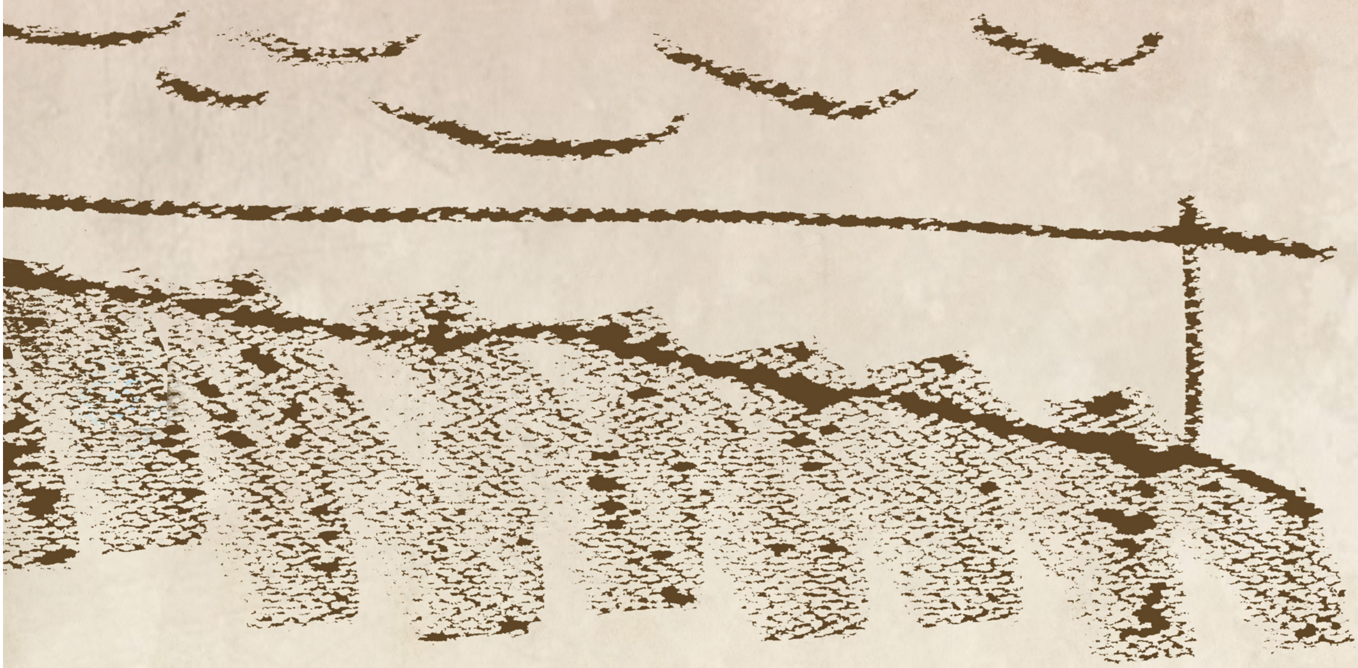
LISTENING TO WINE and TASTING *MUSIC*



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ABSTRACT

Paradiso di Frassina, Montalcino, Tuscany: vines have ears and a taste for Mozart's best symphonies. Tavernelle, Tuscany, same owner. It is where a new, unmatched winery blooms embracing a commercial, social and an artistic dimension. The concept of diffusing music through speakers is maintained and surpassed by the introduction of a Music Hall within the winery that claims to be a prototype for a better development of a stimulating "Architecture of wine". Live music does not only reach the ears of music and wine lovers as they visit the winery; it also knocks on the wooden frames of the oaks, conferring to every drop of wine a musical note to compose a melody that can be heard, smelled and tasted in the glass of wine.

Architecture plunges the visitor into the experience of the senses along the visit. Tectonics shapes the ambiances of the place, enriching the architectural promenade. The project aims for being counted in the restricted circle of wineries designed with rationality and the right hint of flair in the era of "Architainment", respecting and exalting the historical and cultural heritage of a millennial ritual rooted in its terroir.

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PART I - INTRODUCTION

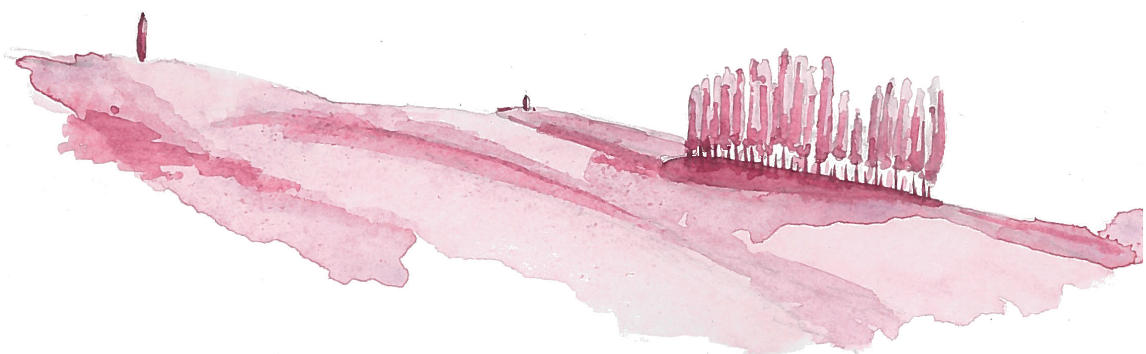
Ill.1 Tuscan Rural Landscape, Own illustration

PROLOGUE

The project develops the idea of designing a winery in the Montalcino area, Tuscany, Italy.
The client, a local wine-maker, owns various vineyards differently located in the area and is considering building a new winery in order to improve the treatment of the grapes in place. The site is located on a hill facing the small rural village of Tavernelle (ca. 300 m above sea-level) and covers approximately 50 hectares on the south side of the hill. Its characteristics and its location in the very heart of the Brunello-di-Montalcino protected area make it an ideal spot for vineyards and an eligible place for a winery.

The client's philosophy in wine production – introducing the use of music to enhance the quality of the product all along the wine-making process, that is where grapevines are grown and where wine is made – presents a challenge and offers stimulating ideas to develop.

The approach we have practiced at AAU will drive us through the design process, which will consider integrating multiple functions in what will result as a hybrid building. The outcome is a place where the visitors' experience is brought to its fullest through the stimulation of all the senses. Visitors are guided through a fully immersive experience in the architecture, in which sight, smell and taste combine with hearing in discovering the perfect integration of the natural landscape of the vineyards with the sound of music.



Ill.2 Tuscan Harmony, Own illustration

THEME AND PROBLEM

Wine-making has been part of man's life since ancient times and has developed depending on various factors, such as climatic conditions and the techniques being developed. Consistently, wine producers have achieved high levels of refinement and are now able to offer a product that is not only drinkable, but also a symbol of elegance, taste and culture. They have also grown more concerned for the aesthetic and functional aspects of their wineries.

Consequently, the Architecture of a winery is the very connection between farming grapes and producing wine. As such, it has to be rooted in the environment it is located in and in its *terroir*, which is the essence of the place. In addition, the design needs to connect the functional requirements with the appeal of a virtuous architecture re-interpreting ancient traditions with a new building that is able to symbolize the brand of the winery and of its product, the wine (Casamonti et al., 2004).

The relationship between wine and architecture has changed in the last few decades, along with the relevant changes in the wine production which moved from quantity to quality.
Along with the original function, which serves the primary need of transforming the grape into the final product, new functions have been developed for the winery as a result of the increasing interest in improving the relationship with the customer, the presentation of the product and the promotion of its quality and history. Indeed, the contemporary winery is the place where wine is produced as well as advertised and marketed as a product. For these reasons many wine producers have turned to architecture to design buildings that are recognisable and easily identified with the brand. In this way, the product gains both in prestige and value.

On the one hand, the remarkable achievements of renowned architects stand out as unique style exercises of their kind. On the other hand, other projects are more closely connected with the territory and the productive system of the area in which they are located. In them, tradition is renewed and contents and values are emphasized, updated rather than distorted. They are inspired by the *terroir* and its vineyards, aiming for sustainability, and dusting off ancient practices and ancient bonds between man and land.
This project aims to reflect the latter approach: in fact, its final result will respond to the following issue:

How to design a hybrid building that integrates wine production with acoustics, structural and sustainable matters adopting a tectonic approach?

METHODOLOGY

TECTONICS

"We build in accordance with specific contemporary conditions, defined by production methods, construction and materials as well as ethics, meaning and values. Tectonic thinking is not only about portraying a constructional logic. Tectonics is to create material realities that reveal narrative meaning. Tectonics is to construct with cultural references".
C. Bundgaard

The theories of tectonic thinking are based on the principles stated by Vitruvius in the first century BC. In his treatise *"De Architectura"*, the Latin writer expresses the idea of a building as having a triple quality, which includes *"firmitas"* (durability), *"utilitas"* (utility), and *"venustas"* (delight) (Rowland et al., 1999). According to Vitruvius, *firmitas* represents physical durability of architecture; *utilitas* symbolises the functionality of buildings; *venustas* stands for the beauty of architecture.

In the XIX century, Gottfried Semper rejected the classical vitruvian theory and classified the elements of architecture as stereotomic, heavy earthwork construction defined as Earth and Mound, and tectonic, lightweight and linear components including Roof and Enclosure (Balinski et al., 2016). Furthermore, he defined the tectonic as a result of an artistic creation based on architectural constructions and material properties (Bech-Danielsen et al., 2012).

In the second half of the XX century, Marco Frascari resumed the dissertation on tectonic thinking claiming that details, which are all architectural objects, contain both construction, which is structure and materials, and construing, which is the meaning and the logic embedded in the forms (Frascari, 1984).
This coexistence of multiple concepts in tectonic thinking is also repeated by Frampton who asserted that tectonic is characterised by the simultaneous existence of knowing and making, of arts and crafts. In this situation, the techne, which is the making, reveals the latent value of a thing, or the knowledge.

Later on Anne Beim reconnected to the discussion adding an interpretation-based layer. In fact she argued that concerning the tectonics of the building the main focus lies in the meaning embedded in the specific construction as it is interpreted by both the architect and the user (Beim, 2004).

TECTONIC APPROACH

Structural Tectonics

The development of design techniques has seen the classical figure of the master builder progressively disappear as compared to the development of two different roles: the architect and the engineer/builder. From the tradition of classic design carried out on the building site as a response to materials and structure, the building industry has changed increasing in complexity providing new challenges for the tectonic traditions (Schmidt et al., 2006).
In these terms tectonics can be used as a mean of increasing quality and efficiency of structure in architecture. This process resulted in a higher level of construction characterised by the integration of the poetic aspects of *techne* and the rational aspects of technology in which the tectonic body creates both the ornament and the structure simultaneously (Kim, 2006).

Acoustic Tectonics

In the field of acoustics, tectonic practice can be enabled by design tools when the aim of the user is a tectonic result. This means using technical tools to support the design and utilising interactive programs in which the development of architectural form and the evaluation of acoustic quality are integrated together (Schmidt, 2007).
Digital parametric models can be used, for example, to support acoustics analysis and develop multiple design proposals and physical models of the design at the same time.

Sustainable Tectonics

This vision of the construction as something that has to express its own logic offers architects and users the chance of understanding the logic of the building and the potential embedded in its structures. In this way, tectonic thinking can be firstly a method to integrate sustainability into the design process and secondly a mean to guarantee a sustainable use of resources from both owners and users through the whole life of the building (Bech-Danielsen et al., 2012).
Tectonic quality in architecture finds in these terms a correlation with sustainability. Indeed, in terms of integrating sustainable approaches into the design of architecture, tectonics can be the ultimate response. The term 'sustainable tectonics' can, therefore, be used to describe a theory that aims to merging sustainability in the integration of art and technology (Ruzbahani et al., 2016).

Furthermore, a different approach to environmentally sustainable architecture can be used. 'Environmental Tectonics' criticises the general approach to sustainable architecture moving the focus of its study on a human-oriented architecture, rather than only on the technological aspects of it (Foged, 2015).

TECTONICS OF THE AMBIANCE

The environment - natural, artificial or built - affects humans and other living creatures. They interact with the external world through the senses and their neural system, and respond to it in different ways. Neuroscience, as the discipline that studies these types of interactions, can be applied to architectural studies and lead

to more conscious choices in terms of design.
Architecture can shape the environment and, consequently, affect man and other biological beings. Indeed, built environment has a great impact on human behaviour and contributes to man's well-being (Pallasmaa et al., 2015). In relation to this, architecture can be used to create an ambiance that affects people's minds, feelings and behaviours.
As Rasmussen stated, the fact of changing environment and entering a building designed in a tectonic way and with the purpose of generating an ambiance always provokes certain feelings in a person (Rasmussen, 1962); this concept can be referred to, as Botticher suggested, 'empathy' and is not based on a dominant idea but on sensory agglomeration. This same concept, indeed, is the base of Schmarsow's theory of architecture as a spatial creation of human perception: the essence of architecture is the bodily movement through space rather than a stationary perception of form (Wagner et al., 2014).
The use of this idea as a design driver can enhance architecture quality, as Pallasmaa effectively explained:

"It is evident that 'life-enhancing' architecture has to address all the senses simultaneously and fuse our image of self with our experience of the world. The essential mental task of architecture is accommodation and integration. Architecture articulates the experiences of being-in-the-world and strengthens our sense of reality and self; it does not make us inhabit worlds of mere fabrication and fantasy" (Pallasmaa, 2005).

Some factors can contribute to creating this distinctive ambiance: light, materiality, structure, acoustics and spatial ratio of a space. These can be all integrated with a tectonic approach into the architecture in order to enhance the visitors' experience of the place.

CONCLUSION

The aim of the project is to translate the theories on sensory studies into Architecture through the integration of acoustic, structural and sustainable considerations in all the phases of the design. The Integrated Design Process will be followed to reach this goal: five phases will be dealt with in the process, adopting iteration rather than mere chronological sequence. Problem Statement, Analysis, Sketching, Synthesis and Presentation will be all connected with each other until the end, when the final design result will be obtained (Knudstrup, 2004).

The design will implement the tectonic studies with a holistic approach aiming to integrate technology with aesthetics in order to design a functional building with inherent architectural qualities. The outcome will be a winery building in which technical elements are turned into architectural features that have a positive mental and physical impact on users. The final design will be a hybrid project which integrates all these themes to give visitors a synaesthetic experience.

VISION

"Wine is the Poetry of the Earth"
M. Soldati

The project will make the dream of wine-maker Carlo Cignozzi come true starting from his theory of playing Mozart's best arrangements throughout the vineyards and in the winery to enhance the growth of grapes and produce a better Brunello di Montalcino. The design will develop this concept extending the function of music to a new hybrid winery that will rise on his vineyards in Tavernelle, just out of Montalcino, and will blend in the natural environment.

The challenge that the project presents is merging the issues related to structure, acoustics and sustainability in a tectonic way, in order to develop a new typology of a winery, to serve for future developments. Driven by the principle of attractiveness and functionality, the winery will host all the activities of wine-production on site, from grapes to bottles, optimising spaces in their structure and their acoustics as well as minimising resources, costs and waste.

The final result will enhance the immersive quality of the place, governed by the harmonious sensory concert to provoke an experience that is brought to its fullest by an orchestra of taste, sound, sight and smell, with Architecture to conduct. The audience - a mixed ensemble of users as to age, language and nationality - will share their passion for wine, music and the stunning Tuscan landscape. Visitors will be transported on an emotional journey with their senses to guide them through.

Ill.3 Trip Restitution, Own illustration

PART II - ANALYSIS

THEORETICAL ANALYSIS
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PROGRAMME CONCLUSION

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THEORETICAL ANALYSIS

This section focuses on the cultural background the design is based on. A theoretical introduction on the two themes - music and wine in architecture - is made, in order to frame the topic of interest.

The themes of Music, Acoustics, Wine and Sustainability will be reinterpreted and integrated in Architecture to provide a base for a modern design which is yet to be rooted in its tradition and its *terroir*.

Ill.5 A Muse, Own illustration

MUSIC AND WINE

"Music is the wine that fills the cup of silence"
R. Fripp

Music and Wine present various analogies.
Recent studies, led by Oxford University professor Charles Spence, matched tastes such as sweet or sour to sound properties like pitch and tempo. Indeed, he claims that a key to making wine taste better while sipping it, is to choose the appropriate musical background (Spence, 2015).

Immortal musicians, from Verdi to Mozart or Mascagni, wrote unforgettable pages dedicated to wine, harbinger of happiness and joy, and the convivial moment of the toast has assumed a key role in the Opera context.
The music-wine combination can be traced back to back to ancient Greece, in narratives and vase paintings illustrating the Bacchanalia, festive celebrations in honour of Dionysos, the Greek god of wine.

In art and literature as well music has been often associated to wine. Some Cubist paintings depict music and wine less or more explicitly. In literature, music and wine are often part of an interesting trio together with poetry. Indeed, poetry lends itself particularly to music by the rhythm of its composition. Some poems as L'âme du vin by Charles Baudelaire starts with "*Un soir, l'âme du vin chantait dans les bouteilles...*" (in English: "One night, the soul of wine was singing in the flask..."), poetically giving a voice to wine.

In conclusion, a common ground is shared by wine and music in all art forms and a common ground can also be found for wine and music in Architecture, to gain for both reciprocal glorification through a sensory experience - a synesthesia.

Ill.6 Mando-vino, Own illustration

ARCHITECTURE OF MUSIC

"Architecture is frozen music"
J. W. Goethe

Several examples of architecture related to music in different ways can be found. All kinds of music halls, such as the exemplary Parco della Musica by Renzo Piano, the Berlin Philharmonie by Hans Scharoun (ill. 7) or the Sydney Opera House by Jorn Utzon, are projects conceived to highlight the quality of the music which is played in them. Indeed, the internal shapes are accurately studied following the acoustics' requirements and aims. In these "cathedrals of music", architecture and music blend though remaining two different entities.

Nonetheless, in some other cases architects tried to associate music and architecture in a much more amalgamated way, trying to respond to the question "can music be translated in architecture?"

In 1958, an interesting figure in the fields of architecture, engineering and music named Iannis Xenakis, collaborator of Le Corbusier, designed the Philips Pavilion for the Universal Expo (ill. 8). The project is not only conceived for music, but conceived by music. Indeed, music is the driver of the architectural form of the pavilion since it is generated by a metastasis, the first music composed following mathematical rules and procedures created by Xenakis himself. The three-pronged tent building in which body meets with sound and space, constructed with thin-shelled concrete panels of hyperbolic paraboloid shapes is borne by a tensile structure of steel cables strung from steel posts at the end of the tent to form the singular curves of the building (Lopez, 2011).

