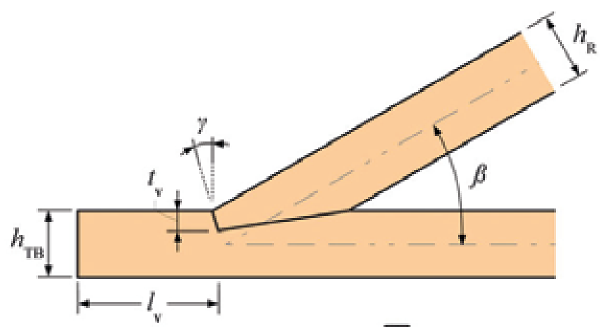


Fig 64 : Traditional roof truss and rafter and the tie beam connection.

This connection structurally will be considered as Hinged (internal forces acting upon it are the axial compression in the rafter, the tension in the tie beam and the supoport reaction) and comprises the definition of load paths between members, by decomposing the thrust from the rafter in components perpendicular to the notched surfaces and by defining appropriate shear surfaces to accommodate those stresses.

Fig 65 : Simple front notched connection without metal parts

Arquitecture Detail 03
Timber roof with new timber structure

This intersection point describes the conection detail between the pre existing roof structure and the new designed timber structure.

The designed member works as an slanted column that carries the loads down of the timber & glass roof , creating a structural frame through a tensioned steel rod cthat conects both ends of the wood beams to the masonry wall.

Timber beams A & B run longitudinal in the roof's direction. This are fixed on its base with steel plates that are inserted on the top edge.
In the spans of the new timber structures there is the glasing windows of the main entrance, The top canal is fixed to the B beam as the top windowsill.
The extension has a double glass roof structured by aluminium profiles .

A waterproof steel shet is placed in the left open spaces below the wood cornise and the glass roof, to avoid any contact with outdoor agents like rain, snow or dust that can damage the new conections between the repaired wood and the new wood.

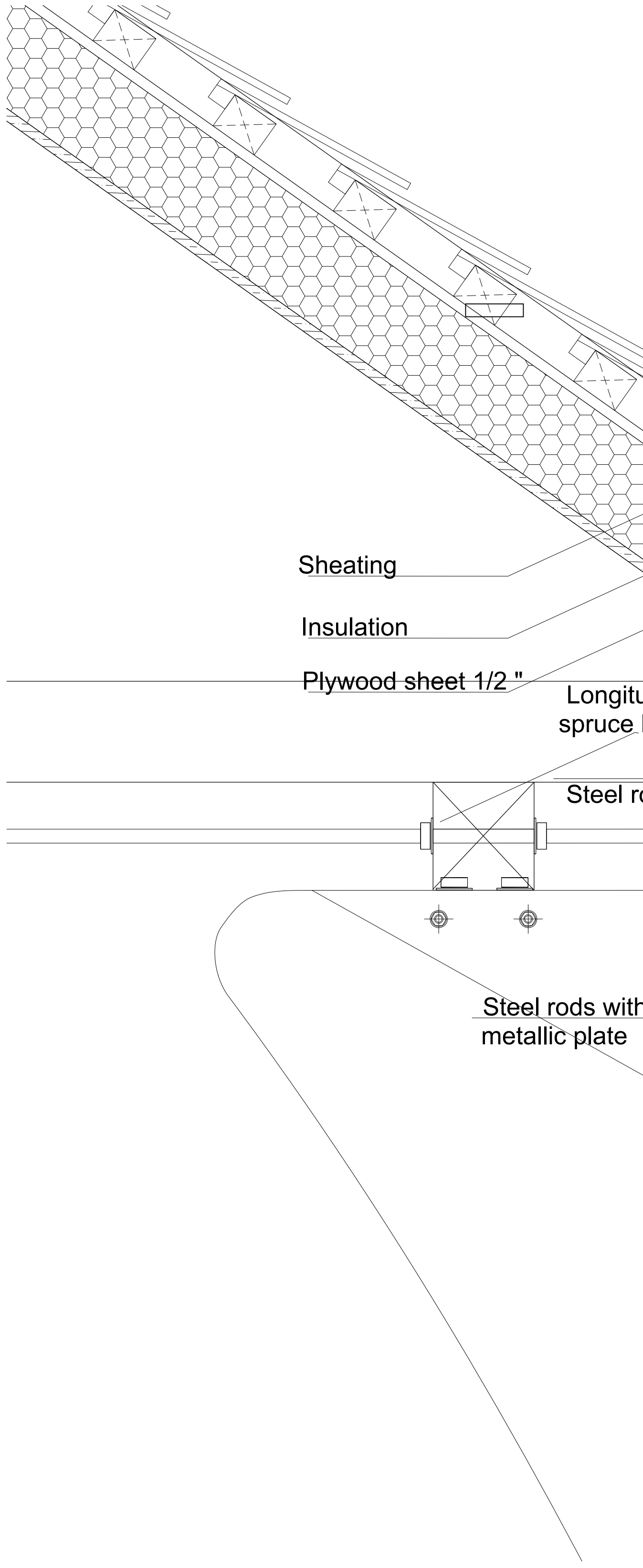
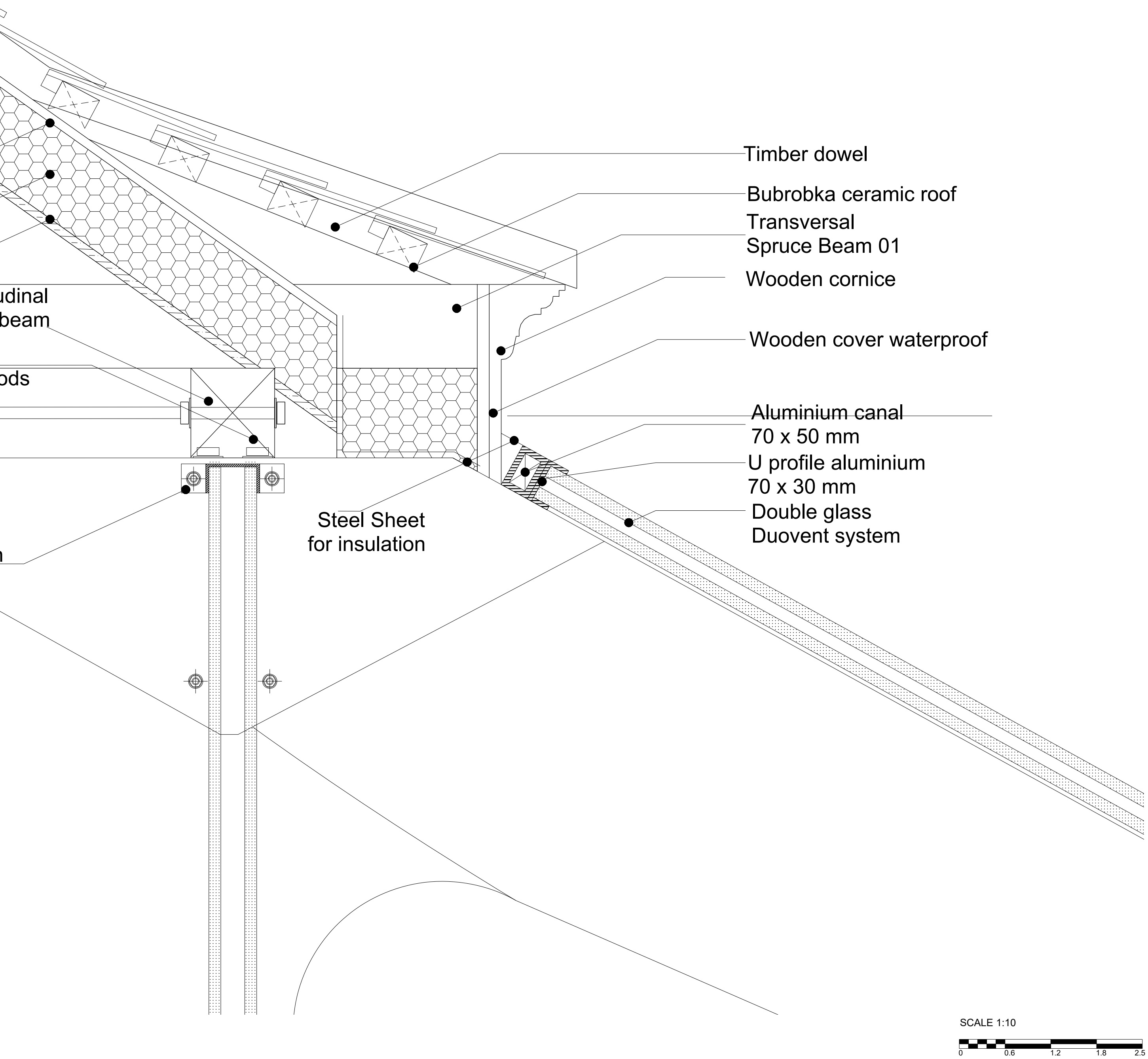


Fig 66 : Traditional roof truss and rafter and the tie beam connection.