In more recent years, Architecture and Music are very often associated by the experts of one or both fields in a comparative approach regarding every scale of it. Studies show how, through a musical score, dynamics as well as rhythms and texture can be read and can be enforced in architecture as representing driving features in both disciplines (Next.cc, 2018). In 2015, Greg Aranda in "The Architecture of Music", defined as a chord and scale encyclopaedia, explains music associating it to architecture as a key for understanding chords and scales. Yet, Lutz pushes the comparison even further leading an inquiry into the similarities between the tectonics of buildings and of musical instruments (Lutz, 2007).

Considering then the definition given by the Oxford Dictionary of Music of "musical instrument" as "a device that amplifies sound", it is no surprise if, two years later, Mahmoud suggests that architectural spaces can be viewed as large-scale instruments (Mahmound, 2009). The architecture-music relation can in fact be glorified and sublimated by a picture (ill. 9) taken from the interior of a musical instrument as a guitar or violin…

Ill.7 Berlin Philarmonie by H. Scharoun, Own illustration

Ill.8 Philips Pavillion by I. Xenakis, Ph. by W. Hagens

Ill.9 Interior of a guitar, by Den Berliner Philarmoniker

ACOUSTICS

"Can architecture be heard? Most people would probably say that as architecture does not produce sound, it cannot be heard. But neither does it radiate light and yet it can be seen. We see the light it reflects and thereby gain an impression of form and material. In the same way we hear the sounds it reflects and they, too, give us an impression of form and material. Differently shaped rooms and different materials reverberate differently" (Rasmussen, 1962).

The sense of hearing, as Rasmussen affirmed, is often downgraded compared to the sense of sight. Nonetheless, this does not compromise the fact that ears can perceive much slighter changes in the environment than eyes can do. In fact, hearing disharmonies in music is far easier than seeing same ratio discordances in built architecture (Rasmussem, 1962).

Acoustics studies date back to the Greek age, in which the first relationship between frequencies and vibration was found and the first analysis on the propagation of sound through material was made (Long, 2014). With the development of the science of acoustics and throughout the history of architecture, as explained before, the studies on this theme have had a great impact on the design of buildings. In some cases especially, acoustic thinking has driven the design through the definition and analysis of some quality parameters. Some of these are for example (Long, 2014):

- Reverberation Time: the number of seconds before the intensity of sounds drops by 60 dB from a specified intensity
- Early Decay Time: reverberation time calculated over the first 10 dB
- Loudness: the human perception of the magnitude of sounds; expressed in dB
- Clarity: the degree to which rapidly occurring individual sounds are distinguishable; early to late signal-to-noise ratio, expressed in dB
- Definition: the same as clarity; early to total sound energy ratio expressed in percentage

The design will therefore be driven by the evaluation of these parameters with the aim of employing the idea of acoustic intimacy (Pallasmaa, 2005): articulating the experience and the understanding of space through the hearing feeling and creating a distinctive space through sound.

EFFECTS OF MUSIC

Music affects human life in many different ways. First of all, it affects the body. According to Nietzsche, “we listen to music with our muscles” (Nietzsche, 1886). Music makes people dance, sing or simply tap their feet, which is also proved by the fact that little children’s bodies react to music stimulation in either positive or negative ways, with no knowledge of music.
A more fascinating aspect is the effect of music on the subconscious. As Rauscher et al. wrote in 1994, a causal relationship can be found between music and spatial task performance. Their studies and experiments intended to prove the connection between listening to classical music, precisely a Mozart sonata, and an improvement in carrying out certain tasks in a group of students (Rauscher et al., 1994). Rauscher’s studies have prompted the scientific debate on the so-called ‘Mozart Effect’, which became matter of wide-spread discussion in the media. Even though in more recent years many others have reconsidered the real effects of the theory, a conclusion on scientific basis is yet to be drawn (Beauvais, 2014).
Music affects human beings as much as it affects other biological beings, such as plants. This evidence, which seems to be based on logical thinking, has been proved by recent scientific studies that experimented how “musical frequencies facilitate such physiological processes in the plant like the absorption of nutrients and the photosynthesis and protein synthesis, which is observable in terms of increased height, higher number of leaves and overall more developed and healthier plants” (Chowdhury and Gupta, 2015).

These studies, based on the pioneering lifelong researches of Sir Jagdish Chandra Bose on the behaviour of plants in response to various stimuli, have been of great interest for Carlo Cignozzi, owner of the vineyards where the winery of the project will rise.
The owner asserts that the positive effects of music on plants, precisely on grapes, are even more clear when they “listen” to classical music, and this is why he is playing Mozart music in his vineyards.

WINERIES ARCHITECTURE IN HISTORY

Wine has always played an important role in Western culture. Wine production can be traced back in time as far back as 4,000 years B.C. in the Mediterranean area. In ancient Greece wine was an important beverage for both the upper classes and the working-class. Wherever wine was produced, wineries were built; however, until around a couple of centuries ago Architecture was not involved in representing wine production; until then, wineries were confined to strategical places like caves, cellars and other service places. The production site was often hidden or located underground, which also facilitated the process of wine making: the cellar could provide steady temperature and humidity conditions that favoured wine and grapes working and storage. Along with this mysticism the wine-maker role was born: the science and art of following precise rituals to obtain wine remained available only to a special elite of people, who were considered alchemists and handed down their secret knowledge to a restricted number of people (Rossetti, 2011).

In more recent times, between the 18th and the early 19th century, the role of Architecture became central to the wine-making process, with the establishment of the French *Chateaux* in the Bordeaux area, where vineyards owners started building castles surrounded by service buildings where wine was made out of the product of their *cru*, land with vine cultivation (ill. 10). These castles featuring various styles, from classical to eclectic, were characterized by a recurring element, the *chais*, the place were wine aged in barrels to be refined at the temperature of 12-15° C.

In the same age in other parts of Europe the trend was different: the common typologies for wine production places were the small-size rural farm and the monastery, both accommodating wine production with a focus on functionality rather than appearance. The Palladian 'villa' in the Veneto region, Italy, is the only exception to this rule, organised into a mansion surrounded by service buildings with similar architectural style (Casamonti et al., 2004).

Following the development of vinification techniques, the late 18th century marks a growth of the wine market, which corresponded to a growth in the dimension of the winery. Iron structures were first used for wine storing places, such as cellars, and the term "wine factory" was coined (ill. 11). These were wineries that worked huge amounts of grapes and produced low-quality wine.

After the dark age of the first half of the 20th century, in which wars and vineyard diseases severely limited wine production, in the 1970s a further advancement in terms of quality took place in the architecture of wineries. The technical revolution in oenology (the "science" of wine), which introduced new production instruments such as the artificially-controlled temperature steel containers, led to the production of higher-quality, branded, genuine wine (Casamonti et al., 2004).

Over the past few years, wine Architecture has slowly developed into a market-oriented symbol of the wine producer to represent local tradition, the culture of the place and its *terroir*. The function of wine making has come to be associated with the functions of reception and entertainment for visitors and the term “wine tourism”, first used in the French Bordeaux region (ill. 12) and in the American Napa Valley, was soon adopted in the rest of the world (Casamonti et al., 2004).

Ill.10 Chateau Mouton Rothschild, Ph. by B. Zingg

Ill.11 Real Bodega de La Concha, Ph. by G. Messian

Ill.12 Chateau Margaux, by D. Perez

WINERIES TODAY

Today wineries are perceived as iconic objects to be quickly associated with the brand of the product. Like the label on the bottle, they serve as the image of the brand at the architectural scale. They are often found dominating vast hectares of cultivated land, which has brought Valeria Tatano (Rossetti, 2011) to define them as “the cathedrals of wine”. The realisation of these Cathedrals in which the *lyaios* (greek for “wine”) is glorified often requires the attentive work of architects. Some projects are architecturally remarkable, both for their functionality and their aesthetic attractiveness.
World-famous architects have worked on wineries, proposing either innovative, beautiful, majestic or more sustainable solutions. Architects like Renzo Piano, Santiago Calatrava, Jean Nouvel, Norman Foster, Frank Gehry, Mario Botta, have served this cause, spawning projects all unique in their shape and architectural style, easily associable to their names because of their unmistakable architectural language.

Bodegas Ysios (ill. 13), designed by Santiago Calatrava in the Spanish northern region of La Rioja in 2000 is an interesting example of a spectacular architecture, thought to follow a horizontal organisation of production. The building integrates in the natural surroundings rather than clashing with the mountainous landscape of the area thanks to its wavy roof that dialogues with the curvy natural background.

Another interesting example of a big modern winery is the one designed in 2003 by renowned Swiss architect Mario Botta in the geographical area of Maremma, Tuscany (ill. 14). The building, standing out for its massive presence reinforced by a strong symmetry, reminds the French *Chateaux* and features a heavy construction that keeps it symbolically attached and bonded to the soil. A central rising staircase is the only element to guide the visitor, both visually and physically, towards the summit of the building, which offers an overhanging view of the property.

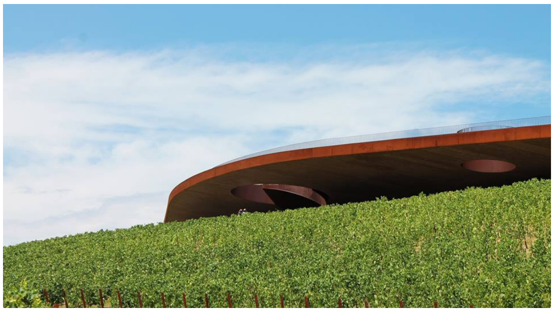
In 2007, Renzo Piano designed an interesting winery in Rocca di Frassinello, also in the Maremma area, Tuscany. For the project, functionality, productivity, and labour were the driving principles of the design, also featuring a 40-metre wide squared barrel room set in a central point hosting barrels and visitors, which on some occasions can also serve as a small concert hall.

In 2013, Archea, a group of Italian architects, conceived a new winery in the Chianti region for the family of the marquis Antinori (ill. 15). Despite its gigantic proportions, the Antinori winery is very gently inserted in the local environment. Being completely underground, it creates a breach into the hillside through a delicate, longitudinal cut. A long transparent surface reflects the surrounding hills lightening the visual effect provoked by the use of corten steel. The project is undoubtedly an example of structure boosting the image of an already prestigious brand.

The relationship between wine-makers and architects has become significant for both parties: on the one side, as a key-factor to promoting their product and increase sales through an architectural branding of their label; on the other side, as an opportunity for architects to step into a multifaceted world that is attracting an increasing number of people interested in the growing phenomenon of oenotourism.

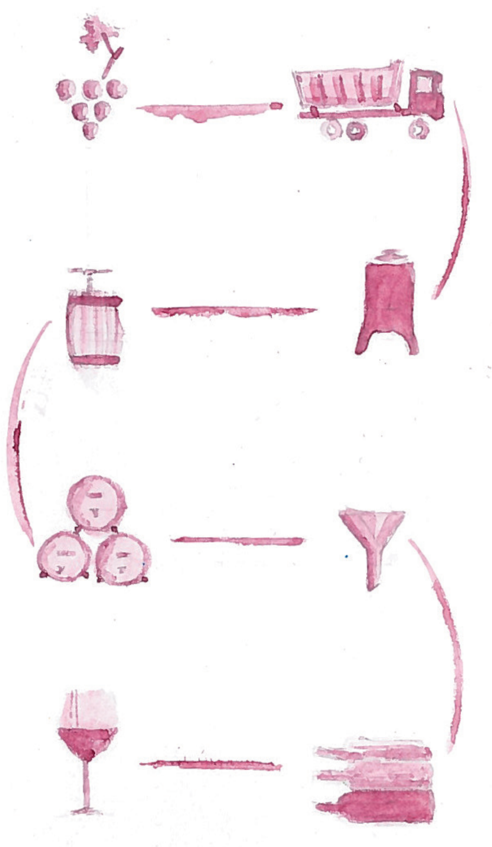
Ill.13 Bodega Ysios by S. Calatrava, Ph. by G. Messian

Ill.14 Petra Wine by M. Botta, Own illustration



Ill.15 Antinori Winery by Archea Ass, Own illustration

WINERY: AN ARCHITECTURAL TYPOLOGY



Ill.16 *Wine Production Steps, Own illustration*

Wine - from harvesting the grapes to the bottle - endures transformations and production phases. Once the harvest takes place early in the fall, the grapes are brought to the winery. Here they are selected and "destalked" (grapes are removed from the stalks with specific machinery). Successively, they undergo a process named 'pressing' by means of which the liquid together with the grape marc is collected in vats (made of steel, concrete, wood or terracotta) for the fermentation (AIS, 2016), which varies from fifteen days to a few months for red wines, like the Brunello, which requires two months. After the fermentation process, the wine is transferred into oaks or *barriques* for ageing. Meanwhile, the grape marc is pressed and can be blended in with aged wine. Afterwards, the wine is bottled by using a three-step machinery through bottle air-vacuuming, wine bottling and corking, after which wine is ready for refinement inside bottles stored horizontally before labelling, stocking and shipping.

The winery is organised into several spaces dedicated to the specific steps of the produc-

tion process (ill. 16).
The place where the picked grapes are received needs to be located close to the exterior area to facilitate the arriving of tractors and the use of the conveyor belt where the first treatment takes place. This first area can be located outdoor, but needs to be screened from the late summer Italian Sun that could provoke a premature fermentation.
From there, the rooms to follow the production. Near the reception area, the fermentation room (in Italian, "*tinaia*"), which has important height due to the tall steel vats that must be accessible from their upper lid, and high temperatures (between 25°C and 30°C). Its floor has to be slightly inclined towards a gutter that makes it easy for workers to wash out the room.
The ageing room, cellar or *barriquerie*, is a big room which has to be located in a fresh environment (11-15°C), humid (70-100%) and softly ventilated in order to avoid any development of mould. Extraneous smells are to be kept away from this area considering the great capacity of wine to absorb smells.
A room hosting the processes of filtering, bottling and labelling is required, as well as a storage room where to stock other machines and working tools. Next to it, the area where the wine is being refined in the bottle for a given period of time. Here temperature can vary from 16° C to 18° C.

Additional rooms hosting functions related to logistics, wine-tasting, entertainment aiming for the aesthetic appreciation and the delivery of a pleasant experience are to be treated when designing a contemporary winery. These include offices, meeting rooms, a canteen for employees, a refreshment point for the visitors, a wine tasting room, a reception, a wine shop and, sometimes, an exhibition room to showcase the product of the winery and its territory (Rossetti, 2011). All areas dedicated to the work on the product and to logistics should preferably have natural light to facilitate working conditions of the employees. Conversely, the spaces where wine ages such as the *barriquerie* and the refinement and stocking rooms do not need any natural light and actually fear light as it could alter the quality of wine.

WINERY: COEXISTENCE OF USERS

Two different categories of users will animate the building: the occasional user visiting the winery and the daily user working on site. The requirements of both users are to be dealt with equal attention, considering activities, facilities and needs.

Visitors and potential buyers from Italy and from other countries devote an average time of two hours for a visit to the winery. The visit must offer them an emotionally exciting and intense experience, guiding them through the winery and its ‘terroir’ and culminating with the wine tasting. There, all the senses will be stimulated - from sight through smell and taste to hearing - to provide a truly immersive experience of the architecture.

The staff working either on the grapes or in the cellar, or in the maintenance of the building, is the beating heart of the winery. As members of the working team, employees are not in search of any special experience; however, they deserve fully adequate hygienic working conditions and a functional, organised process to deal with their daily tasks.

Dealing with two different typologies of users implies two different paths to be considered: on the one side, one didactic, playful and surprising kind of path; on the other side, a clear and functional path serving the working staff’s requirements. The question here is how to fuse the two paths, both accompanying the visit and pacing the work, guiding the visitors through the pure production track, preventing them from hindering the workers’ operations. The two groups will therefore be linked by the Architecture and by the music that will accompany their activities (ill. 17).

Ill.17 Winery Users Flows, Own Illustration

SUSTAINABILITY AND WINE

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (World Commission on Environment and Development, 1987)
Following this first definition of sustainable development given by the United Nations, the concept of Sustainability was developed during several conferences (1992 United Nations conference in Rio de Janeiro; 1997 Climate Summit in Kyoto; 2002 World Summit in Johannesburg, etc.) to include three dimensions: environmental, economic, social. These three parts equally contribute to defining sustainability in all fields, wine-making included (ill. 18).

The challenge for wine-making is to cope with the environmental aspects of its industry.
According to the study “A cross-national comparison of sustainability in the wine industry” (Szolnoki, 2013), which investigates the wine producer’s point of view on sustainability, there is still a considerable lack of information among wine producers, relevant organizations and consumers concerning this matter. Furthermore, most of the interviewed wineries, especially in countries where organizations promoting sustainable wine-making are missing, tend to consider just the environmental dimension, ignoring the economic and social aspects and confusing sustainable with organic or biodynamic production. It is,, therefore possible to assert that organic, which means growing grapes without the use of synthetic plant treatments, and biodynamic, which means using farming techniques that improve soil and plant health, can only be a part of sustainable wine-making. They are not sufficient to transform the industry.

In Italy, in 2010, KlimaHaus agency, an organization for energy performance certification based in Bolzano, created a specific protocol to evaluate sustainability for wineries. The certification, called CasaClima Wine, was meant to be a tool to distinguish virtuous businesses and promote the implementation of sustainable approaches in a huge industry in which they had not been utilised until then. The certification evaluates three fields of wine production: Nature, Life, Transparency. As seen in the diagram, these areas of interest include the three dimensions of sustainability: environmental quality, socio-cultural quality, economic quality. The system is therefore weighing up the overall sustainability of the winery, which is intended as a factory. Some factors included are the building efficiency (envelope and systems), the impact of building materials, the water consumption, the indoor quality (light, sound, air), the sustainable management (economic efficiency, cost-efficient production, use of renewable sources, low-impact packaging) and the advertisement of sustainable approaches (CasaClima Wine Catalog).

In this framework, the project applies sustainability principles to the design and develops its three parts; major attention is given to integrating passive sustainable strategies in the design.

Ill.18 Sustainability, Own illustration

SITE ANALYSIS

Zooming into the area of the intervention, a location of the Montalcino area within Italy and Tuscany is presented.