DA-03


Timber dowel
Bubrobka ceramic roof
Transversal
Spruce Beam 01
Wooden cornice
Wooden cover waterproof
Aluminium canal
70 x 50 mm
U profile aluminium
70 x 30 mm
Double glass
Duovent system
Steel Sheet
for insulation
udinal
beam
ods
SCALE 1:10
0
0.6
1.2
1.8
2.5

Arquitecture Detail 04
Timber structure with foundation

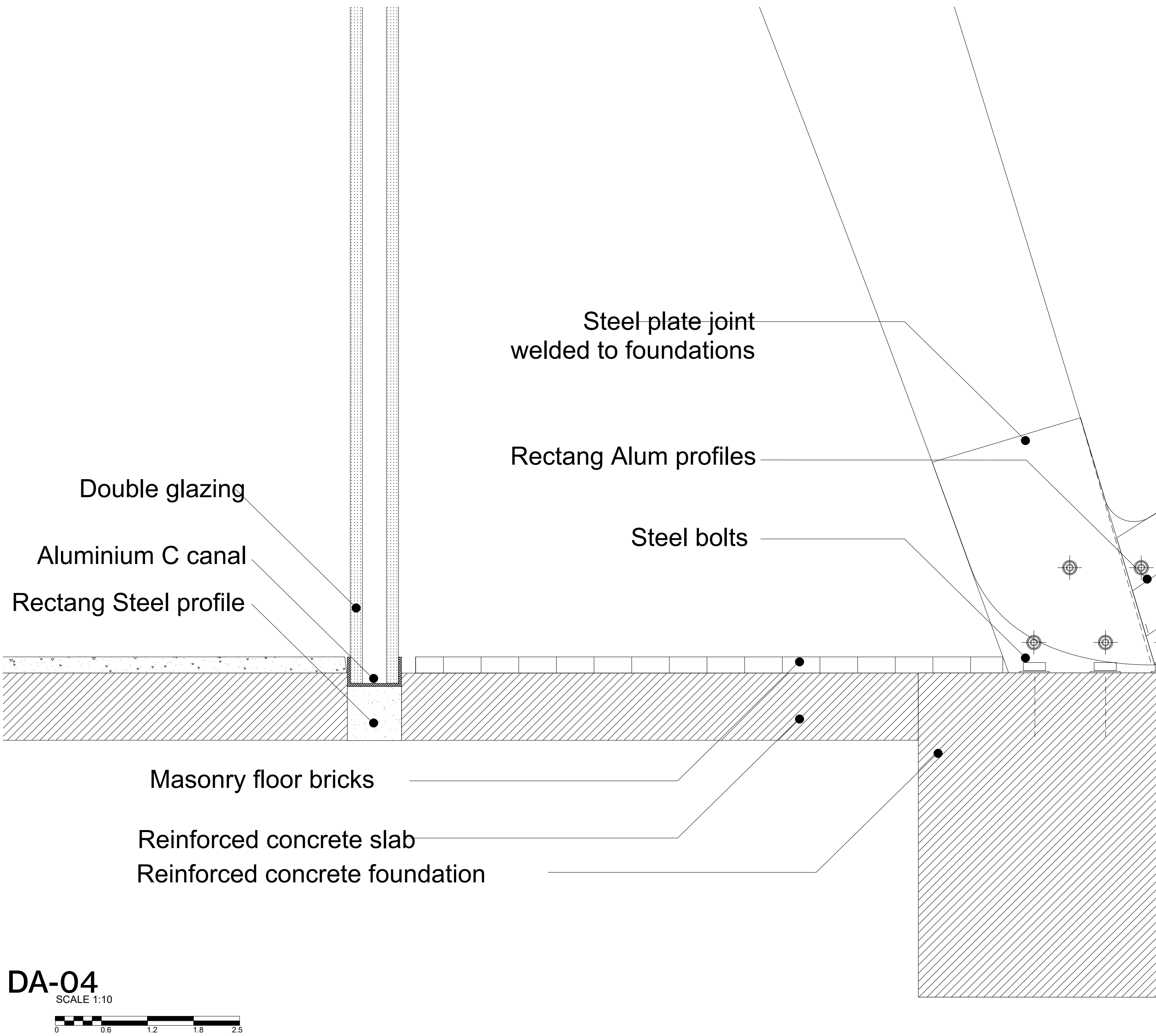


Fig 67 .The metalic plate inserted within the timber members is screwed outside with metalic bolts Leaving an offset of 5 cm outline outside of the timber members

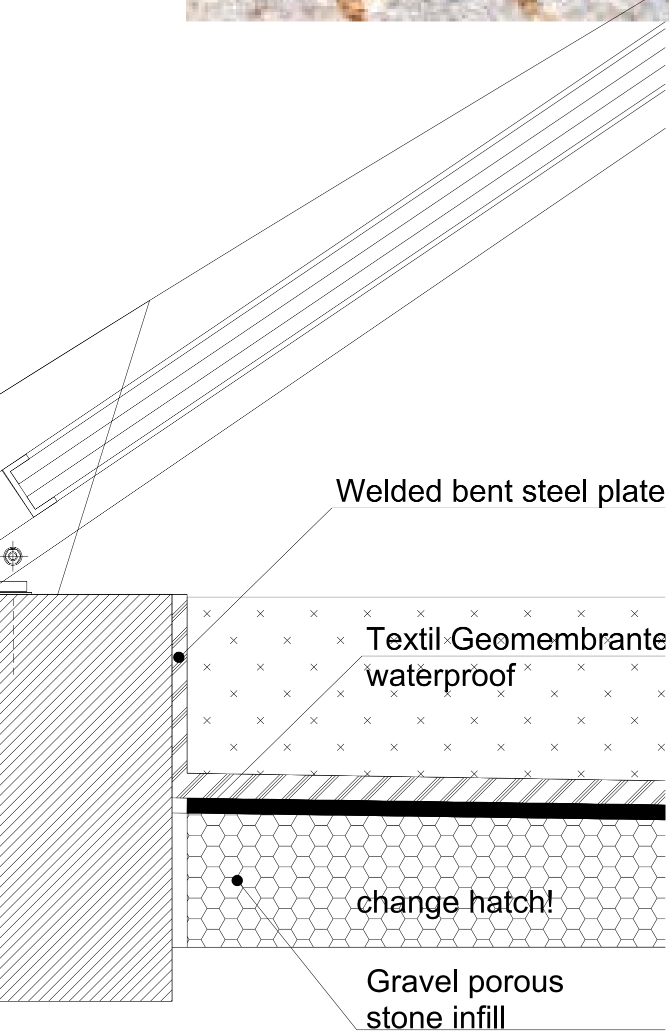
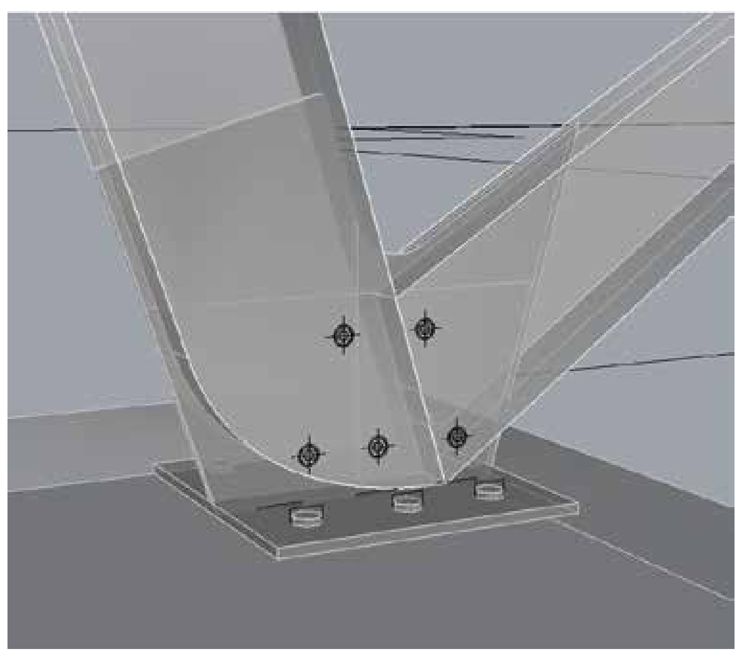


Fig 68. 3D view of steel plate connecting foundations with timber elements.



8. STRUCTURAL ANALYSIS

The new structure adds a permanent load bearing element that replaces the previous timber strutts thatdistribute the loads of the timber roof to the ground. It opens the possibility of having bigger spans for an open space distribution with higher ceilings. The design of this structural system is calculated to hold the loads of the existing wooden trusses with ceramic roof and the glassing for the extension in timber.

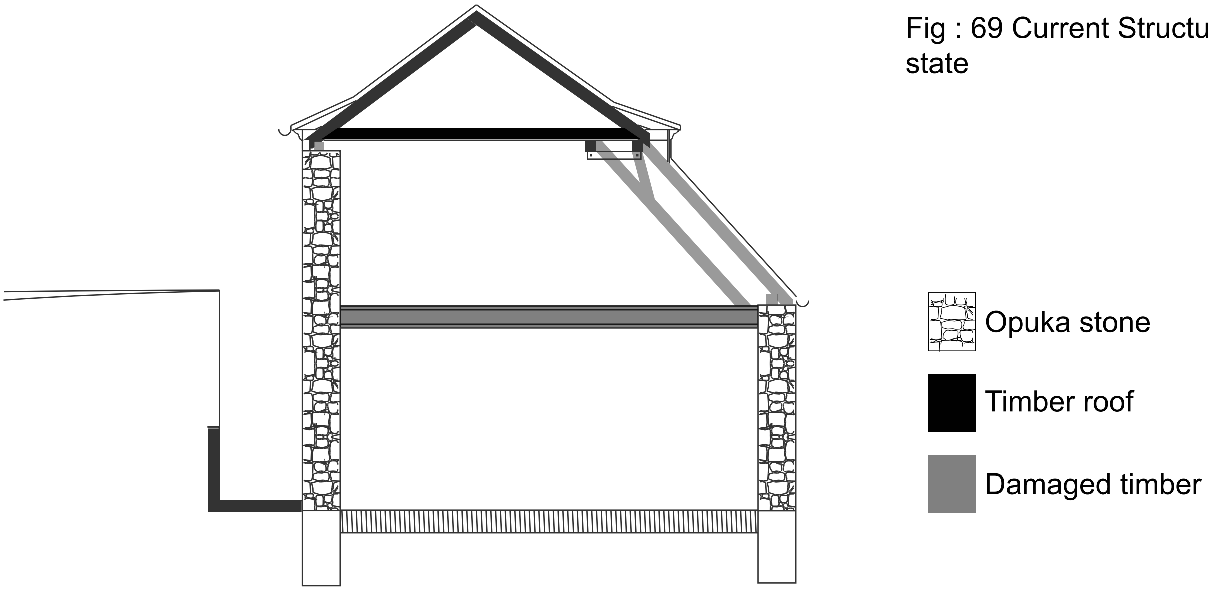
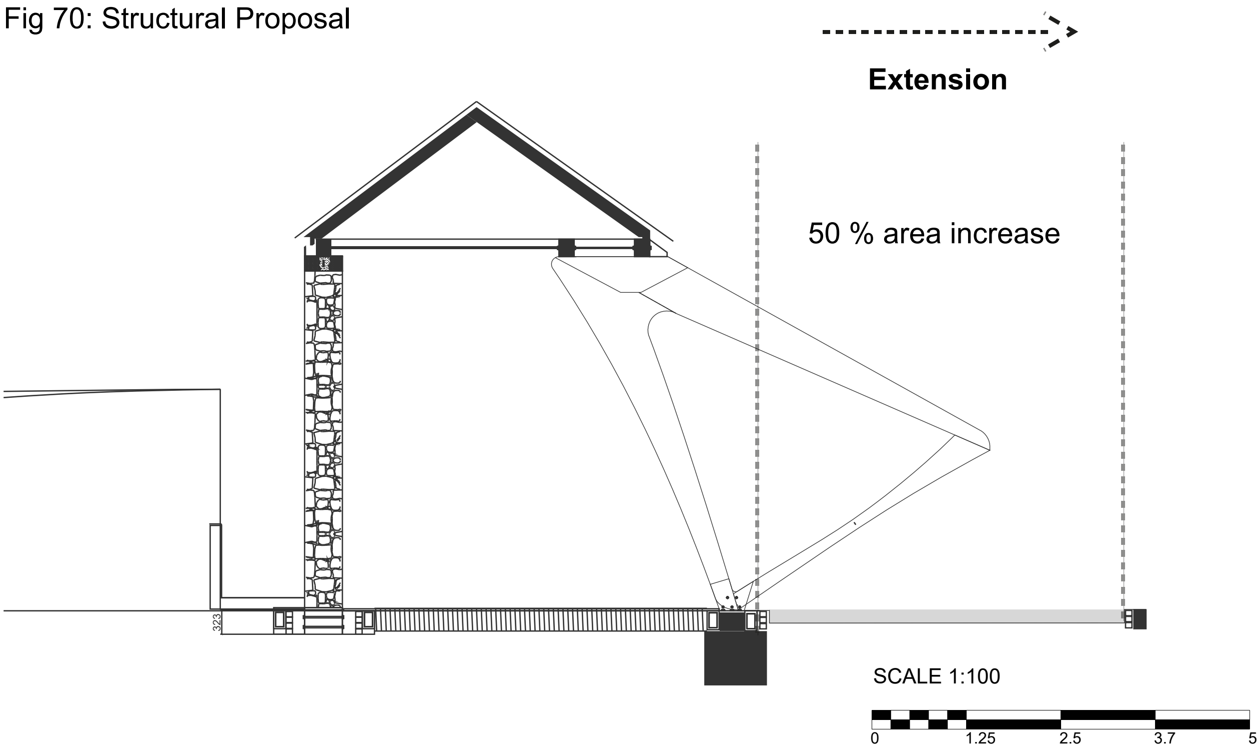


Fig : 69 Current Structural state

Fig 70: Structural Proposal

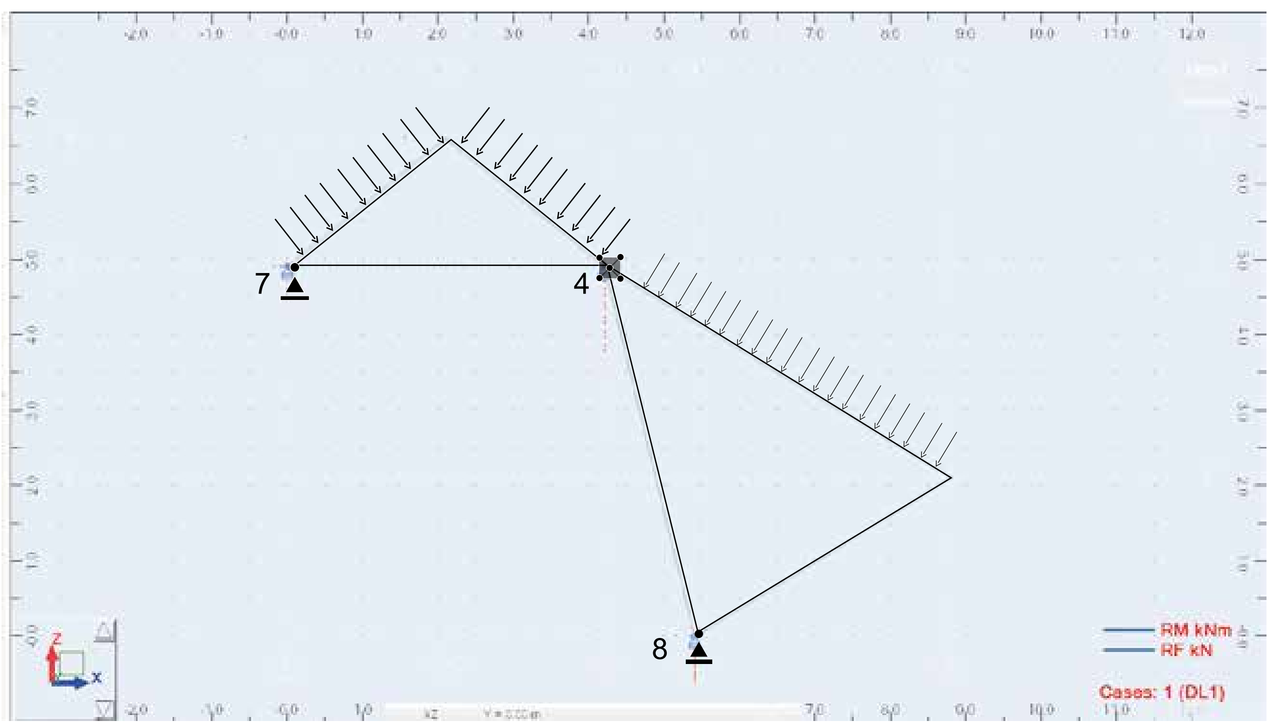


In order to stablish correctly the boundary conditions in the model, first it's necessary to understand which timber members are connecting the structure to the masonry walls and to the ground.The pre existent timber truss has a longitudinal beam that carries the loads of the roofing system down to the masonry walls and then to the ground. For the model of the structural frame the support in this side was asigned at the top of the masonry wall, where this beam rests.
This conection was asigned as pinned. The pinned support has two support reactions and these are vertical and horizontal reactions. It allows the structural member to rotate but does not allow translating in any direction. The pinned support allows the rotation only in one direction and resists the rotation in any other direction. On the right side of the support of the timber roof there is a point of interaction that will be detailed further on.