A description of the site is first given, based on its morphologic and climatic characteristics, to be followed by the story of the arrival. A walk in the vineyards guides you to discovering the atmosphere of the place, which mere observation does not allow.

The section closes with the description of typical Tuscan materials and techniques, with the focus on a possible reinterpretation of these.

Ill.19   re Sole, Own illustration

LOCATION

MONTALCINO AREA

The town of Montalcino lies in the heart of southern Tuscany and its territory consists in one tall hill covered in forests. The name of the city derives from the Latin *Mons Ilcinus*, meaning the hill of holm oaks (Consorzio Brunello di Montalcino, 2018). The surrounding agricultural landscape is rich in beauty and history and has been in the list of the Heritage of Mankind by Unesco since 2004.
These soft reliefs dancing at the foot of the Montalcino mount, are land of the Brunello, lands of small rivers, of forests and stone farms, of the animals of the woods. The Montalcino area is rich in tradition dating from medieval times, linked to the territory. A land of perfumes and flavours, a landscape that dresses up differently every day, in a carnival of colours and emotions governed by the times of nature (Podere Le Ripi, 2018). A Tuscan proverb says “Nature is beyond all teaching”.

Ill.20 Location Diagram, Own illustration

Ill.21 Montalcino Fortress, Own illustration

PROJECT SITE

The site, facing the rural village of Tavernelle, covers an elongated piece of land of about 50 hectares. It is located on the west side of the road that links the town of Montalcino and a southern area of the Maremma in a land characterised by small-size cultivated fields and woodland.
This same road skirts the site to the southeast, gently sliding down the soft slope of the terrain. On the same east side, a dirt road of smaller dimensions, leading to other plots owned by the Azienda Agricola Podere Brizio, delimits the intervention location.
On the south side of the site, another road past an irrigation dam slightly reaches down to a stream running through a wood encircling a small lake. This slim wood of diverse tree species ranging from evergreens such as holm oaks to conifers and deciduous trees such as birches, outflanks the site on the west and north side.
Inside the area described by the two roads and the woods, stretches the site, covered by a mantle of vines disposed in a way to follow the inclination of the terrain. The ground is in fact gently sloping to the west, while steeper to the southwest and crossed lengthwise by and internal dirt road serving the operations in the vineyard.

Ill.22 Site view from north, Own illustration\

Ill.23 Site View from south, Own illustration

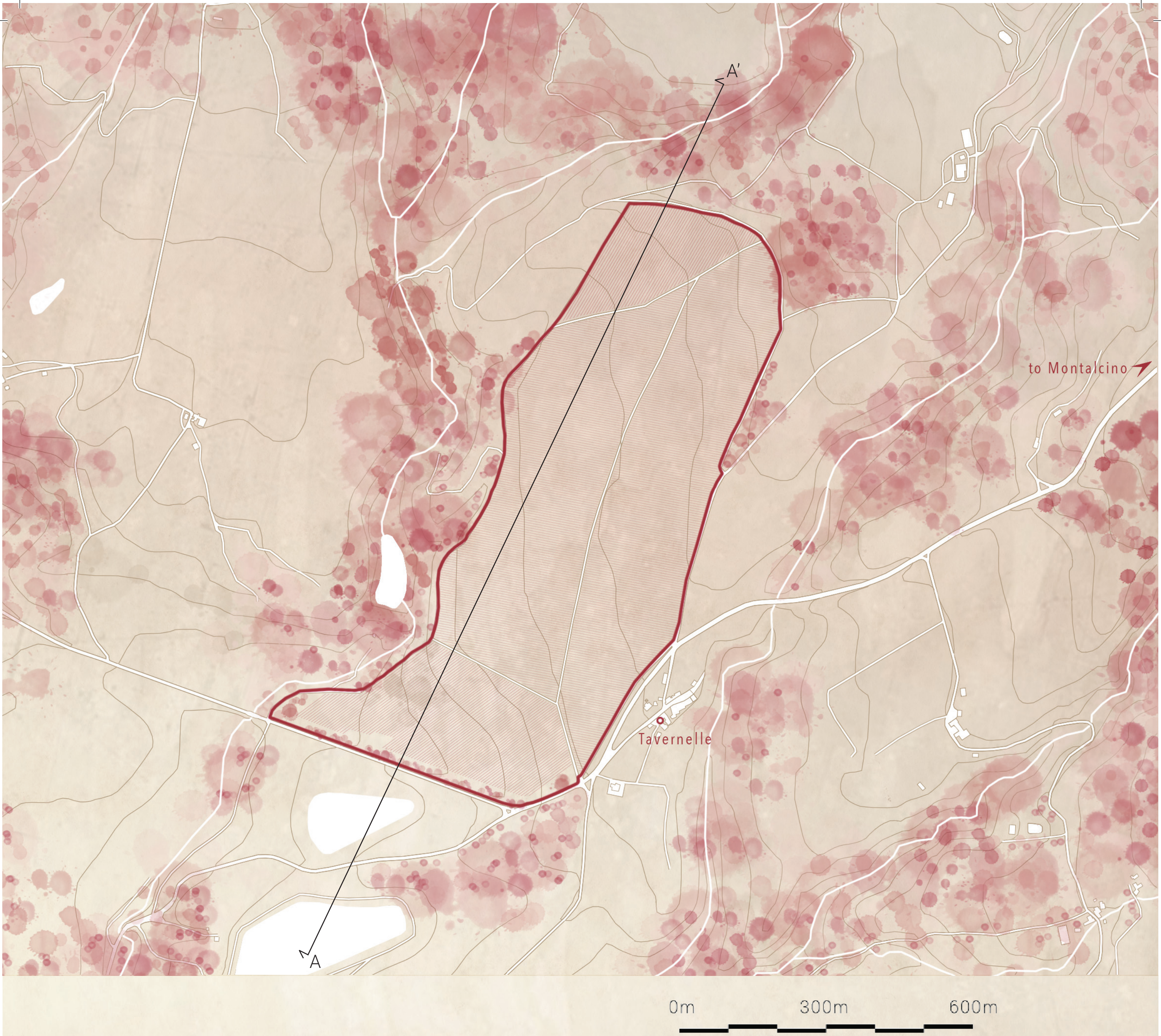
Ill.24 View from the road to Maremma, Own illustration

SITE GEOGRAPHY

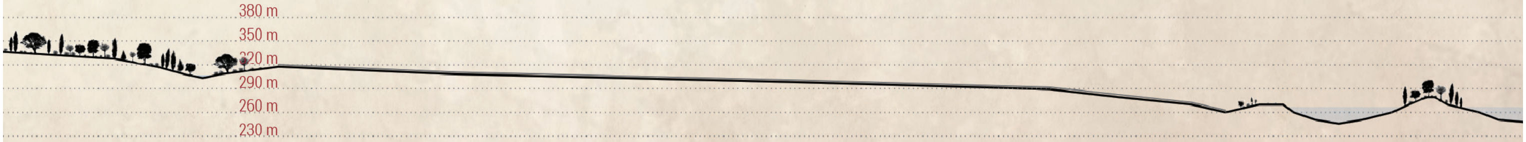
The vineyards lie on a sandy soil rich in clay, which is typical in the area around Siena. The geological name given to the area is in fact "*Crete Senesi*", which means "Senese clays", from the composition of the terrain of a typical grey colouration that gives the landscape an appearance often described as "lunar".
Related to the soil composition is the erosion phenomenon of the *calanchi*, deep grooves into the hill-side caused by the run-off water on the clayey soil, which is very easy to find all around the region (Consorzio Brunello di Montalcino, 2018).

The project site is located on the southern hill-side of the Montalcino mound, whose top reaches 600 metres above sea level making it classifiable both as low mount or high hill.
The cultivated land develops at variable altitudes, ranging from 320 m and 240 m above sea level. It features a gentle slope at the top of the hillside which increasingly gets steep at its lowest point (SIR, 2018). Thus, the site, which has a difference in level of around 80 metres between its two extreme points (ill. 26), offers visitors a view to the south of the Maremma valley and Mount Amiata (1738 m).

As regards its spatial location and hydrography, the site is located close to the Ombrone river flowing through the Chianti region into the Tyrrhenian Sea to the southwest.
On the site, a small watercourse slides down through a wood on the west side and a tiny trench delimits the intervention site on the south side just before the road. Both these courses nourish two small irrigation ponds across the road on the south of the site. On the east, beyond the little built-up area of Tavernelle, another stream runs down from the hill (SIR, 2018).



Ill.25 Site Plan, Own illustration



Ill.26 Site Longitudinal Section A-A', Own illustration

CLIMATE ANALYSIS

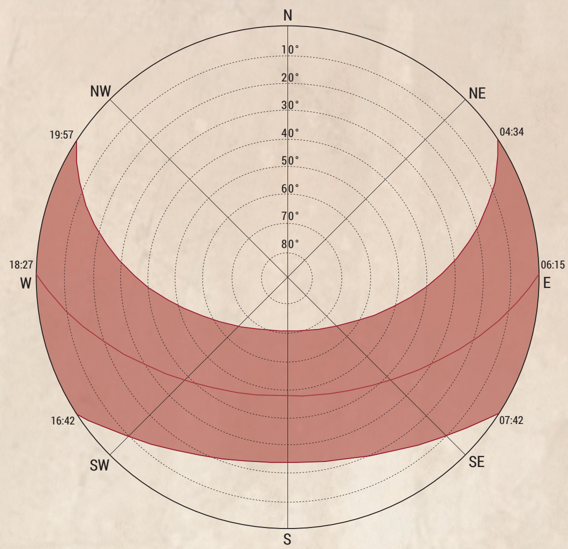
The climate in Montalcino is typically Mediterranean, generally dry and windy during the summer months, providing a good habitat for the growth of vegetation. Thanks to Mount Amiata, which rises 1740 meters high just South of Montalcino, the territory is naturally protected from weather hazards like rain and hail storms. The hills, which rise up to 600 metres above sea level, provide slopes which vary in orientation, where the vines have found the most favourable growing conditions.

SUN
The project site is located on the south side of the Montalcino hill in North-South orientation. The position offers a great amount of natural light (ill. 27). The Sun hits the site from 04:34 to 19:57 in the summer solstice and from 7:42 to 16:42 in the winter solstice, while during the equinoxes from 6:15 to 18:27 (SunEarthTools, 2018).

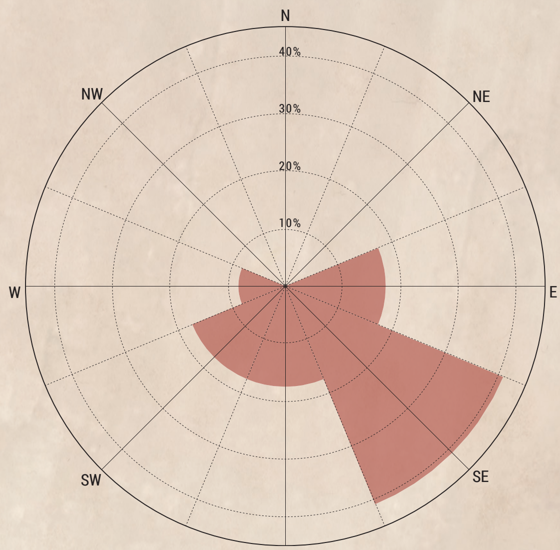
WIND
Winds do not have a strong impact on the local climate. Nonetheless, they can help lower down the humidity level in winter and soften the high summer temperatures. Over the last years, lightly stronger winds have been hitting the area in summer (1.7 m/s compared to 1.4 m/s). The prevalent direction of the wind was South, with a variation towards South-West in summer while more towards South-East in winter (ill. 28). The wind maximum speed was basically equal in summer and winter, reaching around 25 m/s (SIR, 2018).

TEMPERATURE
The temperature can vary considerably between the maximum and minimum ones throughout the year (ill. 29). In fact in the last five years the mean maximum temperature was 36,2° C, always registered in July, and the mean minimum temperature was -2,7° C, usually registered in January. Even though the thermal excursion was high in the year, the temperature varied slowly during the seasons; in fact the yearly mean Maximum Temperature was 20° C and the mean Minimum Temperature was 10° C, with a mean yearly Temperature of 15° C (SIR, 2018).

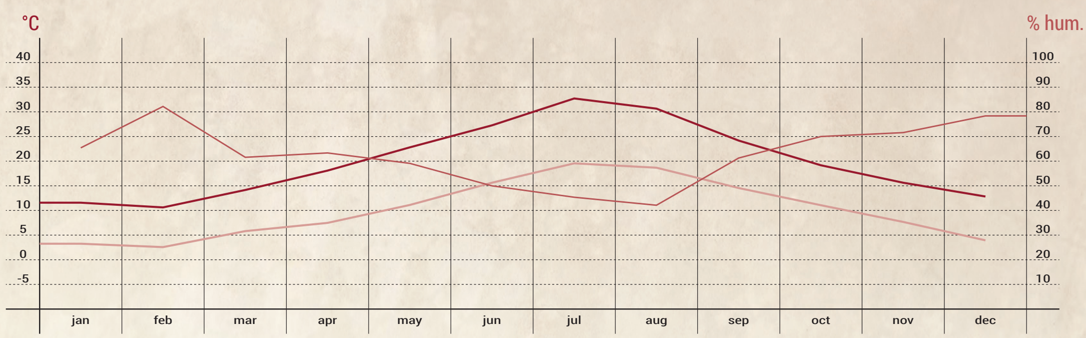
RAIN
Precipitation is an important factor for vines: too little rain compromises the growth of plants, whereas too much rain can bring to high levels of humidity which can cause fungi growth. The area is characterised by a usually dry summer. In the last five years the mean number of rainy days was 92 with 940 mm of rain throughout the year (ill. 30); the cold months were generally 50% more rainy than the warm months, but few showers were registered in summer. The levels of relative humidity were higher in winter, between 60% and 80%, and lower in summer, between 40% and 60% (SIR, 2018).



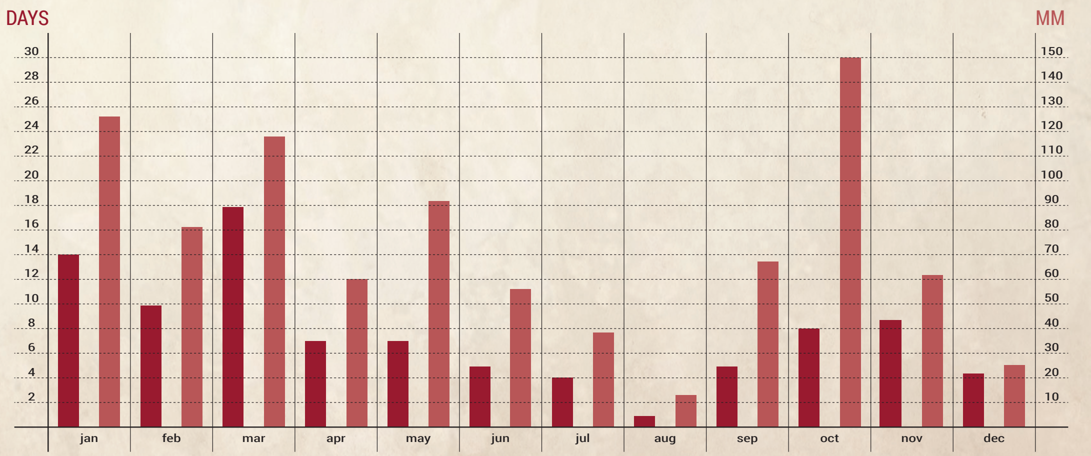
Ill.27 Sun Path diagram, Own illustration



Ill.28 Wind Direction Frequency diagram, , Own illustration



Ill.29 Temperature and Humidity diagram, Own illustration



Ill.30 Precipitation diagram, Own illustration

ATMOSPHERE OF THE PLACE

Gently rolling downhill, a curvy road crawls from Montalcino to the geographical area of the Maremma. It ploughs woods and then fields, mostly vineyards of small dimensions.
To our surprise, the road stunningly runs straight down the hill and opens up to the valley. Few isolated cypress trees along the road timidly interfere within the picture. On the left, the stone-built medieval hamlet of Tavernelle faces the site of our intervention, on the opposite side, to the right, the vines rows unroll on the slope the site.
Turning right at a crossroad into a smaller road gently descending downhill, transversally, and up again on another mound, along the road that delimits our site.
We leave the car in the small dip between these two hillocks where a tiny stream alimented by natural precipitation, slips between the hillside, dressed in a mixed and colourful vegetation, and the first line of a poetic landscape marked by the geometry of the vineyard. We are walking on the soil, feeling it under our feet, breathing its smell, released by the recent rain. We both realize how important these steps are while considering designing a winery as a structure where the product of a unique *"terroir"* is processed.
A gentle first slope covered with vine rows, a combination of stakes, threads, and plants of vine growing according to the *"guyot"* technique (ill. 31), prevents the view of the rest of the site, which extends in a less steep area. The picture is charming and the strong perspective of the straight rows dialogues with the soft and curvy course of the land profile. The colourful chaotic mix of shrubs frames the vegetation domesticated by man.
Walking further uphill, we meet a dirt road, connected to the main road and splitting the vine in two. From here, a view of a piece of Tuscany, with its charming road leading to isolated rural houses, fields and vineyards unrolled on the fertile hills, the woods and the lonely cypress trees, the mountains in the background.
Up here, the first vines are younger, while further on an older vine raises a different sensation: the sight gets lost in between what seems to be a crowd of errant souls inhabited by straight and thin then contorted wooden bodies. Young and old plants cohabit in the same site, time runs its course, the seasons follow each others, and the humans sip the gift of the earth, wine.