Support name	List of nodes	UX	UZ	RY	BETA (Deg)	KX (kN/m)	KZ (kN/m)	Hy (kNm/De
Pinned	7 8	fixed	fixed	free	0.0	0.0	0.0	0.0
Interaction point	4	free	free	free	0.0	0.0	0.0	0.0
Fixed		fixed	fixed	fixed	0.0	0.0	0.0	0.0

Table 8: Supports asigned in Robot

Fig 71 : structural frame made in robot autodesk with supports and loads illustrated



Supports : Pinned conection
Point of interaction

Loads : Dead weight, roofing
Uniformly distributed

SECTIONS & MEMBERS GEOMETRY

For the structural analysis, the design of the timber structue frame, was modelled with Robot Autodesk software in order to understand the overall beahviour of the structure obtaining the internal forces such as reactions, moments, stresses and most important the maximum deflections or displacements in the members of the structure.The final results obtained out of this numerical model , followed the next procedure.
Geometry; definition of main axis of the structure, that will create the framework for locating the members of the structure, loads and supports. Having created this grid, two diferent type of members were created . The pre existing ones, made in spruce with its original section of 160 mm height by 140 mm width, and the new timber elements with tappered sections. This shape derived as a result of several tests , in order to make it stiffer and less prone to deformations and deflections. By designing this tappered elements the structure has a better optimization and use of the material. In this case the geometry was simplified to get a wider and slender section at the beginning and end of the elements.

Pre existent timber members		New Timber Members			
# Element	section (mm)	# Element	width (mm	Height (start)	Height (end)
1	140 x 160	4	100	820	250
2	141 x 160	5	100	578	220
3	142 x 160	6	100	410	200

Table 9

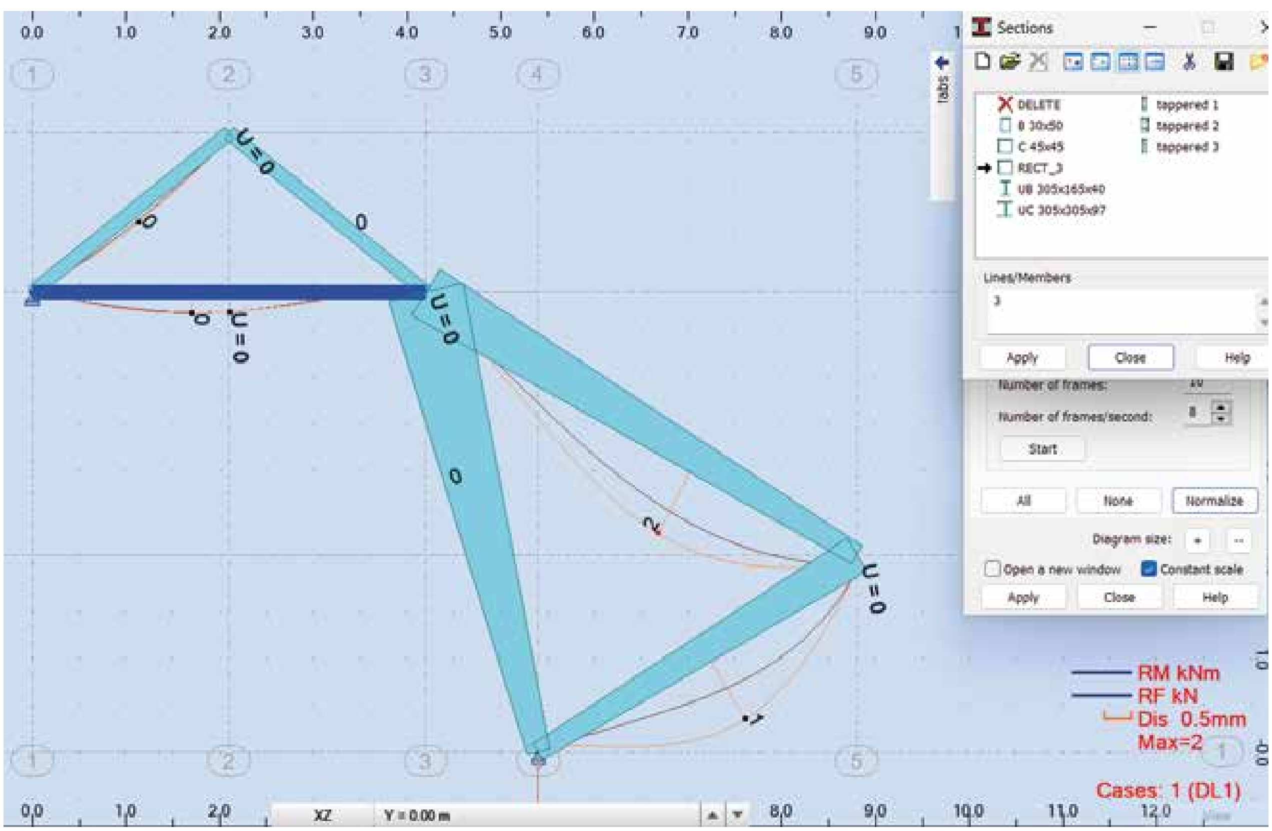
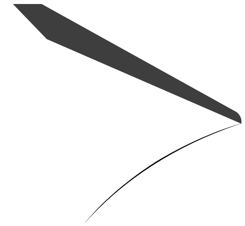


Fig 72 : Diferent cross section between original timber truss and new timber structure with tappered sections.

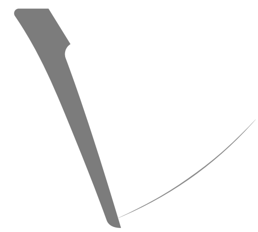
STRUCTURAL DESIGN

The function of the new timber structue is to add a load bearing element that will help distribute the loads of the pre existing timber roof from the masonry wall ,and also the loads from the new glass roof of the extension. The shape of this frame is the result of an iteration process that seeks to continue the inclination of the traditional roof in order to create more space for the new demands of wine tasting and shop. This design opens the possibility of having bigger spans with an open layout distribution with higher ceilings and bringing more light to the interior with a full glass cover. The next diagrams show how this system work in section.

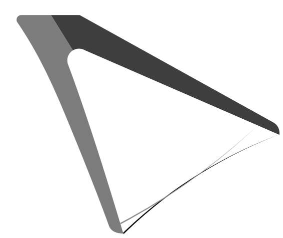
Top element acts as beam

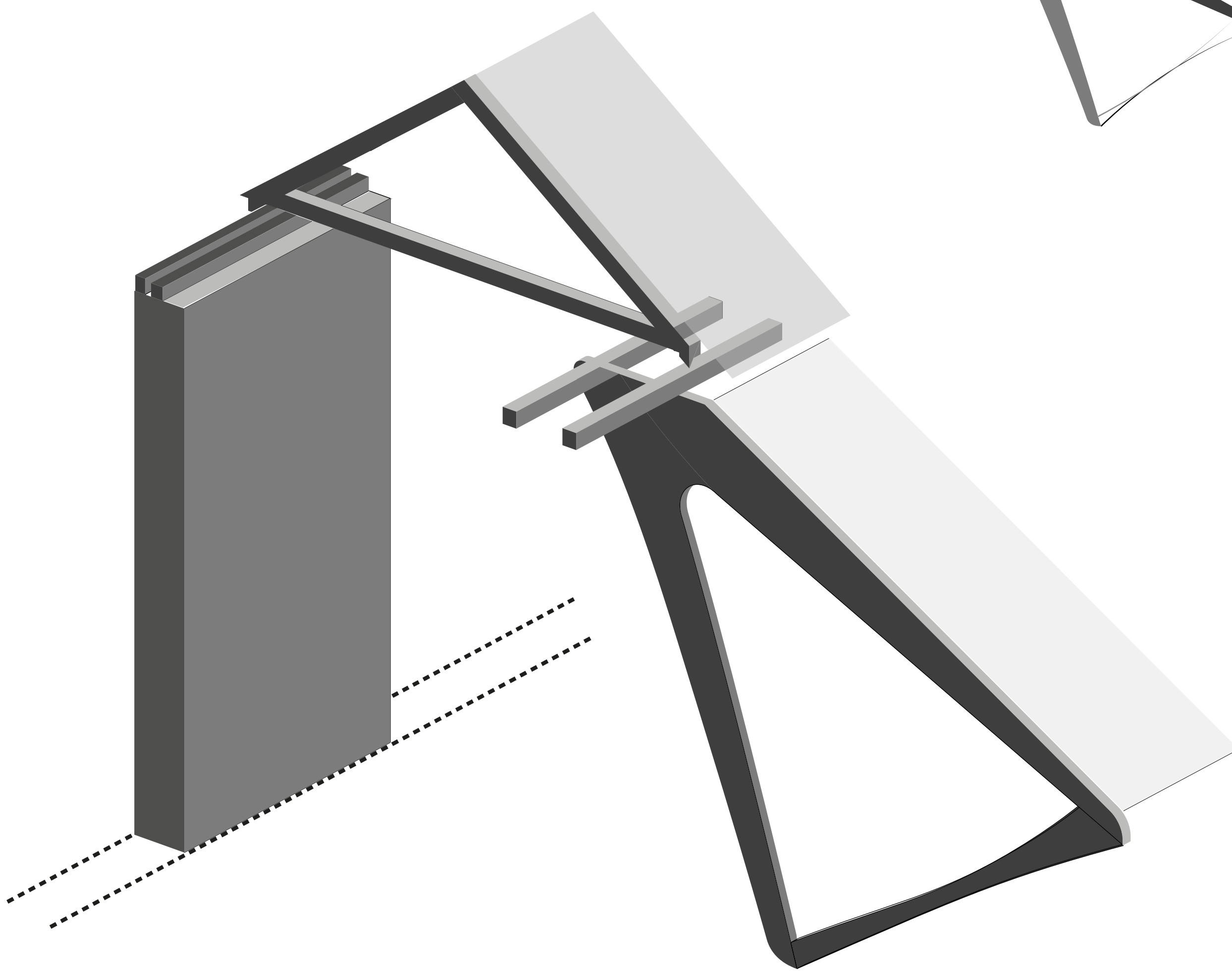


Bottom element acts as column



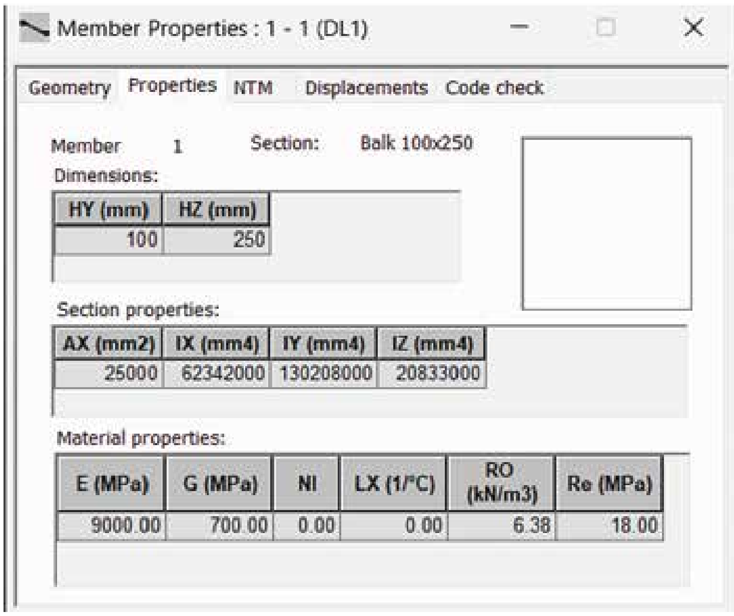
Link or connection





MATERIAL PROPERTIES

Having made the visual inspection and mechanical tests on the timber trusses it is concluded that for structural analysis porpouses the conserved elements have the same characteristics as a timber C24, which comply with the Eurocode 1995.
Within Robot software all the timber members were asigned with this same properties, for pre existing elements and for new ones, only modifying the geometry in sections for the tappered members of the new structure. The Eurocode considers the next properties to be meet by this members.


Member Properties : 1 - 1 (DL1)

Geometry | Properties | NTM | Displacements | Code check

Member 1 Section: Balk 100x250

Dimensions:

HY (mm)	HZ (mm)
100	250

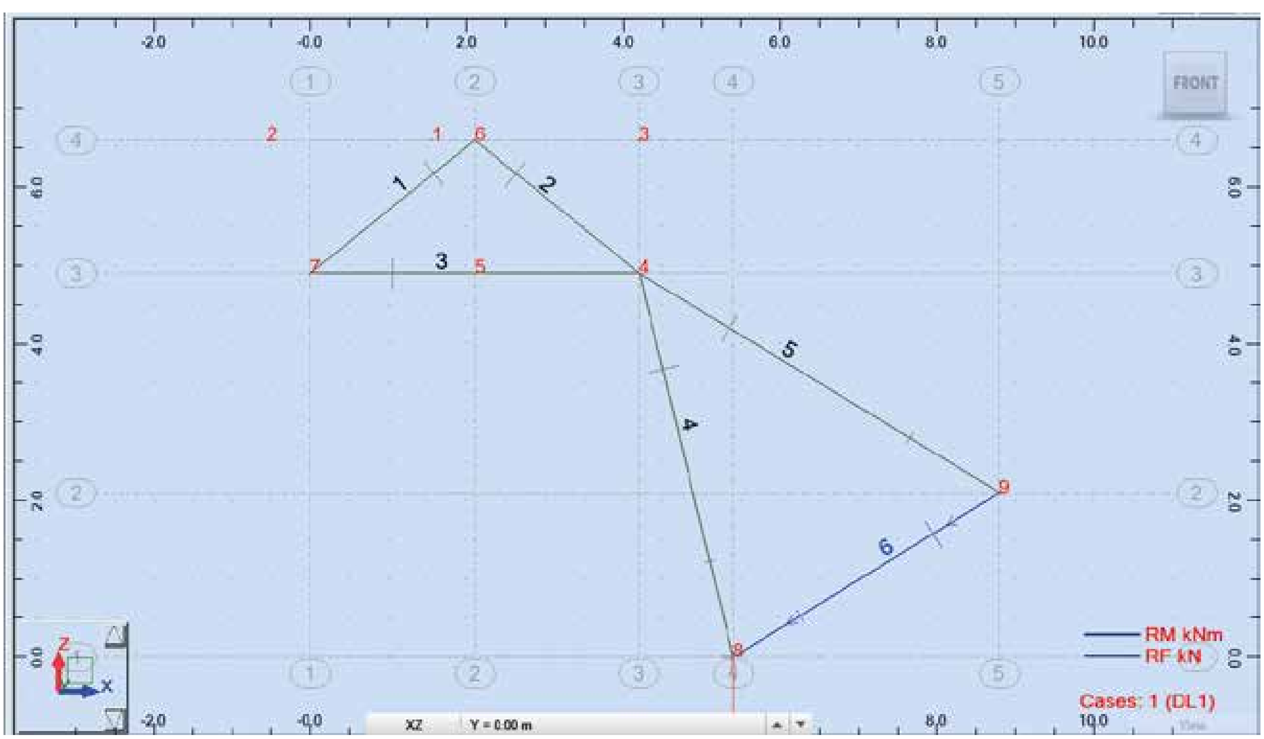
Section properties:

AX (mm2)	IX (mm4)	IY (mm4)	IZ (mm4)
25000	62342000	130208000	20833000

Material properties:

E (MPa)	G (MPa)	NI	LX (1/°C)	RO (kN/m3)	Re (MPa)
9000.00	700.00	0.00	0.00	6.38	18.00

Fig 73 : Member Properties



LOAD DEFINITION

For thie calculations of the static analysis the type of loads considered were the dead load combinations from the two types of roof systems (traditional Bubrobka and double glass roof), along with the timber's structure selfeweight and accidental / incidential cases such as wind and snow. The load cases derived from a detailed design of all the elements that are embeded in both roof systems, were studied for the middle section of the structure, which is the one with bigger span and weight on it. Appart from this calculations for ULS (Ultimate Limit State) & SLS (Service Limite State) were also calculated in the software.