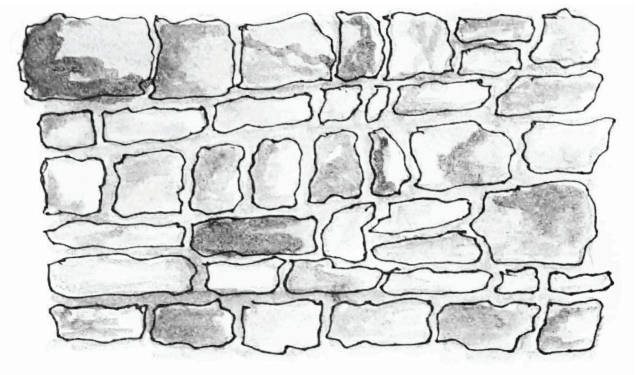
Ill.31 Souls, Own illustration

TYPICAL MATERIALS

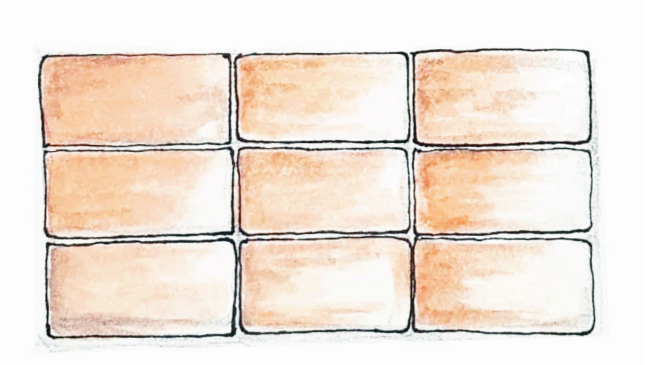
A presentation of the building materials of Tuscany is fundamental for understanding the local artificial landscape. These materials have contributed to creating the large palette of colours of rural Tuscany. The focus is not about the materials that can be found in the cities of the same region, such as Florence, whose prestigious buildings were often realized with precious materials like marble, but about the architecture of the hilly countryside of the Montalcino surroundings. Away from the small villages, the area is characterized by the presence of typical rural Tuscan houses called "*poderi*", isolated residences built in the typical materials of the rural architecture. A parallel can be drawn between these lonely dwellings and our intervention, relatively isolated and plunged into the land.

The stone, mostly sandstone with a porous and rough texture and shades that flirt between the light brown and the grey (ill. 32), is mostly used for the walls of the house. It is undoubtedly the element that adds to the poetic charm of the unique Tuscan *podere*. In several cases, the walls can be found in mixed masonry, meaning a chaotic but amiable melange between stones and clay elements as bricks and tiles, but also in brick exclusively. These latter elements are used in the roofing with the typical shingles as well as for the ceilings with the terracotta flat tiles that go in-between the secondary beams which support the floor above. The classic floor is also constituted by terracotta tiles disposed in different combinations (ill. 33). Even though wood is not an evident material in the outdoor aspect of the typical Tuscan architecture, it plays a relevant role in the bearing system of the house. All traditional primary and secondary beams (ill. 34), included the ones supporting the roof but except the steel ones supporting the *voltine* (small vaults), are timber elements, as well as big part of the house old furniture.

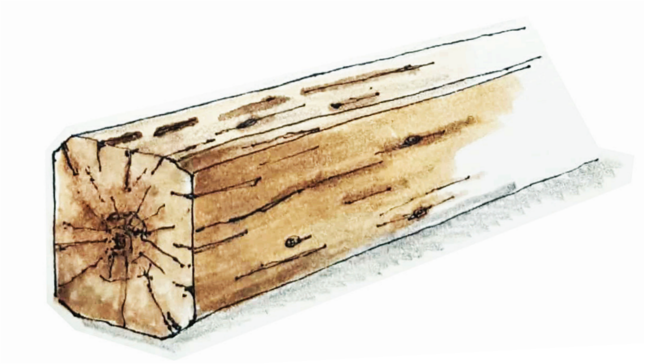
An analysis of the typical materials of the surroundings is important in order to design an architecture that integrates with the territory and the landscape painting, as the *podere* does in an exemplary way. The use of bricks or stone, for their aesthetic and porosity represents an interesting feature applicable to the project of a winery and wood can represent an interesting solution in reference with the wooden oaks in which wine ages.



Ill.32 Stone, Own illustration\



Ill.33 Masonry, Own illustration



Ill.34 Wood, Own illustration

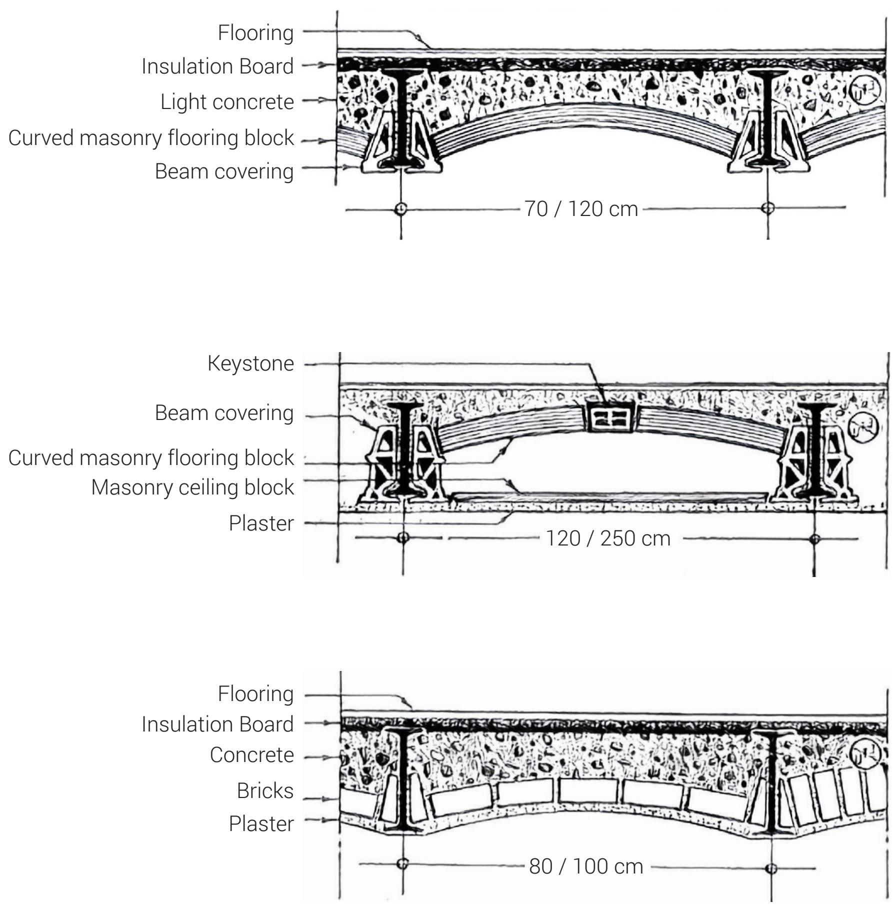
REINTERPRETATION OF TECHNIQUES

Some typical building techniques need to be considered while designing with local characteristics materials. The two issues are related, as materials represent an integrating part of the constructive techniques. The most widely adopted techniques of the area date back to the Middle Age when the rural Tuscan houses, the *poderi,* were rising here and there. These historical residential and rural buildings carry some appealing and traditional elements and techniques.

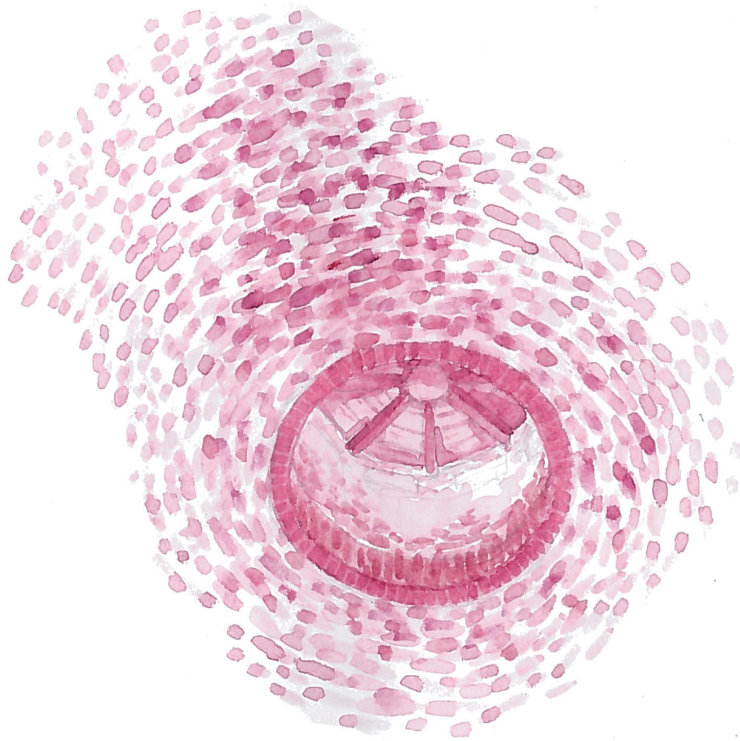
A peculiar example is what locals call "*mezzana",* which defines a terracotta element measuring around 12 cm by 25 cm. Thinner than a brick and smooth on one side and rough on the other side, it is traditionally found in the ceiling in between the timber joists that run from a beam to another. The *mezzana*, from its analogy with the brick, can be employed elsewhere as cladding, wall, flooring and details linked to furniture. Moreover, this Tuscan element can be found in different shades, going from a more reddish colour, to a yellowish one passing by a more pink shade, and can react to humidity evoking a "vintage" effect. Nobody ever prohibited playing with the different shades or effects of the *mezzane*.

A typical Tuscan construction technique for the ceiling is the so-called "*soffitto a voltine"*, consisting of small vaults, which was also used in the past for the ceiling of the barn. Here, small vaults, generally around one metre wide and supported by steel beams, span across the room. The vaults are realised in masonry elements and mortar (ill. 35). Different layings can be adopted to create various patterns and a varied palette is possible for this type of ceiling as it is with the flooring.

Traditional building elements and techniques historically created by master builders can be improved following a tectonic approach today. Their tectonic quality appears in the way they represent structural elements and affect the aesthetic aspect. Based on the previous analysis, the idea is to use the tectonic approach to bring back the old techniques and combine them with advanced technology.
The use of the software Grasshopper and its plug-ins can allow the exploration on these building techniques in a parametric way in order to realise multiple iterations and design proposals while maintaining the age-old tectonic integration of the aesthetic quality and the structural quality.



Ill.35 Traditional Steel - Masonry slab techniques, Own illustration



CASE STUDIES

Two interpretations by two architects of the theme of the winery, which present different solutions in terms of scales, configuration, structural expression and construction techniques, exemplify the diverse ways harmony has been sought for, the visitors' path and the wine path have been articulated, the insertion of the project in the context has been treated.
In this section, the sensations after the visit to the wineries are evoked.

On the one side, the harmony of the golden ratio and the charm of ancient building techniques; on the other side, the scenic effect of an immense central room underneath a stage for the play of Nature: Rocca di Frassinello VS Podere Le Ripi.

Ill.36 Pantheon, Own illustration

CASE STUDY: ROCCA DI FRASSINELLO

"Like entering a church. A ray of sunlight in the centre; around, in the darkness, 2500 *barriques*". Renzo Piano.

Rocca di Frassinello, which opened June 2007 in the Maremma region, Tuscany, was created by an international joint venture between Castellare di Castellina and Domaines Barons de Rothschild. The prestigious ownership requested the service of one of the most eminent signatures in the architectural field: Renzo Piano.

The starchitect designed a winery essential in the lines, enhancing the functionality of a factory, a place serving a particular production intended as an almost sacred ritual (Domini di Castellare di Castellina, 2018). Piano has revolutionized the concept of the sequence of spaces placing at the centre of the project a very suggestive room: the barriquerie (ill. 39). Located underground to maintain naturally stable temperature and humidity levels, the squared room measuring 40 x 40 metres represents a notable constructive challenge as the ceiling stands without any supporting columns. The space is also open to exploring the theme of music when, once or twice a year, it stages a concert, for an audience of spectators and silent oaks containing the aging wine. All around this "hearth" the production rooms are located: on two sides the steel vats for fermentation are distributed. Each vat is arranged below a chute accessible from the roof from where, during harvest time, grapes fall down (Rossetti, 2011). Despite the complexity of the building, the project surprises for the highly functional systems alimented by a carefully conceived and designed track for the product. In the building Piano included spaces like offices, meeting rooms, a canteen and apartments, which are indispensable in a winery of such dimension. In addition, to prompt the dialogue between the project and the history of the territory, a Museum is integrated, which houses Etruscan artefacts dating from approximately 2,800 BC and testifying the production of wine since ancient times.

On approaching the site from downhill, the project expresses a strong horizontal gesture within the landscape. On the other side, the volume articulates following a more transitional approach thanks to new volumes of diverse heights and green terraces linking the building with the verdant hill. From the big scenic *parvis* (ill. 38) that opens up to the spectacle of Nature and that the architect himself calls "the churchyard", a 'bell tower' rises serving as a landmark for the winery (ill. 37), whose long low volumes prevent it from being seen at a distance.

Renzo Piano's signature is evident: the project is judicious, functional and poetical at the same time, careful of the details, embracing history and diffusing culture, stimulating such sensations as harmony, elegance and majesty.

Ill.37 Rocca di Frassinello Tower, Own illustration

Ill.38 Rocca di Frassinello Wine Shop, Own illustration

Ill.39 Rocca di Frassinello Ageing Room, Own illustration

CASE STUDY: PODERE LE RIPI

"Everyone entering in this cathedral of wine can clearly and explicitly feel the harmony that the winery emanates".
Francesco Illy

The winery rises close to the little town of Castelnuovo dell'Abate, few kilometres south of Montalcino. The estate, whose name dates back to the XIII century, was converted from breeding to wine production function around the year 2000. Thereafter the project for a new winery started with the idea of building a low budget, functional building with the use of local material and traditional techniques. During the eight-year long design process and the four years of construction the owner perfected his wine-making philosophy, which involves increasing the vines density to get deeper roots and therefore better-quality wine, and oriented the production towards biological and bio-dynamic approach.

The winery (ill. 40), whose 800 square meters were opened to the public in 2014, reflects the owner's philosophy and is inspired by the natural golden ratio (1:1,618033), chasing, according to the owner, a certain harmony that helps both wine and workers. The central vaulted room, inspired by the Roman Pantheon, is the heart of the building in which wine ages and is enclosed by two rounds of a large vaulted sloping corridor where the production areas are located (ill. 41). The slope exploits gravity to facilitate the workers in most production processes, as it reduces the use of electric pumping.
The whole building was built with local materials, using natural clay bricks and lime mortar, and using ancient manual techniques to avoid, according to the designer, the use of steel and the creation of electromagnetic fields that could have a negative impact on the wine (Le Ripi, 2018).

The great functionality of the winery, its harmonious proportions and the use of local materials to integrate it in the surrounding will be used as inspiration for the design of the winery.

Ill.40 Podere Le Ripi Outdoor view, Own illustration

Ill.41 Podere Le Ripi Fermentation Room, Own illustration

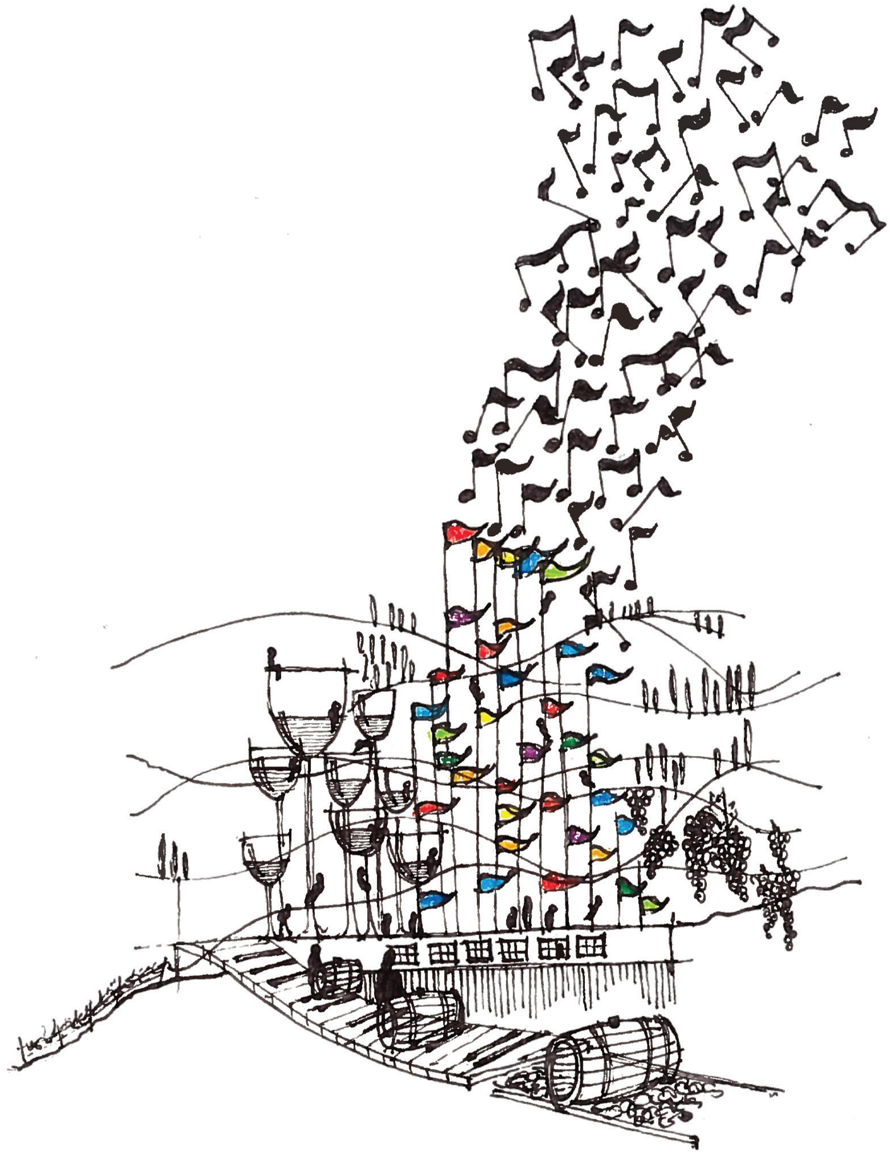
PROGRAMME CONCLUSION

The theme of the winery has been presented and exposed in the introductory section, then developed in the analytic part.
Tectonics and the exploration of the theme of the creation of an immersive ambiance are a relevant sphere of action as well as a methodological tool driving the design.
Wine and music are the subject of our exploration. A brief account of the themes has shown how they have been associated in the arts and how they can be treated in Architecture in a fertile relationship. Wine and Architecture: a strong connection that has undergone a significant mutation since the first wineries were established, to implement facilities serving oenotourism.
The analysis on the site, in terms of climate, morphology, atmosphere, building materials and techniques, has followed.