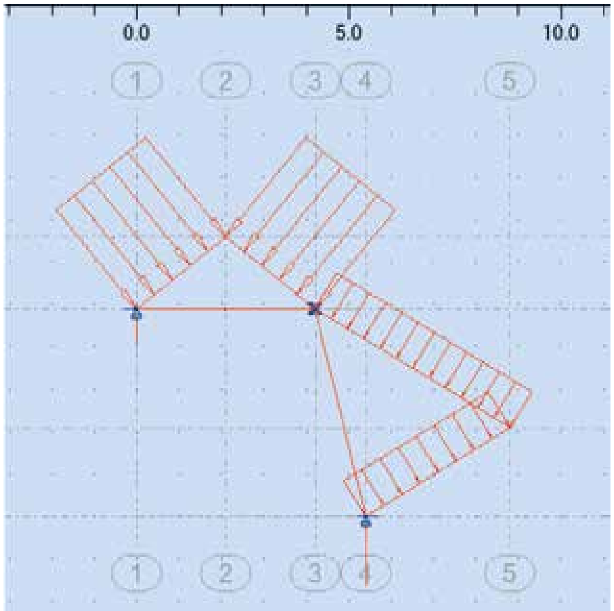


Fig 74: Deadweight Bubrovka & double glass

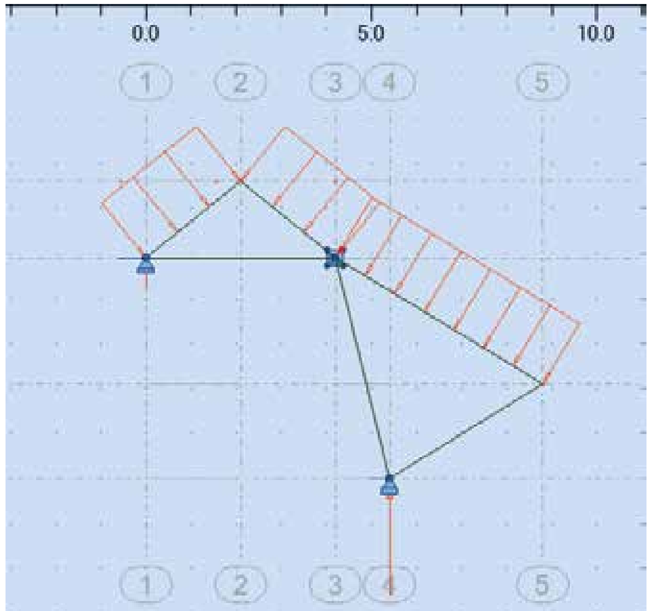


Fig 75: Snow weight, uniformly distributed

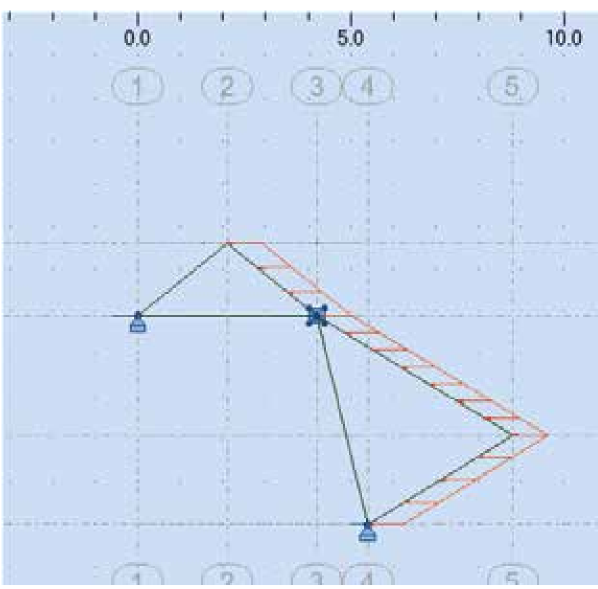


Fig 76 :East windws, lateral load

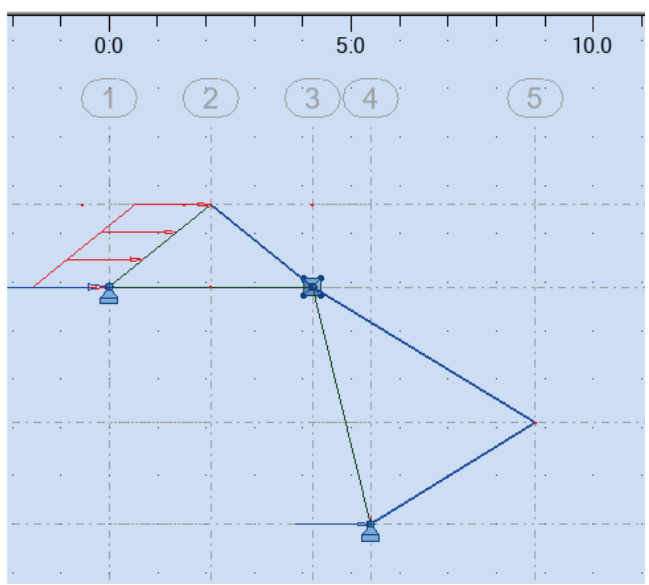


Fig 77:West windws lateral load

LOADS TABLE & COMBINATIONS

Table 10

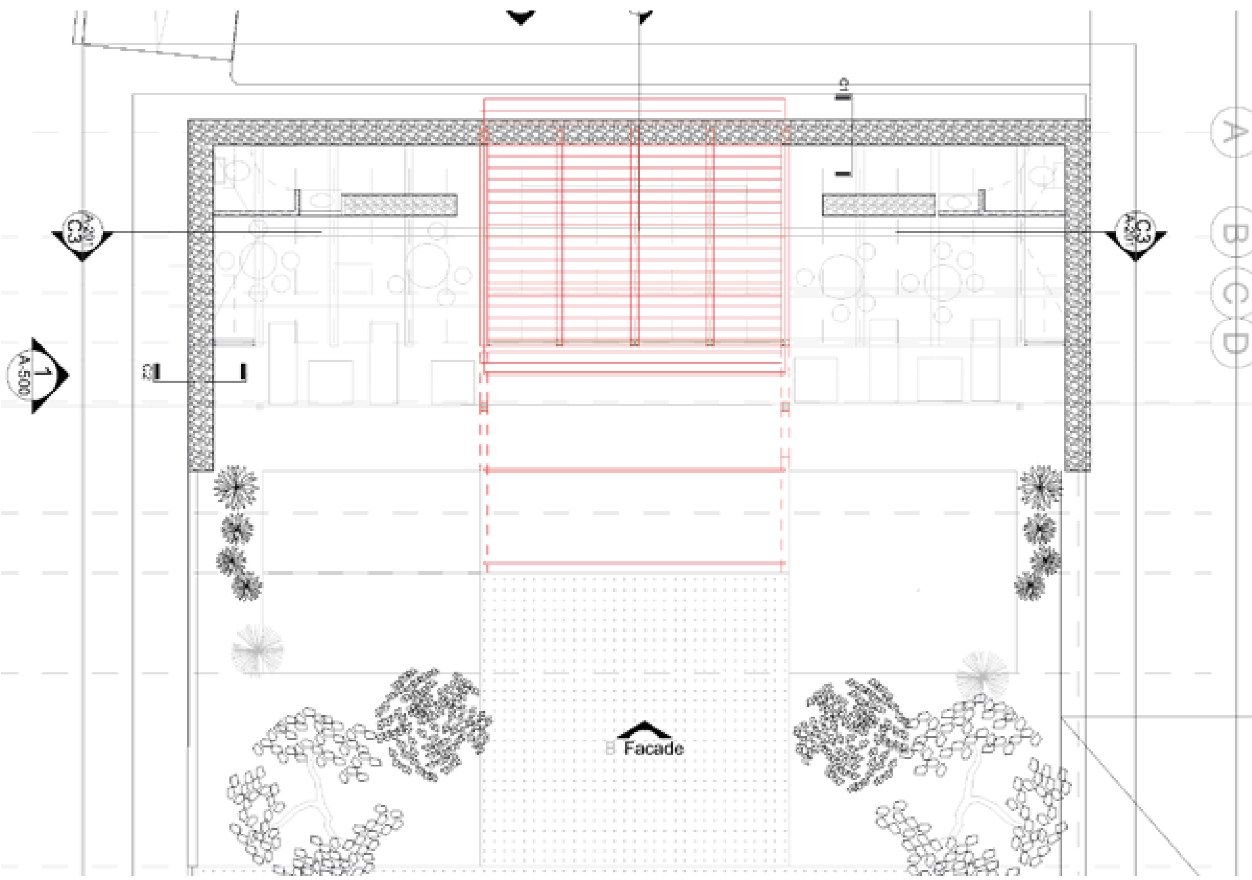
Bubrobka timber roof system				
Material	Weight (kg)	Area	Total Kg	Total Kn
Bobrobka tiles	519	8.25	620.68	6088.87
Roof battens	16.83	8.25		
Plywood (2 sheets)	64.35	8.25		
Insulation	20.5	8.25		

New structure with glass roof				
Material	Weight (kg x m2)	Area	Total kg	Total KN
Double Glass roof syste	30	8.25	206.25	2.02331
Rectangular steel profile	16.83			
L steel profiles	64.35			
Glass weight (kg) = Glass area (m2) x Glass thickness (mm) x Factor (2.5)				

Table 11

Case	Load type	List								
1:DL1	self-weight	1to6	Whole structur	-Z	Factor=1.00	Normal	MEMO:			
18:WIND6	uniform load	2 5 6	PX=-1.00	PZ=0.0	global	projected	absolute	BE=0.0	DZ=0.0	MEMO:wind to
1:DL1	uniform load	5 6	PX=0.0	PZ=-2.00	local	projected	absolute	BE=0.0	DZ=0.0	MEMO:glass
19:DL7	uniform load	1 2	PX=0.0	PZ=-6.10	local	projected	absolute	BE=0.0	DZ=0.0	MEMO:BOBR
8:SN1	uniform load	1 2 5	PX=0.0	PZ=-1.00	local	projected	absolute	BE=0.0	DZ=0.0	MEMO:snow