Working on the ambiance and the experience offered to users in a tectonic perspective poses a stimulating challenge for the design.
An historical account of the typical local wineries has inspired us precious ideas to develop in conceiving a modern winery as a building that sings music, exhales sustainability and is capable of welcoming the visitors, who will interact with the employees as their paths can be fused.
The mild weather conditions do not affect remarkably the building, yet the climatic factors are potential sources of sustainable passive strategies. The morphology study undoubtedly helps understand the terrain and informs about the installation of the building within the parcel.
Some of the typical materials and techniques can be used and reinterpreted thanks to modern technology to create a modern winery that dialogues with the past.

These partial conclusions represent the transition to the following part, as they define the initial choices inspired by the researches and the favourable conditions that the site offers, guiding the work towards the design criteria generation in the second step of the conceptual phase.

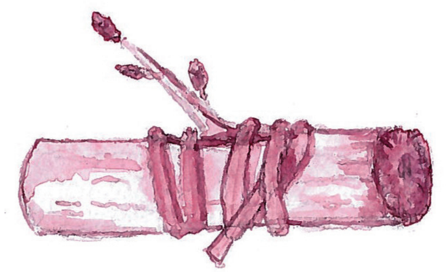
Ill.42 Pruning, Own illustration



PART III - DESIGN DRIVERS

Ill.43 Happiness, Own illustration

CONCEPT



In growing vineyards, a botanical graft is a common technique of plant manipulation which consists in inserting into a receiving plant, named “stock”, a different plant’s shoot or twig, usually of the same species, and mending the two with a binder so that the latter can grow from the former (ill. 44). The result is a hybrid plant giving peculiar flowers and fruits.
Analogously, in the project, music is grafted into wine-making. In the process both parts benefit from each other. The grapevine process is cut off on its stem in order to receive the “music shoot”. In fact, in this innovative rural establishment, Music is grafted into the typical wine-making production process, enhancing its quality in terms of product and space, with the visitors to bind the two elements and make the combination of wine and music vibrate.
Architecture is the key to expressing the graft, throughout its shapes, atmospheres, elements, spaces. Indeed, the architectural shape voices the “graft” concept through the lateral insertion of a musical facility interfering within a wine-production block, to represent the shoot added onto a different plant stem (ill. 45). The meeting point between the two different entities brought together is a hybrid space dedicated to the visitors of the establishment.

Ill.44 Graft, Own illustration

Ill.45 Concept: the Graft, Own illustration

COMPOSITION PRINCIPLE

The building elevation is the materialisation of a metaphor. Indeed, the facade expression and its architectural language are a built translation of the language of music.
The written form of the latter is the musical score, the essential base for the writing of a melody through notes. It reminds of something fixed, strong, basilar, with a regular horizontal geometry. The notes instead, interrupt and overwrite themselves on the score, carrying a melody of lightness and fluidly dancing together in their heterogeneity and articulation (ill. 46).
This poetical image can be translated into Architecture, considering a score as being a long, horizontal and solid block as a departure base of omogenous aspect. On this block, some lighter structures presenting sinuous-shaped roofs, translate the harmony of the music notes into Architectural language, to be read while approaching the building from its facade and while experiencing its atmospheres.

Ill.46 Composition Principle, Own illustration

DESIGN CRITERIA

Integration in Landscape:
The new winery needs to be inserted within the natural as well as artificial context in a reciprocal relationship in which the landscape exalts the architecture and the architecture glorifies the landscape

Landmark:
The project must represent a landmark. It has to be visible and recognizable as outstanding in the surrounding area and catch the attention of the passerby or indicate to intentional visitors that they are on the right way, just as a lighthouse guides a boat to a harbour

Functionality of Production Process:
A winery is to wine what a furnace is to bricks. Indeed, a winery is above all a factory transforming grapes into wine, thus the production process must be articulated in a functional and practical manner, rationally designing the spaces according to the steps of wine-making and easing working operations

Reinterpretation of Techniques:
Learning from the past to conceive a modern building. Some typical and traditional building techniques of Tuscan architecture will be dusted off and reinterpreted under a fresh look involving detailing as well as structural strategies

Acoustics:
Acoustics must be considered while designing a building that grafts the theme of music in its midst. Sound has to propagate and be received in the right way: therefore, acoustics strategies shall be integrated within the Architecture, driving, to a certain degree, the design

Production Process + Visitor's Path:
The grape will take the lead. Its transformation process into the bottle of wine will dictate the track to be followed by the visitors during their discovery of the winery. Music will be the common ground between the grape's track, the workers' one, and the visitor's path

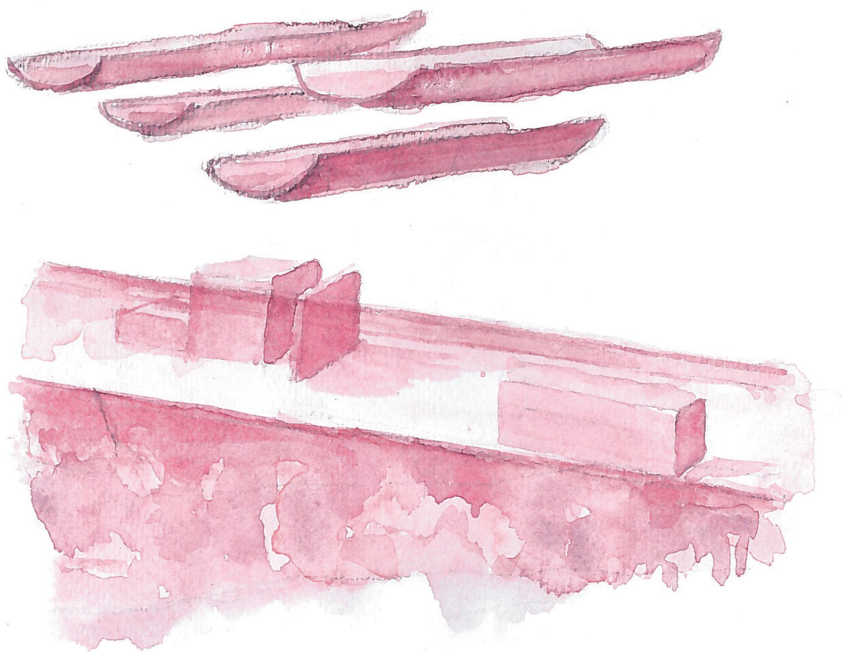
Ambiance Design:
Architecture is a great tool. Through different treatments on materiality, light, structure, space and sound, it can shape a characteristic atmosphere. This ambiance shall awaken and gather the human senses in a synaesthetic architecture

Sustainable Approach:
Each new building should be respectful of sustainable matters. A factory treating an element derived from the soil, shall, for even stronger reasons, lead the way. Thus, several passive strategies can be considered in order to reduce the needs of a highly demanding establishment in terms of resources

ROOM PROGRAMME

	Room #	Room Name	Function	Area m^2
WINE PRODUCTION AREAS	3	Oak Room / Barriquerie	Wine ageing in oaks	1050,5
	4	Bottling & Labeling Room	Wine bottling & labeling	43,0
	1	Fermentation Room	Wine fermentation in vats	560,0
	2	Laboratory	Wine experimentation	28,5
	9	Loading Zone	Shipment	304,0
	7	Machine Room	Machinery and systems	37,6
	6	Refinement Room	Wine refinement in bottles	320,5
	28	Grape Reception Area	Grapes processing	131,0
	8	Stocking Room	Bottle Cartons stocking	84,6
	5	Restrooms	Service	7,7
VISITORS' AREAS	14	Access Staircase / Audience	Access / seating	317,0
	12	Coatroom	For visitors	8,9
	13	Main Hall / Music Hall	Music performances	97,4
	10	Reception	Welcoming visitors	53,3
	35	Outdoor Restroom	Wine shop service	3,2
	32	Outdoor Restrooms	Wine bar service	13,5
	30	Outdoor Stage	Outdoor performances	74,2
	9	Parking	For employees and visitors	304,0
	11	Restrooms	Reception service	8,6
	29	Terrace	Outdoor area	970,0
	36	Wine Bar	Wine and food service	119,0
	34	Wine Shop	Wine selling	18,0
	33	Wine Tasting Area	Wine tasting	35,0
	31	Wine Tasting (outdoor)	Outdoor wine tasting	23,0
EMPLOYEES' AREAS	27	Canteen	For employees	79,5
	16	Changing Rooms	For employees / musicians	34,5
	17	Employees' Room	Employees' recreation time	30,7
	26	Kitchen	For canteen and wine bar	47,5
	25	Meeting Room	For employees	38,2
	23	Office (director)	For employees	21,7
	24	Office (shared)	For employees	34,0
	22	Office (small)	For employees	12,0
	15	Relax Area	Musicians' recreation time	41,5
	20 - 21	Restrooms	For employees / musicians	28,0
	18	Storage	Employees' service	9,0
	19	Technical Room	Systems	4,0
			TOTAL ROOM'S AREA	4993,1
			BUILDING'S GROSS AREA	5369,1

	Temperature °C	Humidity (RU) %	Natural Light	Comments
	12 - 16	70 - 100		Underground
	-	-		
	25 - 30	50 - 70	x	Natural ventilation
	-	-		
	-	-		Outdoor
	-	-		
	16 - 18	< 50		Dark environment
	-	-	x	Outdoor
	16- 18	< 50		
	-	-		
	-	-		Acoustic quality
	-	-		100 coats
	-	-	x	Acoustic quality
	-	-		
	-	-		
	-	-		
	-	-	x	Landscape view
	-	-		70 spots, outdoor
	-	-		
	-	-	x	Outdoor
	-	-	x	Landscape view
	-	-	x	
	-	-	x	Landscape view
	-	-	x	Landscape view
	-	-	x	30 employees
	-	-		
	-	-	x	
	-	-	x	Connected to Wine Bar
	-	-	x	
	-	-	x	
	-	-	x	
	-	-	x	
	-	-	x	
	-	-		
	-	-		
	-	-		



PART IV - PRESENTATION

Ill.47 *Architectural Score, Own illustration*

MASTER PLAN

Three internal dirt roads meet: the one to the north for transporting the harvested grapes, the one to the east slightly sloping down for the visitors to reach the winery from the parking site, the one to the south for the final product to leave the winery and be delivered. This is the spot where the building lies respectful of the place, flirting with the site's boundaries, yet clearly visible from the two departmental roads. To the west side, the long and slightly tilted parallelepiped is marked by a wooded area embedding a small lake. To the other sides, the mighty vineyards of the property to gently embrace the building. The wooden structures on the roof are the first visible element of the building, while the access staircase is the first architecture part linked to the built block to be walked.
From a top view, the establishment is a composition made up of a light-brown and yellowish brick base and some lighter elements in the same colour and material as the wooden structure of the roofing or the access staircase to the building. The roof terrace offers a panoramic view of the 50-hectare property and a 360-degree view of the landscape uphill and downhill onto the Maremma region.

Ill.48 Master Plan, 1:1000, Own illustration

FLOOR PLANS

The Floor Plans are organized in a linear and rational way.
The Cellar Floor (ill. 49) hosts the rooms dedicated to wine production along the whole length of the building, from the Fermentation Room to the Stocking and Logistic Areas.
At Ground Floor (ill. 50), the distinction of the two wings and the Main Hall are clear: the north wing is occupied by the Fermentation Room that develops itself in double height, and the Reception area that disperses the flows by ramps and staircases. The southern wing is the employee's area: offices, meeting room, services and recreational areas are planned for their use.
The Terrace (ill. 51) is constituted by a large outdoor area partially shaded by wooden structures, which cover multiple functions, such as wine-tasting and shop and wine bar.

Ill.49 Cellar Floor Plan, 1:500, Own illustration

GROUND FLOOR PLAN

10 . Reception
11 . Restrooms
12 . Coatroom
13 . Main Hall / Music Hall
14 . Access Staircase / Audience
15 . Relax Area
16 . Changing Rooms
17 . Employees’ Room
18 . Storage
19 . Technical Room
20 . Ladies Restrooms
21 . Gentlemen Restrooms
22. Office
23 . Director’s Office
24 . Shared Office
25 . Meeting Room
26 . Kitchen
27 . Canteen

Ill.50 Ground Floor Plan, 1:500, Own illustration

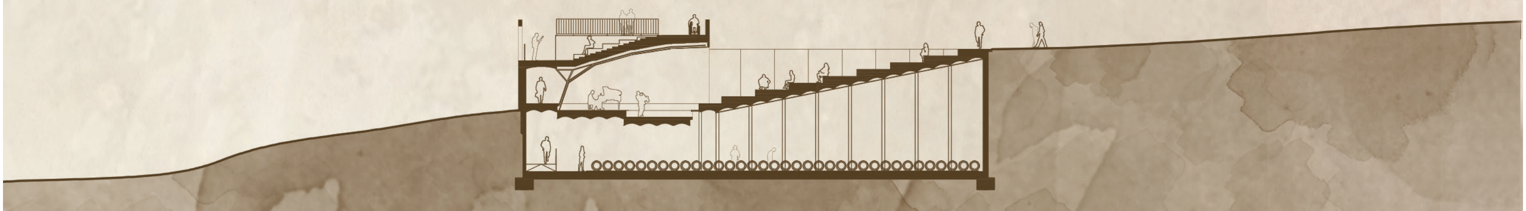
TERRACE FLOOR PLAN

28 . Grape Reception Area
29 . Terrace
30 . Outdoor Stage
31 . Outdoor Wine Tasting Area
32 . Restroom
33 . Wine Tasting Area
34 . Wine Shop
35 . Restrooms
36 . Wine bar

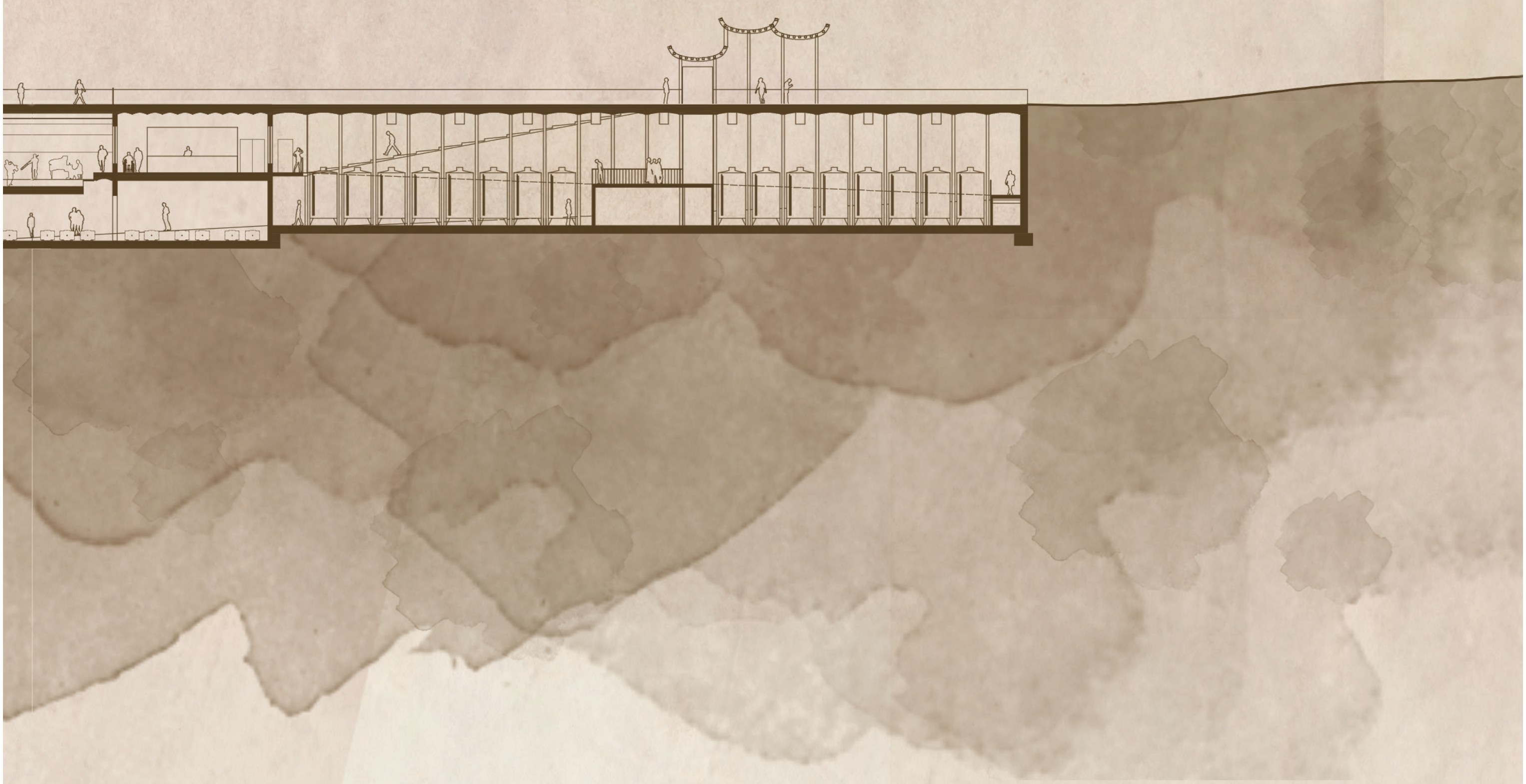
Ill.51 Roof Plan, 1:500, Own illustration

SECTIONS

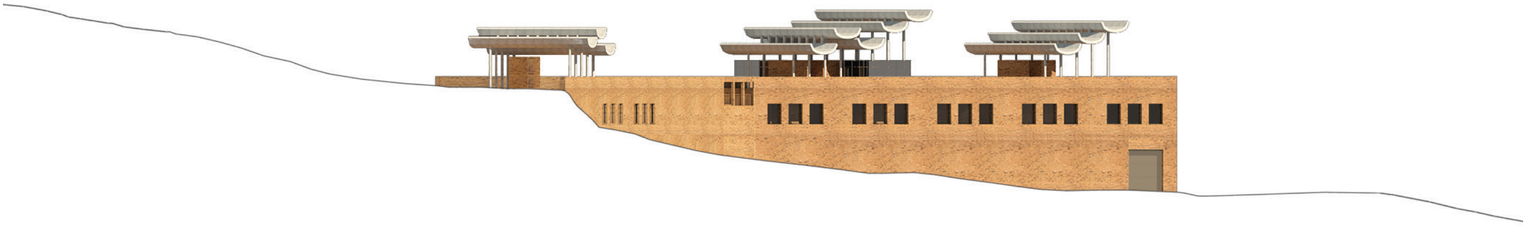
Ill.52 Section A-A', 1:500, Own illustration



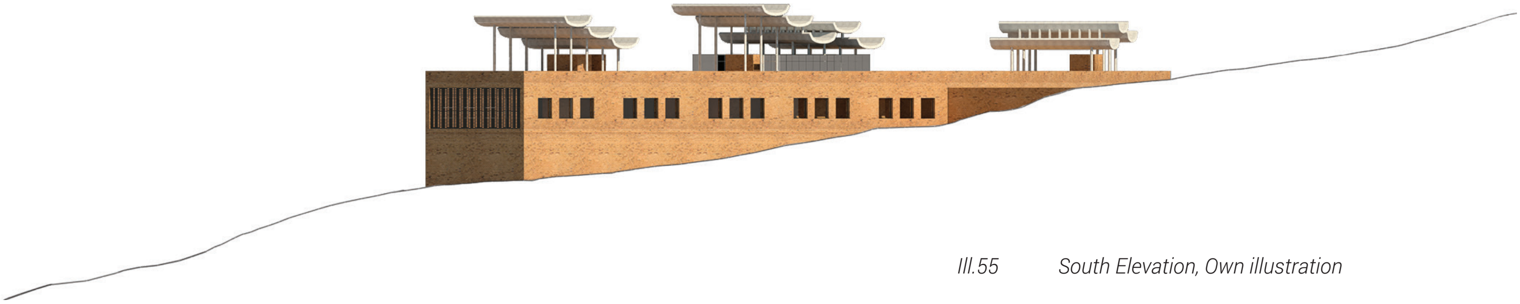
Ill.53 Section B-B', 1:500, Own illustration



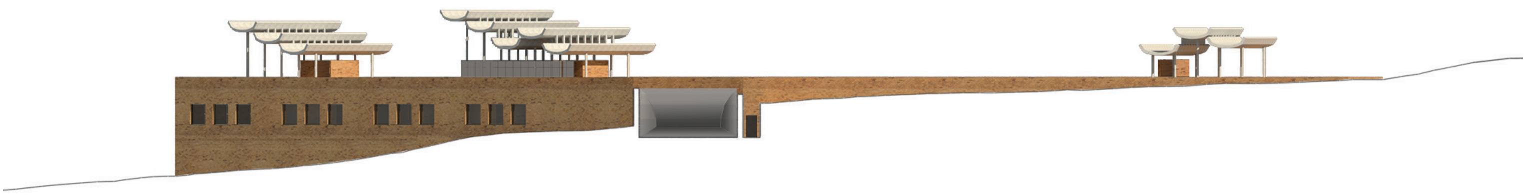
ELEVATIONS



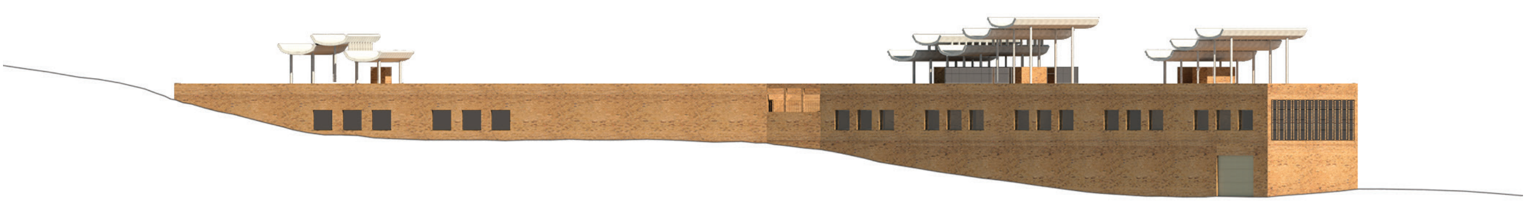
Ill.54 North Elevation, Own illustration



Ill.55 South Elevation, Own illustration

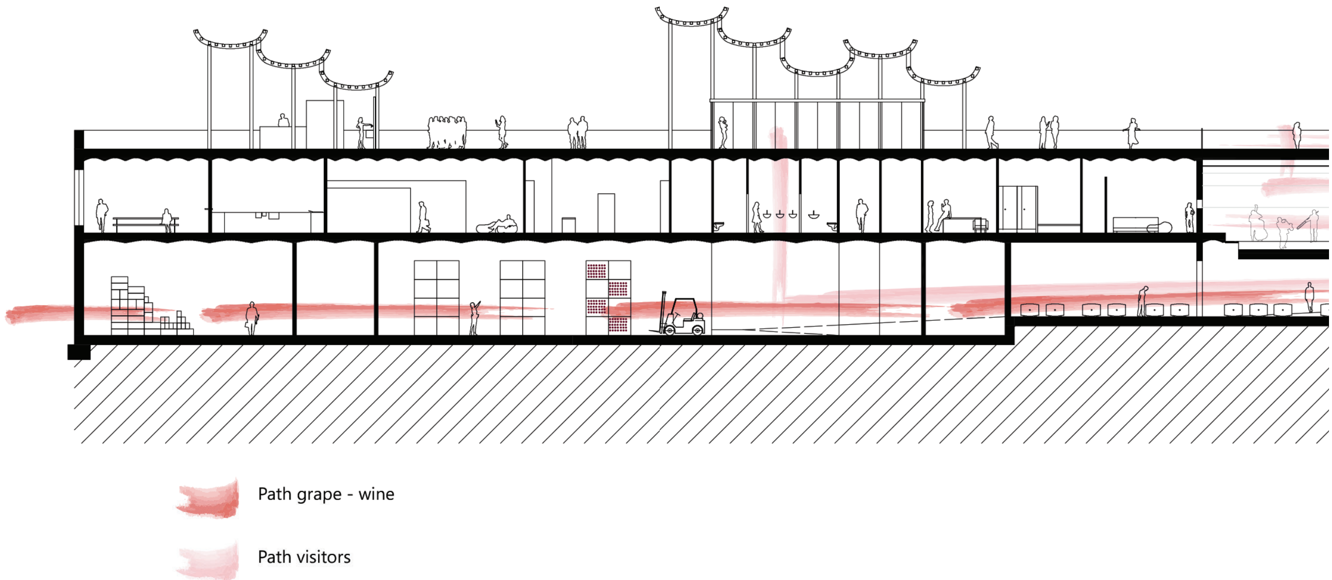


Ill.56 East Elevation, Own illustration



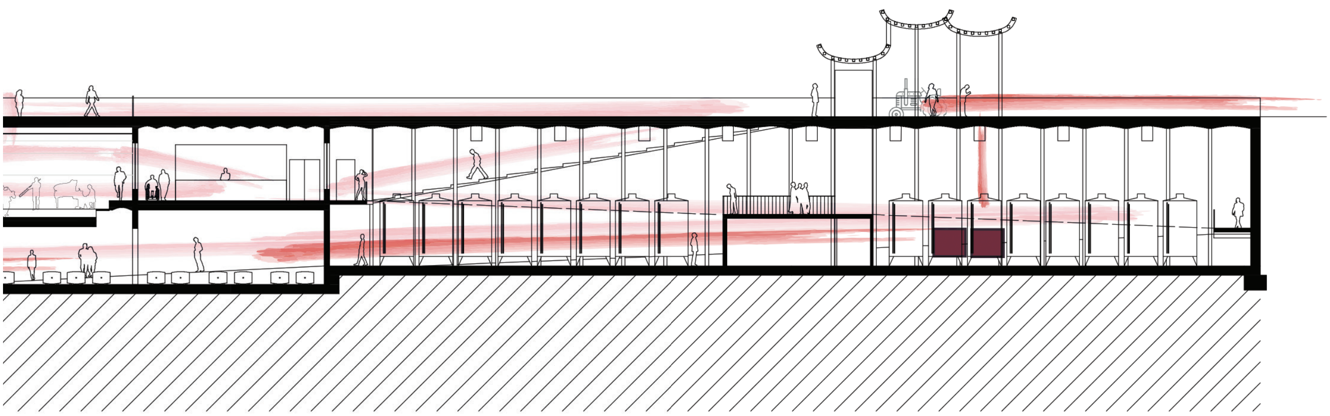
Ill.57 West Elevation, Own illustration

PATHS: WORKERS & VISITORS



During the harvest period starting from late September, the grapes are collected and directed by means of tractors onto the Terrace to the shaded area under the wooden structure to the north. Here, the grapes, are separated from the stalk and pressed. The liquid, together with the peels, moves vertically into the steel vats of the Fermentation Room, falling in tubes through opening chutes placed on the terrace floor.
The grape juice ferments there for a period of two to six months before being siphoned, with the use of gravity, in the oaks or *barriques*, into the adjacent room, the *Barriquerie* or Ageing Room in which the liquid rests for up to three years for the *Brunello di Montalcino*. After this period, the wine is bottled and undergoes a refinement process, which lasts up to one year depending on the kind of wine.
Before being stocked in boxes waiting for the shipping, the bottles are labelled in the labelling room.

The visitor's path starts with accessing the building from the stone staircase, which also serves as stands for the audience of the Music Hall. From there, visitors are directed to the Reception where they are welcomed. Here the guided tour starts. Bypassing the Reception, an



Ill.58 Visitors' and workers' paths Scheme, Own illustration

exterior flight of stairs leads users to a landing that serves as a stage for what can be a small outdoor performance hall. Integrated into this, a second staircase brings the visiting group to the Terrace Floor. Here, on their guided walking tour, the visitors are given an outline of the history and the concept of this special place, while contemplating the property productive yards. The area underneath the wooden structure, where the first treatment of the grapes takes place, is shown.
Afterwards, the visitors are brought back, down into the Fermentation Room through a long, comfortable staircase set between two walls, one of which is glazed, offering attractive glimpses of the Fermentation Room. A ramp descending all around the perimeter of the latter, guides the visitor to the production Cellar Floor. From there, the ramp follows the path of wine down to the *Barriquerie* and then to the Refinement Room, where a staircase invites the ascent towards the wine tasting area on the Terrace.
Finally, the visitors are free to distribute themselves on the large area of the roof; buying wine, sitting at the Wine Bar or simply enjoying a walk, where they can admire the hilly landscape as far as their eye can reach.

MATERIALS

Architecture is a concrete art. Hence, it is about materiality. A material confers the building a peculiar texture, colour and in some cases smell. The choice of the materiality is mostly based on the availability of the materials in the Tuscan region. The bearing skeleton of the building is reinforced concrete and steel beams. The concrete perimeter walls are left "naked" in the inner side, giving the interior a smooth simple surface, suitable for the production work. The several steel beams running from one side to the other of the building are perceivable only from their bottom part as they are filled in their height with the structural system of the *voltina*. The ceiling appearance is thus defined by the clay puzzle of the typical Tuscan flat bricks called *mezzane*.

The outer skin of the winery is made of bricks. Masonry is very common in the typical Tuscan rural architecture. Its reddish and warm colour and slightly rough texture makes the facade vibrate and constantly change under the diverse lights of the day and integrates in the palette of a burning Nature in the Autumn season without clashing against the context in the other times of the year. In order to create formal differentiation from the bricks, another material is introduced. The Main Hall and the entrance staircase are indeed covered with travertino, a light-colour stone characterised by a smooth surface. It is comparable to Carrara white Marble, but with a beige shade, and presents some slightly brownish marbling that makes it a very rich and elegant stone. This colourwise lighter entrance Auditorium/Ramp dialogues with the light shades of the shell structures on the terrace, for which an ash wood was preferred to concrete for its light weight, its flexibility in the structural system and its texture and modulation of light. In addition, wood is the material of the roof for all the Tuscan *poderi*: in the same way, the idea is to "crown - the building - towards the sky" (VACCHINI, 2006) with the same material.

Last but not least, glass is the material of light and of flexibility for the terrace's boxes, the windows as well as for the closure system for the Music hall. With extendable systems that can be packed during the warm season it gives flexibility to the space and grants the possibility to close down whenever needed.

Ill.59 Materials collage, Own illustration

AMBIANCES

Structure, light, space, sound, taste, smell, colour and many other elements are devices to offer the user a unique experience every time a door is opened, enriching his/her journey through the winery. Here, tectonics is expressed not only as a structural system, but also as a generator of sensations by creating spaces for what is a veritable *promenade architecturale*.

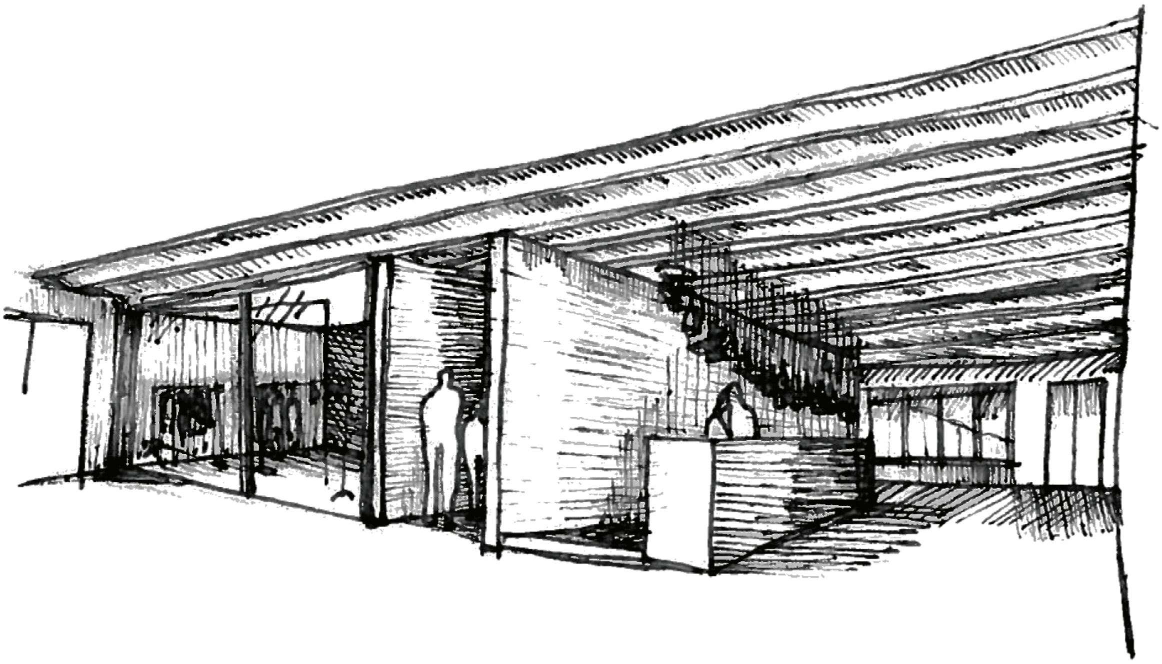
APPROACHING THE BUILDING: *The waltz*

Walking the road leading to the building, feels like walking onto a music sheet. The deep but smooth perspectives offered by the three-metre wide lanes of musical vines escort the visitor and wrap him up like a transporting waltz. The building's massive basement reveals itself while increasingly approaching it, softened by the "light" structures on the terrace, which are visible from the beginning. The walk is a delight for the two senses of sight and hearing.

MAIN HALL: *Music for people and wine*

The steps of the staircase are also seats, as the entrance of the building also serves as Music Hall, where music is played for an audience of visitors as well as for the wine. An enveloping, transitory space, between inside and outside, a cross between users, a sounding box reaching the ears of the listeners as well as knocking on the wooden membrane of the *barrique*: these are the facets of this hybrid room, in which music meets wine.

Ill.60 View of the Main Hall from the Outdoor Staircase at Ground Floor, Own illustration



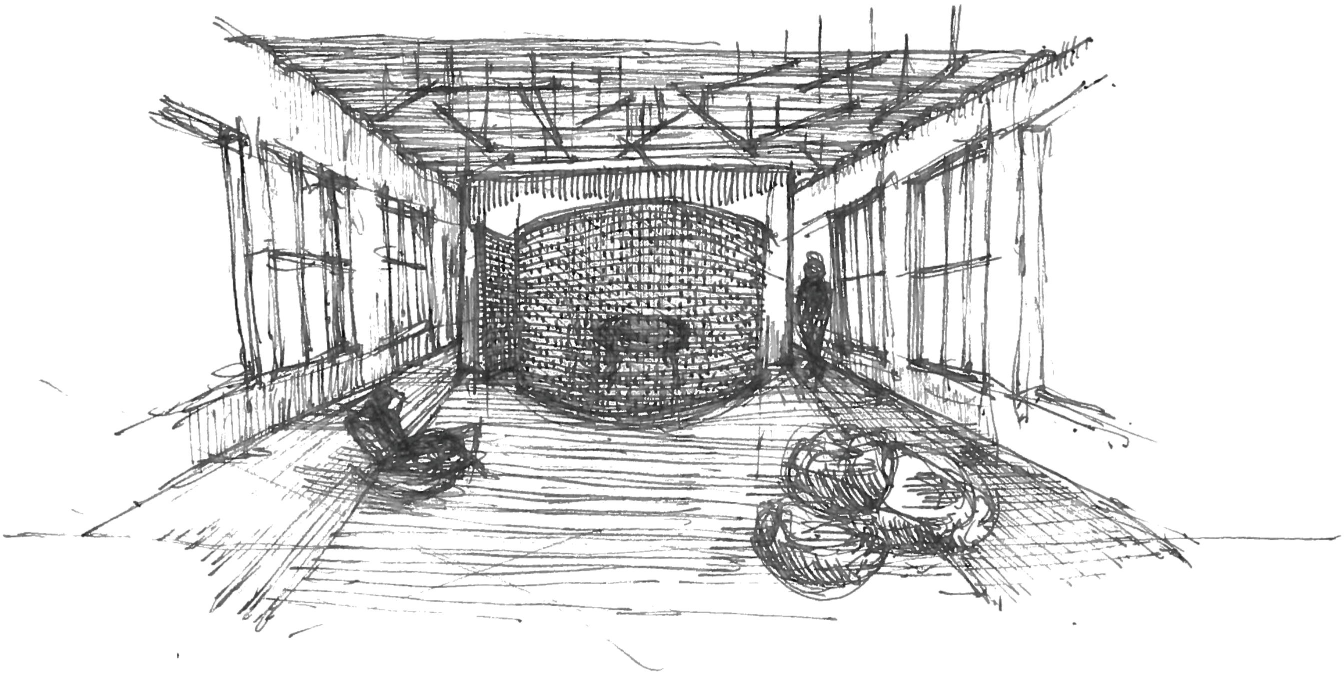
Ill.61 View of the Reception from the Main Hall at Ground Floor, Own illustration

EMPLOYEES’ AREA: *Working all together*

The area dedicated to the people that make all of this possible is a long wing of the building including work, recreational spaces as well as services. Some empty spaces are to be interpreted by the users. The main atmosphere can be qualified as light, peaceful and lively at the same time. The area is bathed in natural light and the presence of some transparent walls offers interesting indoor perspectives but also stunning views of the Tuscan landscape.