Fig 78: Roof plan middle section



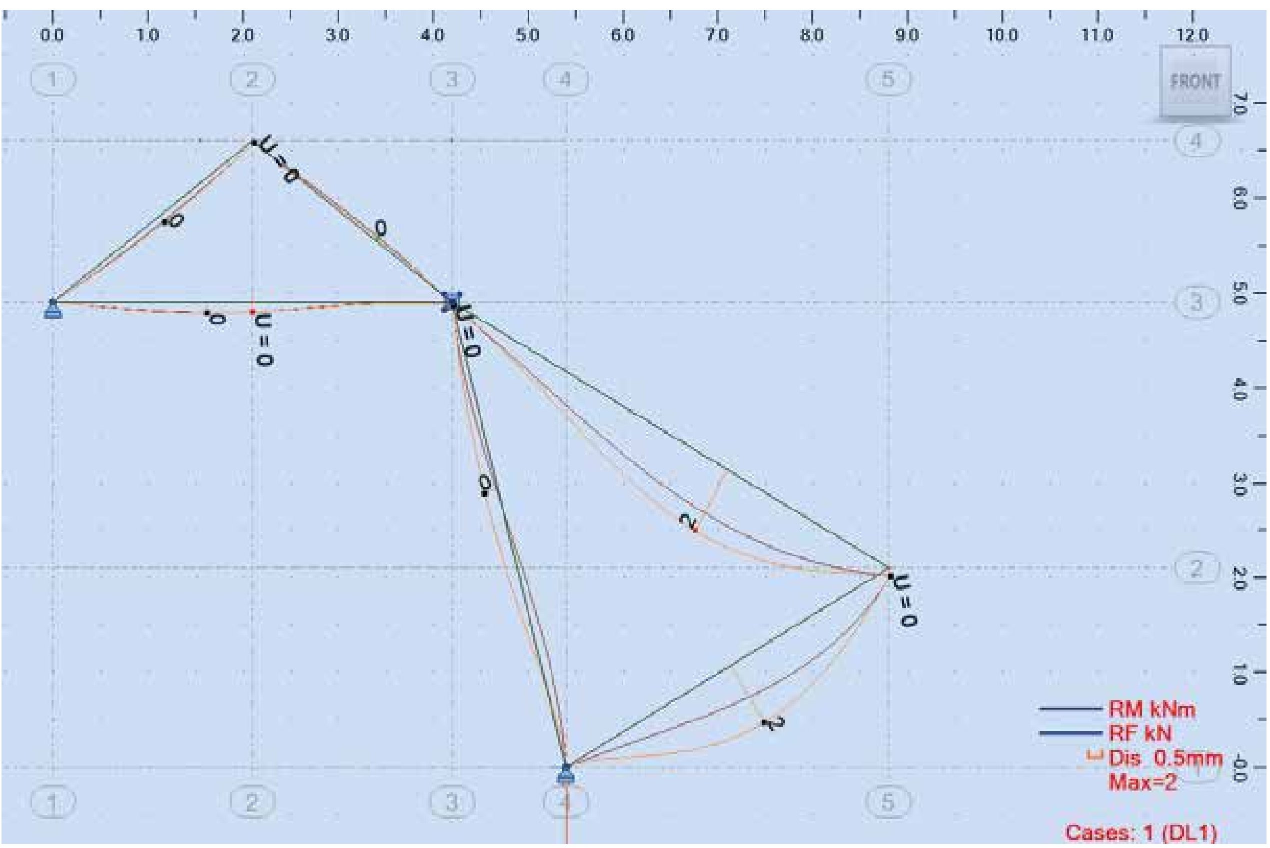
DEFLECTIONS & DISPLACEMENTS

One of the most practical results to know if the structure is stable or not , are the displacements of the nodes and members of the design. Therefore under the previous asigned loads Robot makes the calculations for this loads and also for ULS AND SLS which combine other factors take in consideration like fire, wind, snow,etc. For this analysis the results observed where the structure has the biggest deflections is member 4 and 6 each with 2 mm of displacement. The software also helps visualizing the deformed shape of the structure in an exagerated way to fully apreciate milimesimal behaviour of the frame. For this case 2 mm of displacement complies with an acceptable deformation from Eurocode 5 which states that the maximum displacements in timber elements can be up to .....
This analyisis can be complemented with the verification of each timber member under ULS and SLS.

Table 12: Member verification for SLS and ULS

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(uz)	Case (uz)	Ratio(vx)	Case (vx)	Ratio(vy)	Case (vy)
1 Member_1	RECT_3	TIMBER	62.40	62.40	0.75	19 DL7	0.00	DL7	0.40	(1+0.6)*1 + (1+0.6)*	-	-	-	-
2 Member_2	RECT_3	TIMBER	62.40	62.40	0.69	19 DL7	0.00	DL7	0.18	(1+0.6)*1 + (1+0*0.	-	-	-	-
3 Member_3	RECT_3	TIMBER	96.99	96.99	0.23	19 DL7	0.00	DL7	0.19	(1+0.6)*1 + (1+0.6)*	-	-	-	-
4 Member_4	tappered 3	TIMBER	32.66	174.76	0.68	1 DL1	-	-	-	-	0.00	WIND6	0.00	WIND6
5 Beam_5	tappered 1	TIMBER	46.75	185.55	0.41	1 DL1	0.00	DL7	0.12	(1+0.6)*1 + (1+0*0.	-	-	-	-
6 Member_6	tappered 2	TIMBER	45.39	138.43	0.53	1 DL1	0.00	DL7	0.16	(1+0.6)*1 + (1+0.6)*	-	-	-	-

Fig 79: Displacement diagrams in structural members and nodes

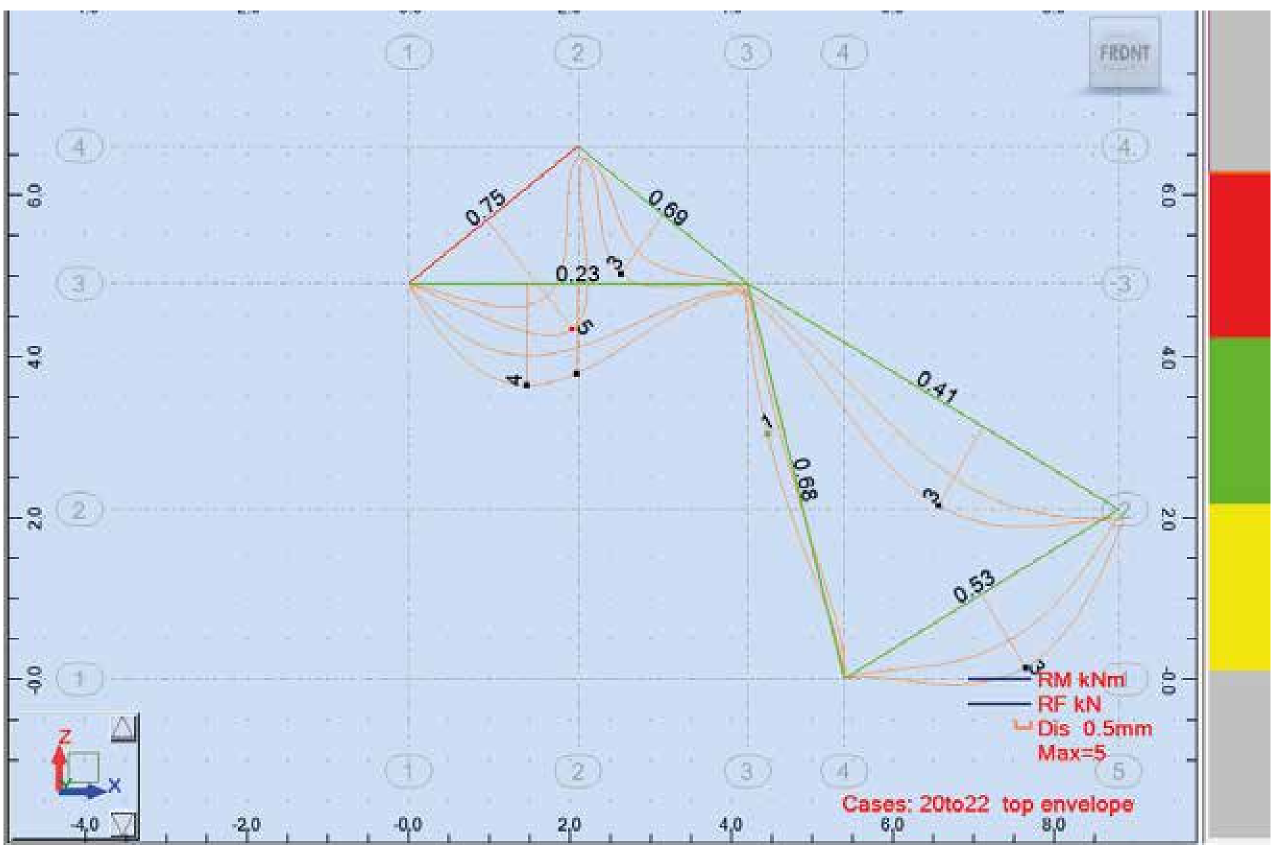


MEMBER VERIFICATION

Member verification applying Combination of actions - ULS fROM Eurocode 0

Introduction to EN 1990	Equation	Permanent $\gamma_{G,j}$	Variable (floor) $\gamma_{Q,1}$	Variable (wind) $\gamma_{Q,i}$
Combinations of Actions	6.10b	0.925 x 1.35 = 1.25	1.5 (Leading var.)	1.5 x 0.5 = 0.75
ULS	6.10b	0.925 x 1.35 = 1.25	1.5 x 0.7 = 1.05	1.5 (Leading var.)
SLS	6.10b	0.925 x 1.35 = 1.25	1.5 x 0.7 = 1.05	1.5 x 0.5 = 0.75

Fig 80 : ULS Code combination mapping on timber members



8. CONCLUSIONS

Since the beginning of the project with the atelier and the professors, several discussions were made regarding the number of features to preserve of the original structure on base with its state of conservation and heritage value. In this fashion these conclusions follow a criterion based on the original materials, architectural design, structural analysis and conservation principles.

Regarding the masonry walls , by combining different consolidation techniques for instance; grouting, repointing of joints with lime-based mortar and the addition of a confinement belt at the top of the walls, it’s possible to ensure a proper monolithic behaviour of the structure. It would be advisable to roof the building in such a way that the structure does not cause any horizontal reactions to the masonry, or so that the masonry itself is capable of horizontal load direction, for example in combination with beams. Furthermore, it would be advisable to cover the basics at least in the corner of the northwest side of the building and repoint or re-pave critical areas of the masonry, stitching or other crack fixing. After ensuring its stability follows the adequate maintenance to ensure this repairment. Conserving the exposed masonry helps preserve not only the shell of the building but also the urban image of the town and its surroundings. Which is a respectful approach towards a traditional town that also needs new development.