FERMENTATION ROOM: *The Cathedral of Wine*

The fermentation room is the first space entirely dedicated to the rituals of wine production of wine. It is high and enlightened by the side openings bringing a warm, delicate beam of light in the summer late afternoons, and by the zenithal manholes cut out in the vaulted ceiling. Daylight sculpts a space invaded by light and shadows. Passing the reception door feels like entering a cathedral: two rows of columns divide the space into three “aisles” that the visitors to the winery will be able to walk along the three axes - length, width and height - thanks to the ramp. The main features of the cathedral are the majestic steel vats containing the divine liquid to which all the goodwill prayers are addressed.



Ill.63 View of the Meeting Room from the office corridor at Ground Floor, Own illustration

Ill.62 View of the Fermentation Room from the corridor at Ground Floor, Own illustration

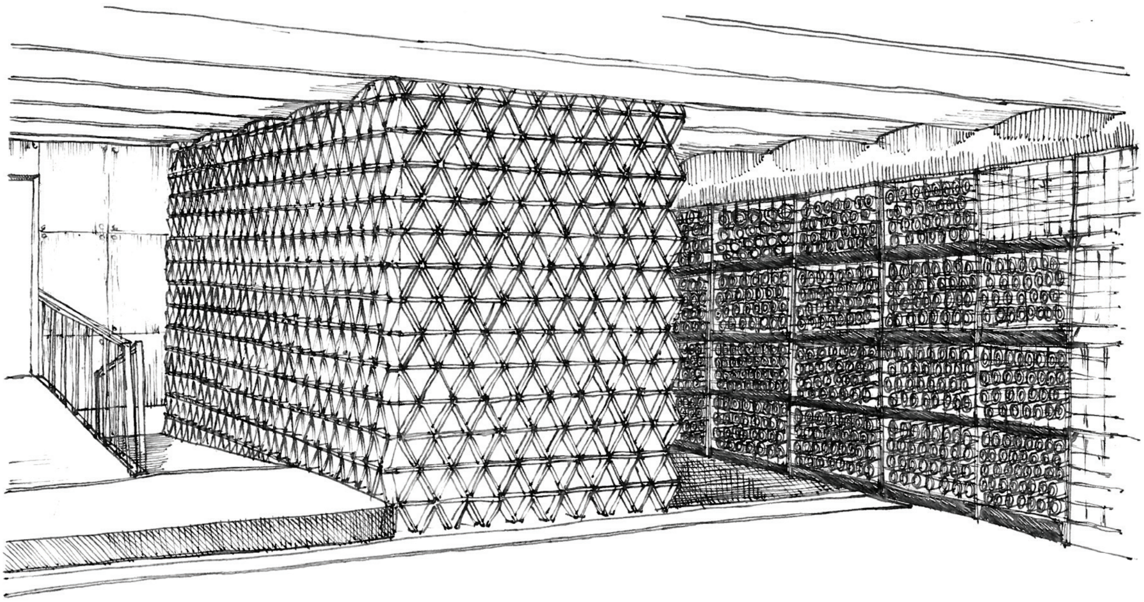
THE AGEING ROOM: *The precious crypt*

The visit continues in the Ageing Room. Passing from the Fermentation Room into the Ageing Room feels like descending into the crypt of a church. A lower ceiling with the typical Tuscan *voltine*, defines a dark, fresh and humid space, mostly dug inside the hill. The curved ceiling has a dialogue with the curves of long lanes rolling *barriques* placed on rails, that shape long perspectives. Natural light is kept away from this precious room; only some small hanging lamps allow the room not to be plunged in total darkness. This is the place where the ageing wine receives the additional taste of music.

REFINEMENT ROOM: *The Glass Castle*

Stepping into the refinement room gives the visitor the feeling of being in a glass castle whose walls are covered with large hampers full of bottles of red wine. A very technical and logistical area where the last treatment on wine is made before stepping over the exit door of the winery and ending up in a glass. A central staircase, gently trapped in-between a permeable wall of *mezzane* following a typical Tuscan rural pattern, ascends vertically towards the upper floors, offering framed views towards these bottle towers.

Ill.64 View of the Ageing Room from the corridor at Cellar Floor, Own illustration



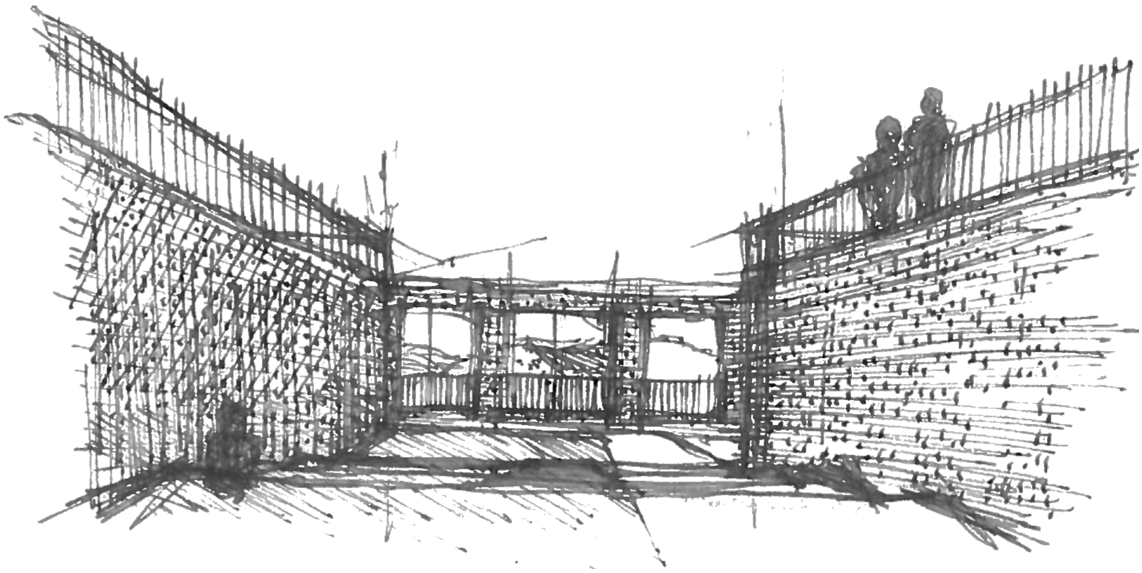
Ill.65 View of the Refinement Room from the corridor at Cellar Level, Own illustration

ROOF TERRACE: T*he stage of the Landscape Show*

The immense terrace can be walked on in its totality. It is the ideal place where to enjoy a walk under the Italian Sun, sensing the warmth released by the masonry floor. This is the place that offers that offers a full view of the vineyard and a panorama of the surroundings. The terrace is also a space that can stage a small outdoor music or theatre performance with the dramatic backdrop of the surrounding natural setting.

WINE TASTING: *Protected by the notes*

A crossable space, the area defined by the structures standing on the terrace hence integrates itself in the walk on the roof. The attention is attracted towards the ceiling. Indeed, the convex ceilings deserve a look from the visitor, attracted to the soft appearance rendered by the curvy shape mirroring the ones of the surrounding hills and the light painted by a gentle touch on the curve. Here, the construction, together with the light that the structure invites in, modulates a free, ventilated and shaded space to be closed or opened up in boxes where to drink a glass of wine that tastes of music.



Ill.66 View of the Outdoor Stage from the Staircase at Terrace Floor, Own illustration

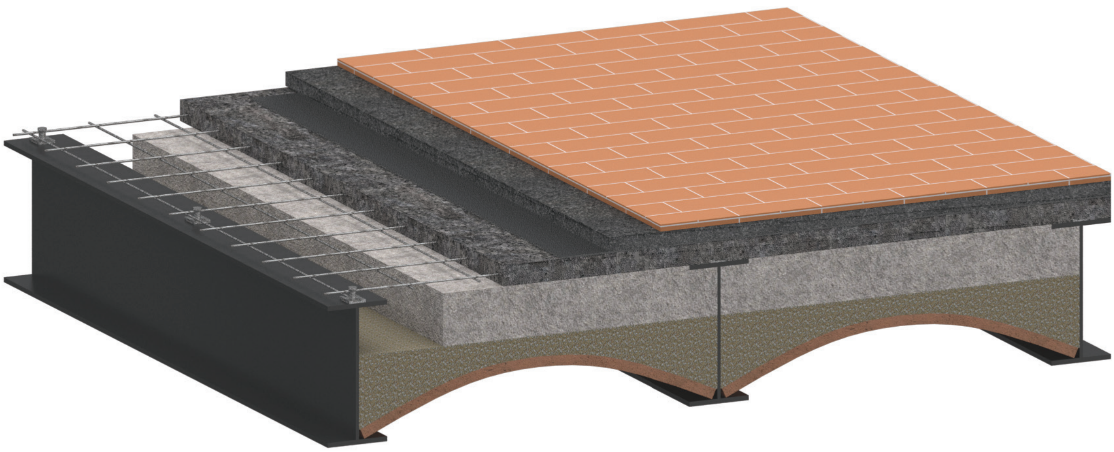
Ill.67 View of the Wine Tasting Area from the Terrace, Own illustration

VOLTINA STRUCTURE

The interest in the *soffitto a voltine* (Italian for "small vaults ceiling"), as explained before, was dictated by the idea of using traditional Tuscan building techniques that could give the building a strong sense of affinity with the local building tradition. For this reason the technology has been used and optimised following contemporary techniques that enhanced its performance without depleting its strong appearance. A focus on the stages of the design can be found in the Design Process section at page xx.

The final structure combines the three main materials – steel, reinforced concrete and masonry – in a collaborating slab in which the various elements take different kinds of stresses: the reinforced concrete and the masonry are in compression, while most of the steel beam is in traction (Barbisan in Benvenuto et al., 1994). The collaboration between the parts is made possible by the mechanical insertion of steel stud connectors between beams and the welded mesh that is reinforcing the concrete (ill. 68). With this solution the masonry, which functions both as finishing and formwork, is covered by a light filling, insulation and reinforced concrete, while the steel beams' cross-section, as explained later in the Design Process, is reduced by 15% (Tecnaria, 2018).

This solution is developed in two variations depending on the pitch of the steel beams: 225-centimetre pitch is used in tall rooms, such as Fermentation Room and Refinement Room; 112,5-centimetre pitch is used in the rest of the building. Dimensioning of the beams, which can be seen in the table below, was made with the use of the software Robot. Double T profiles are chosen, IPE 500 for wider vaults and IPE 400 for the others (ill. 69). The important dimensions of the cross-sections derive from the fact that the roof is accessible not only from visitors but also from small trucks bringing the grapes during the harvest season and therefore the loads the roof structure needs to support are calculated on this worst possible scenario (see Appendix 3 at page xx).



Ill.68 Slab detail axonometric view, Own illustration

Room	Span	Pitch	Beam Cross-section	Slab Thickness
-	[m]	[m]	[mm]	[mm]
Fermentation Room	8,0 (12,5)	2,250	IPE 500	625
Oak Room	9,5	1,125	IPE 400	565
Refinement Room	12,5	2,250	IPE 450	615
Offices Wing	12,5	1,125	IPE 500	625
Main Hall	12,0	2,000	IPE 400	600

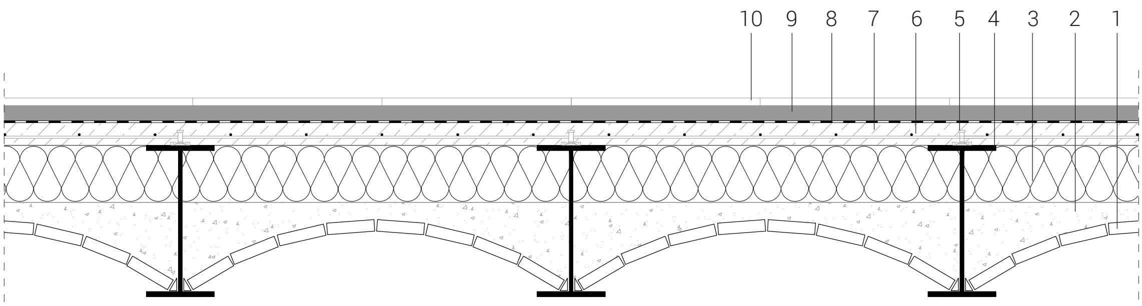
Ill.69 Beam dimensioning Table, Own illustration

VOLTINA DETAILS

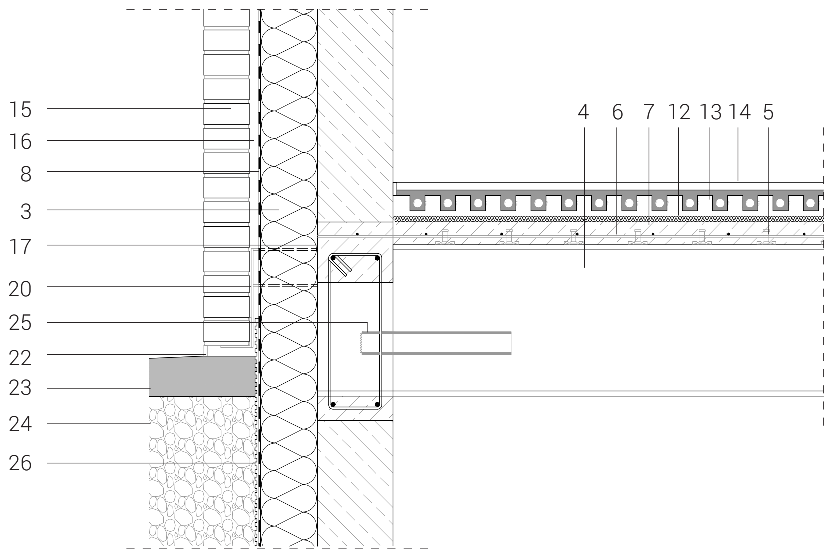
The design of the details has had a considerable impact on the overall architectural expression. The structural system chosen for the building, which in its variations is able to create certain ambiances, had to be designed in a very detailed scale in order to understand its functioning and to perfectly integrate it in the project.
The attention was focused on the slab system and the connection of this with the load bearing concrete walls.
In the first case (ill. 70), as explained, a collaborating slab is designed with the use of reinforced concrete connected through steel stud connectors to the steel beams. The system is finished, and enclosed on its lower side, by small masonry vaults, the *voltine*.
In the second case (ill. 71 - 72) the solution was achieved by using connecting elements between the slab's reinforced concrete welded meshes and the reinforced concrete kerb of load bearing walls. The latter are then finished on the exterior with a brick hung facade.

Legend

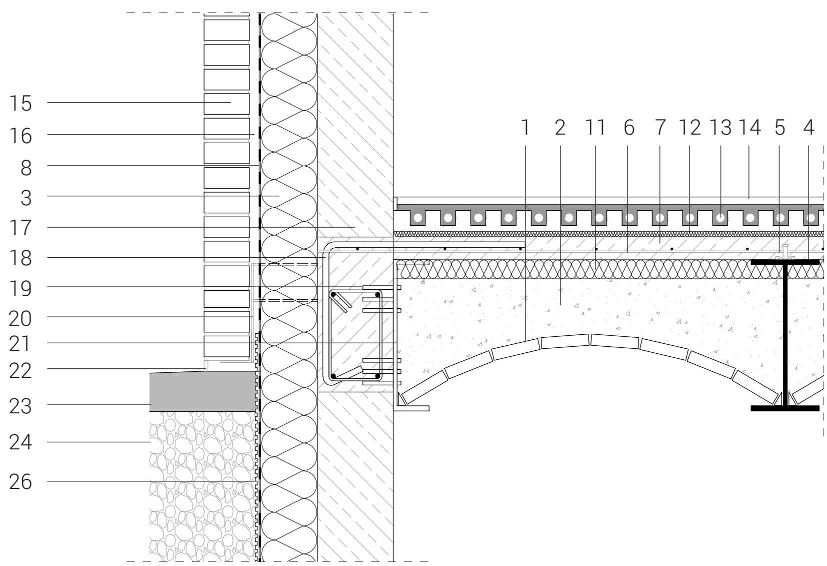
1 - 30 mm - Masonry (*mezzane*)
2 - 45 mm - Light filling
3 - 150 mm - Insulation Board
4 - 400 mm - Double-T Steel Beam IPE 400
5 - 40 mm - Steel stud connector Tecnaria CTF
6 - Ø 6 mm - Welded mesh
7 - 60 mm - Reinforced concrete
8 - 3 mm - Waterproof membrane
9 - 40 mm - Floor screed
10 - 20 mm - Masonry flooring
11 - 50 mm - Insulation Board
12 - 15 mm - Acoustic insulation mat
13 - 70 mm - Floor heating system
14 - 20 mm - Concrete flooring
15 - 120 mm - Hung brick facade
16 - 30 mm - Air gap
17 - 200 mm - Reinforced concrete
18 - Ø 16 mm - Steel slab/kerb connector
19 - Ø 10 mm - Steel beam/kerb connector
20 - 4 mm - Steel hung facade connector
21 - 400 mm - C profile steel beam
22 - 3 mm - Metal grid
23 - 100 mm - Soil
24 - 800 mm - Gravel
25 - 5 mm - Steel angular connector
26 - 8 mm - Studded membrane



Ill.70 External slab Detail, 1:20, Own illustration



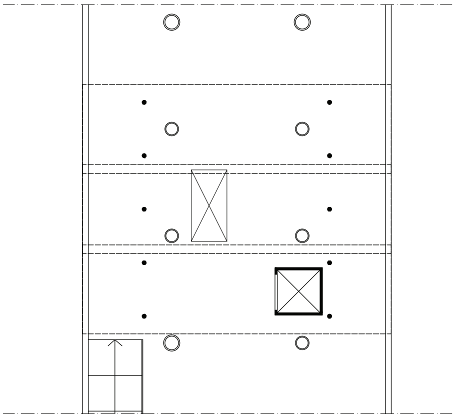
Ill.71 *Floor slab - Wall connection Detail, 1:20, Own illustration*