For the material characterization of timber, the analysis of critical sections and planning of interventions, it’s necessary to conduct further NDT and MDT that were not possible to realize due to time availability with the owners. To conclude in this matter it would be necessary to know the real resistance of each element to find the strength class of the timber. It is very important to assess the state of conservation of all the elements and to characterize its “natural” defects such as knots, slope of the grain, cracks, resin, or bark pockets, among others.

Regarding the architecture, the design of the extension and intervention takes the advantage of dealing with a non-listed heritage building, in which progressive ideas can be developed for a structural retrofitting with a contemporary geometry. The principle of form follows function is one of the criterions to validate the proposal, which is as response to a structural problem in which the shape follows the function of a permanent structural prothesis that will retrofit the whole structure to preserve the built heritage value of the building.

The structural intervention composed by the new timber elements and the steel rods that cross transversally to the masonry wall, joins back the original structural frame. Supported by new reinforced concrete foundations on the new elements, This retrofit ensures the desired box behaviour of the building and its safety to open as public space. The result of this intervention keeps the structural elements at sight. By exposing this, it also makes a differentiation between the preexisting elements and the contemporary interventions, which is desirable in any intervention on a historical building.

The proposed intervention also seeks to become a strategy for revitalizing any non-listed heritage buildings that currently are in a degraded state. The members can be recalculated based on specific loads and parameters of the property in question.

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10. LIST OF FIGURES

LIST OF PLANS

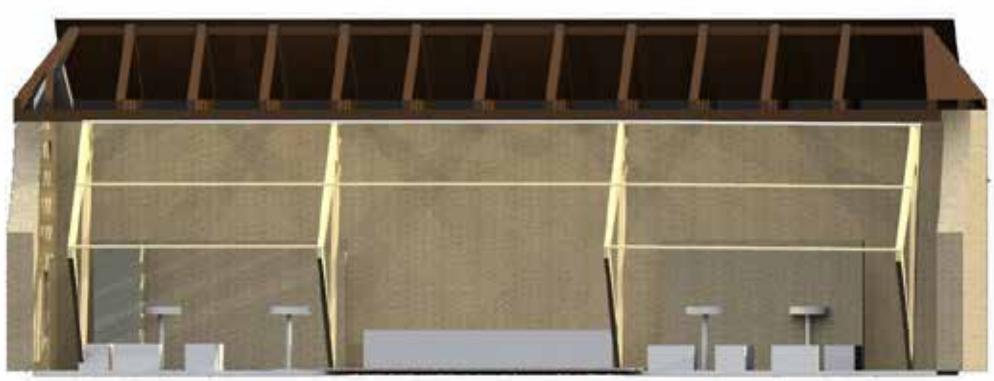
LIST OF TABLES

LIST OF GRAPHS

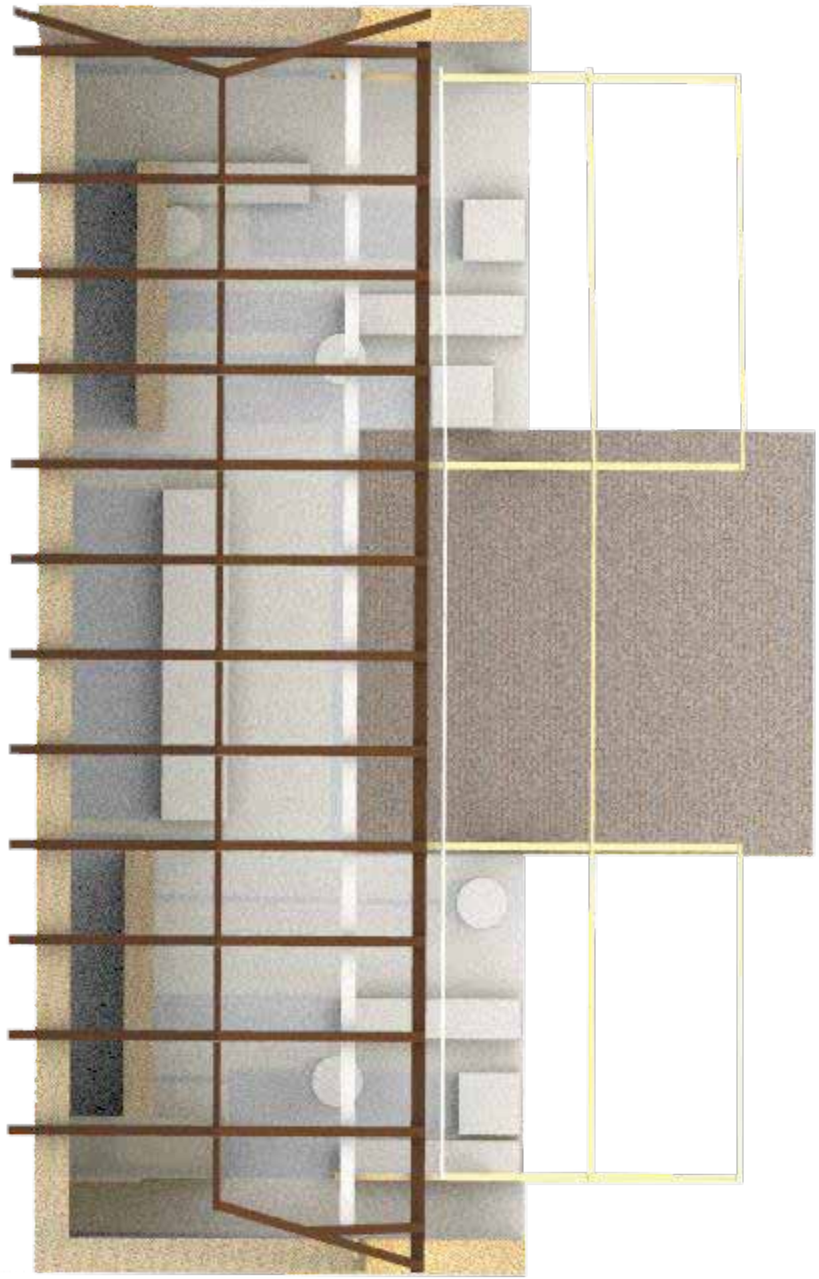
12.ANNEX

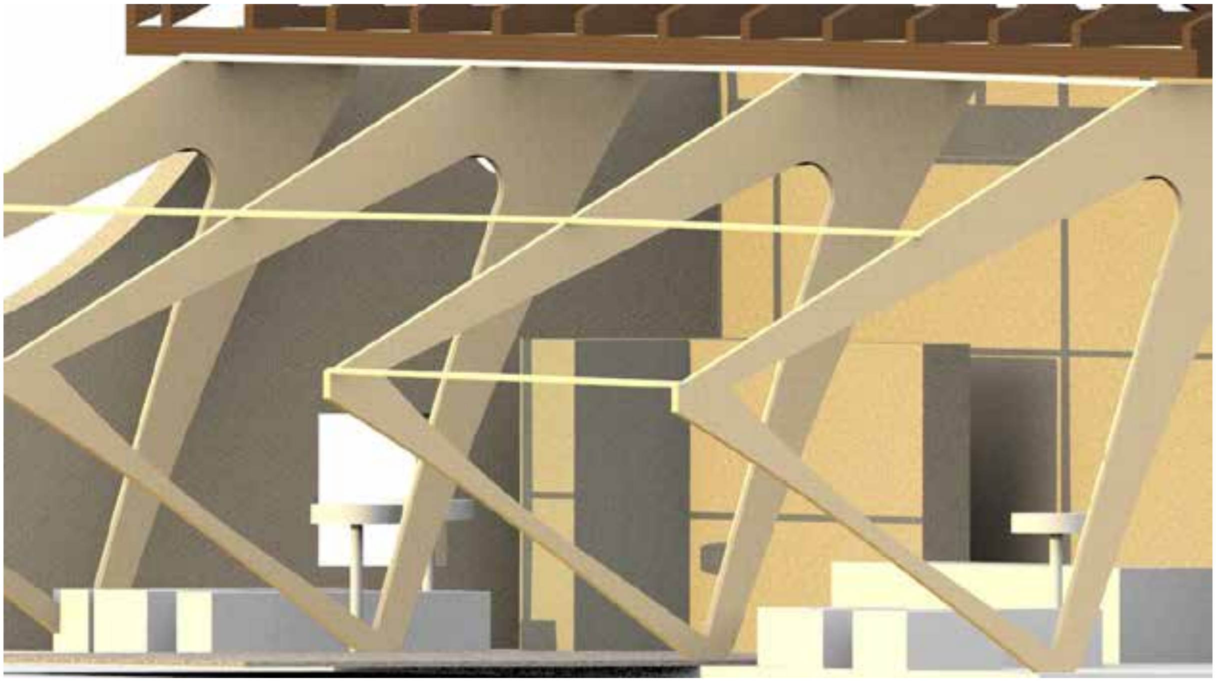
a. 3D model ortho view seen from the back, draft model

b. 3D model ortho view from west facade, draft model



c. 3D model ortho top view of ground floor,draft model





d. 3D model orthoview of designed timber structure , draft model

e. Material pallete selection process