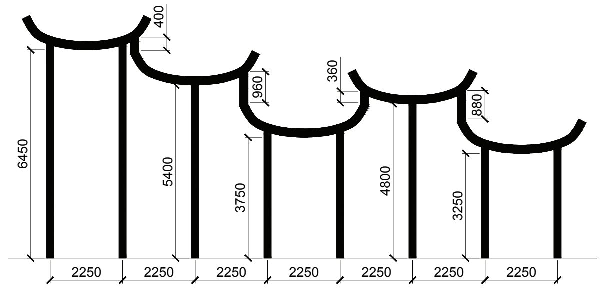
Ill.72 *Floor slab - Wall connection Detail, 1:20, Own illustration*

TERRACE WOODEN STRUCTURES

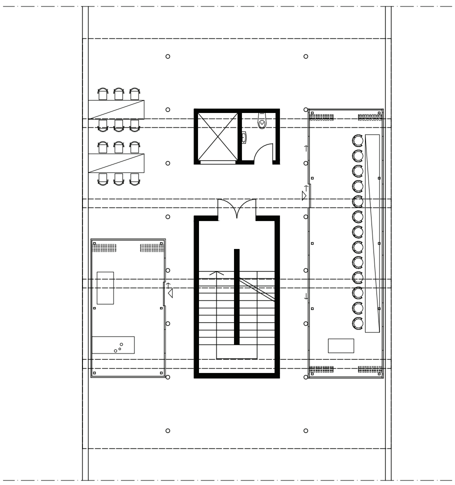
The three wooden structures on the roof, with their variable design, carry out a dual purpose.
Firstly, of all they offer shade for the functions located on the roof: starting from north the first structure covers the grape destalking and soft-pressing area (ill. 73), the second one protects the wine tasting and wine shop areas (ill. 74); the last structure shades the wine bar area (ill. 75).
Secondly, they constitute an element that can easily be recognised from far away and that "architecturally breaks" the building stiffness and solidity. Their design was in fact guided by the image of the musical score with its steady horizontal lines that are suddenly disrupted by a sequence of notes.
The final resolution of these elements presents a sequence of glue-laminated timber curved grid structures supported at various heights by few circular wooden columns (ill. 76). The asymmetric height variations of the grids enable light to travel through the openings and create variable natural lighting effects. The curvature of the grid is then covered by wooden slats that create a smooth surface on the upper part, while revealing part of the main curved beams in the lower part (ill. 77- 78). In fact the grid structure is divided into main glue-laminated timber curved beams, with a 180 by 260 millimetres cross-section, and secondary elements which are perpendicular to the main beams and have a 160 by 160 millimetres cross-section. Studies regarding shape, composition and dimensioning of these structures can be found in the Design Process section at page xx.
Underneath these wooden shading elements, where the hosted functions are permanent, extendable modular glass boxes are located. This choice is justified by the need to protect wine tasting and wine bar areas from meteorological precipitation while leaving maximum flexibility in terms of use of outdoor areas in the warm season.



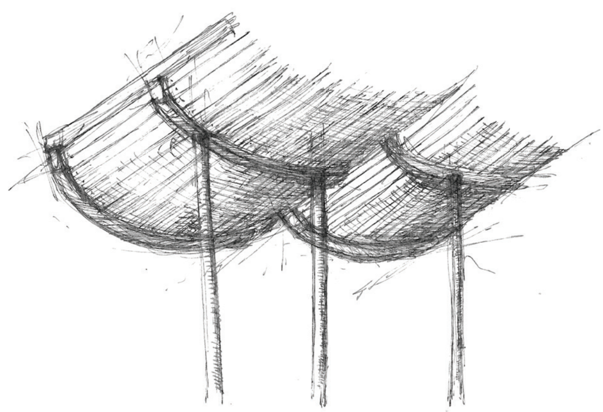
Ill.73 North Wooden Structure Plan, Own illustration



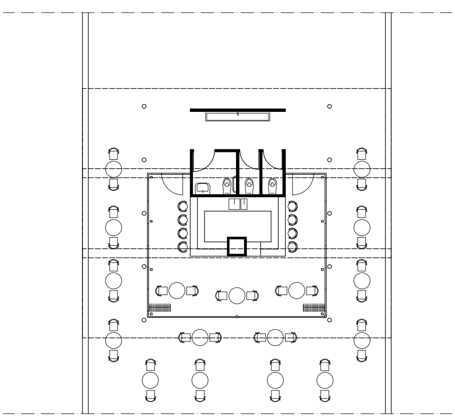
Ill.76 Central Wooden Structure East Elevation, Own illustration



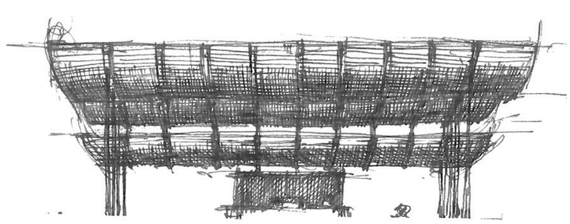
Ill.74 Central Wooden Structure Plan, Own illustration



Ill.77 Wooden Structure view from below, Own illustration



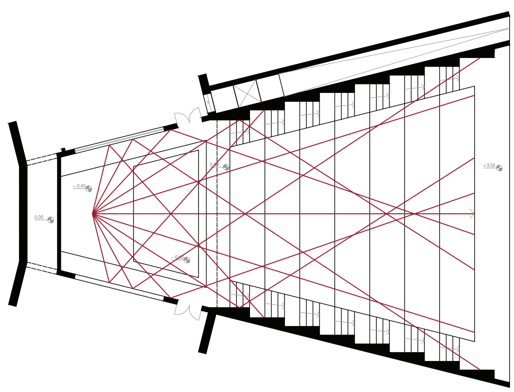
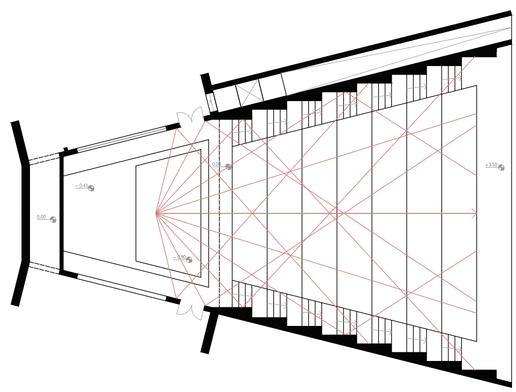
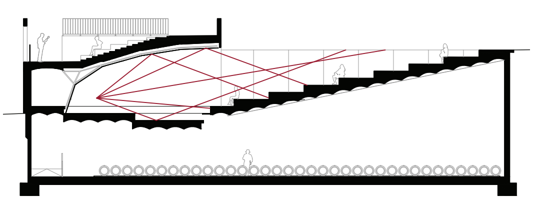
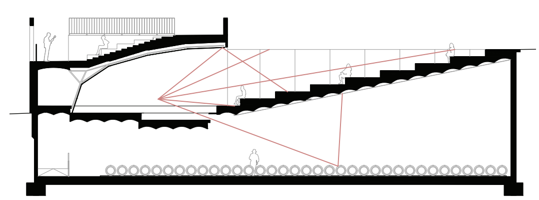
Ill.75 South Wooden Structure Plan, Own illustration



Ill.78 Wooden Structure view from side, Own illustration

ACOUSTICS

The design of the Main Hall has been driven among the others, by the acoustic qualities to be achieved. The space is intended to host two types of musical performance: a small one, in which few musical instruments and the audience can “fit in” the room; a bigger one, in which the room can stage a small orchestra and the audience can find seat on the outdoor entrance staircase. In this way the architecture is used as “sounding box” in order to diffuse sound both horizontally and vertically: the two main challenges of the design were in fact to diffuse sound in the outdoor staircase, where the audience is located, and in the lower floor, where the Barriquerie is located.
The result of the design is visible both in Floor Plan and Section (ill. 79). In the first case, a fan-shaped room diffuses the sound towards the audience, where the same shape is modified by straight walls that increase sound reflections on the sides of the staircase. In Section, the ceiling of the Auditorium is attached to the roof following the slope of its staircase and creating a composite curvature that increases sound reflections outwards; while the floor is divided in multiple sections that differ in height, granting a split from which sound waves can travel down to the Oak Room.
Numerical results of this solution are visible in Appendix 7 at page XX and further information can be found in the Design Process section at page xx.

Small Performance	Large Performance
Audience close to the Stage	Audience spread on the Staircase
Floor Plan	Floor Plan
	
Section	Section
	

Ill.79 Main Hall Acoustic Diagrams, Own illustration

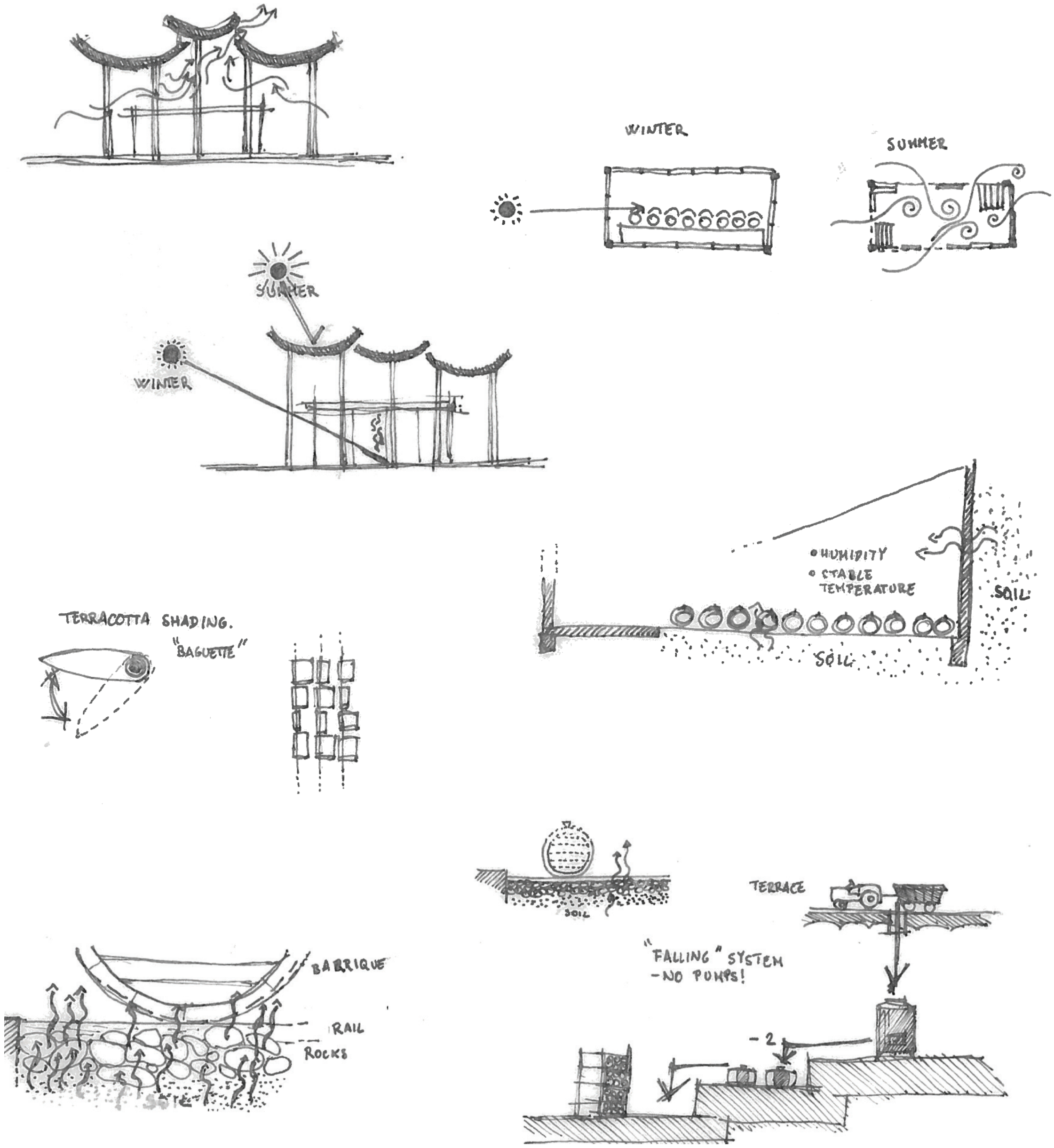
PASSIVE STRATEGIES

A certain number of passive strategies were considered in the integrated design process of the winery (ill. 80). In this regard, it is interesting to point out how important it is for the requirements of both the users and the precious product to be taken into account.

Regarding heating: passive heating is largely considered in this project. The places requiring a constant presence of people and hence demanding an agreeable indoor environment are subjected to the beneficial phenomenon of passive heating. At all times, through windows oriented south, east and west, daylight penetrates the building, notably during the winter when the sun angle is lower, passively heating the space. However, passive heating, together with a blinding quantity of light, can in some cases be excessive, as for the area facing south occupied by the employees' canteen. This space may risk overheating, especially during long Italian summer days. To face this issue, shading elements are installed in front of the large south window, regulating and modulating light and thus heating.
The glass boxes located on the Terrace are interesting examples of how to deal with heating. Indeed, the low winter sun reaches their transparent skin, heating the inside through a greenhouse effect. The burning summer sun instead, is intercepted by the curvy shapes of the wooden structures. In the summer, the box is undressed of its glasses, folded and packed in its corners. It is well known that wine is very sensitive to temperature and a quick important thermal shock could damage it irreversibly. To face this challenge, most of the production area is located underground. In this way, the temperature is kept stable as well as fresh and humid in the Ageing and Refinement Rooms. The concrete based walls of the whole building handle the temperature issue with their thermal mass, allowing a profitable thermal displacement along the day. Humidity is conducted by the walls retaining the natural soil as well as by special rocks placed under the *barriques* absorbing the humidity and releasing into the space from the ground.

Regarding ventilation: natural ventilation intervenes in several cases. As to the glazed boxes on the roof, the possibility of opening up the space offers a pleasant fresh breeze to the wine-tasting ritual. In the employees' wing, the specular windows on both sides facilitate refreshing cross ventilation. In the fermentation room instead, stack ventilation is provided by the opening chutes on the ceiling evacuating the air blowing across the production rooms and crossing the separating walls between Fermentation, Ageing and Refinement Rooms through air vents in the walls.

The energy demands are reduced starting from the very basic function of the building. In fact, the building is conceived to adopt what is called the "falling processing", as for most of the liquid's commutes, the gravitational pull is exploited, reducing the use of high energy demanding pumps. Also, the satisfying daylight intake in working areas minimises artificial lighting.

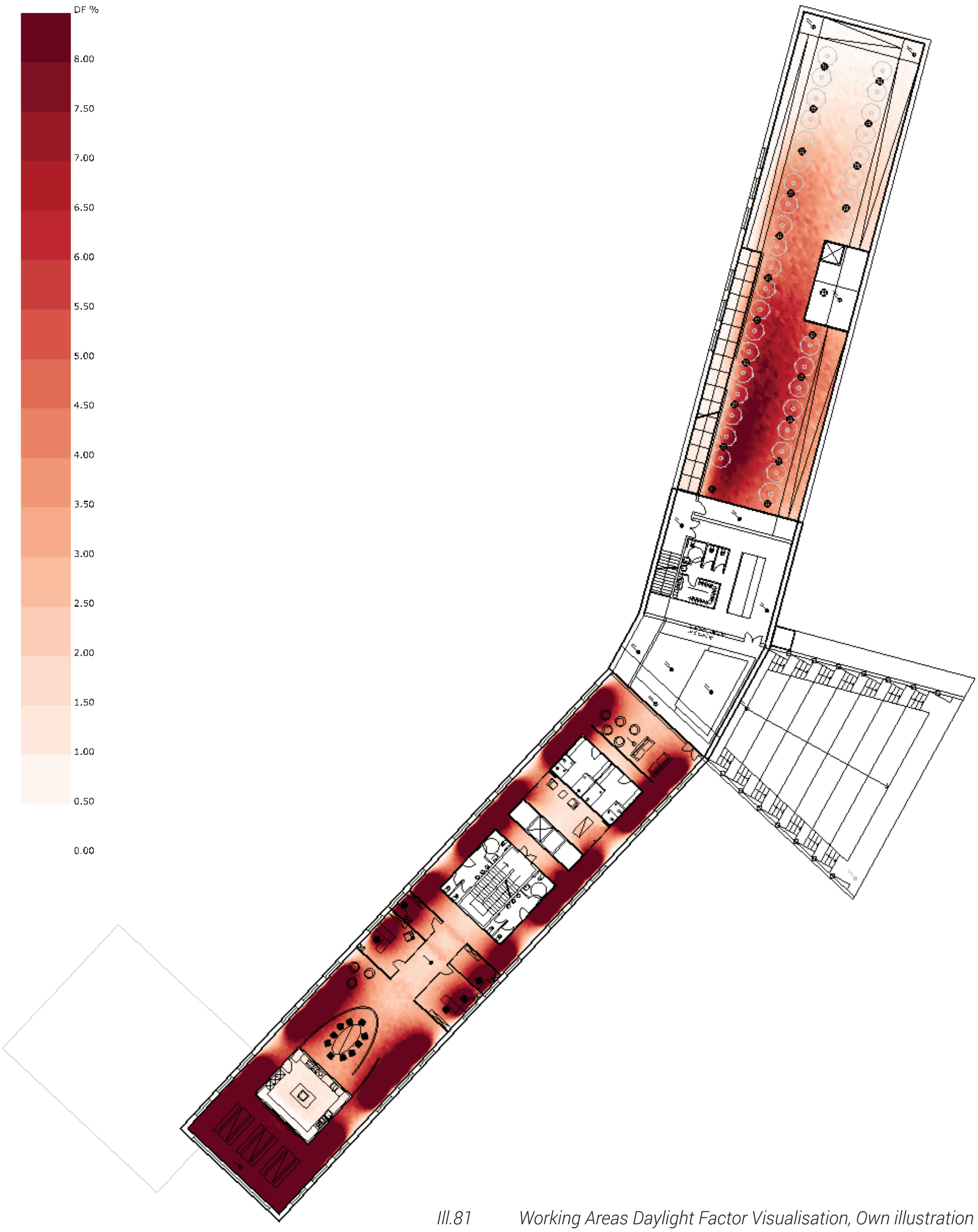


Ill.80 Sustainable Passive Strategies Diagrams, Own illustration

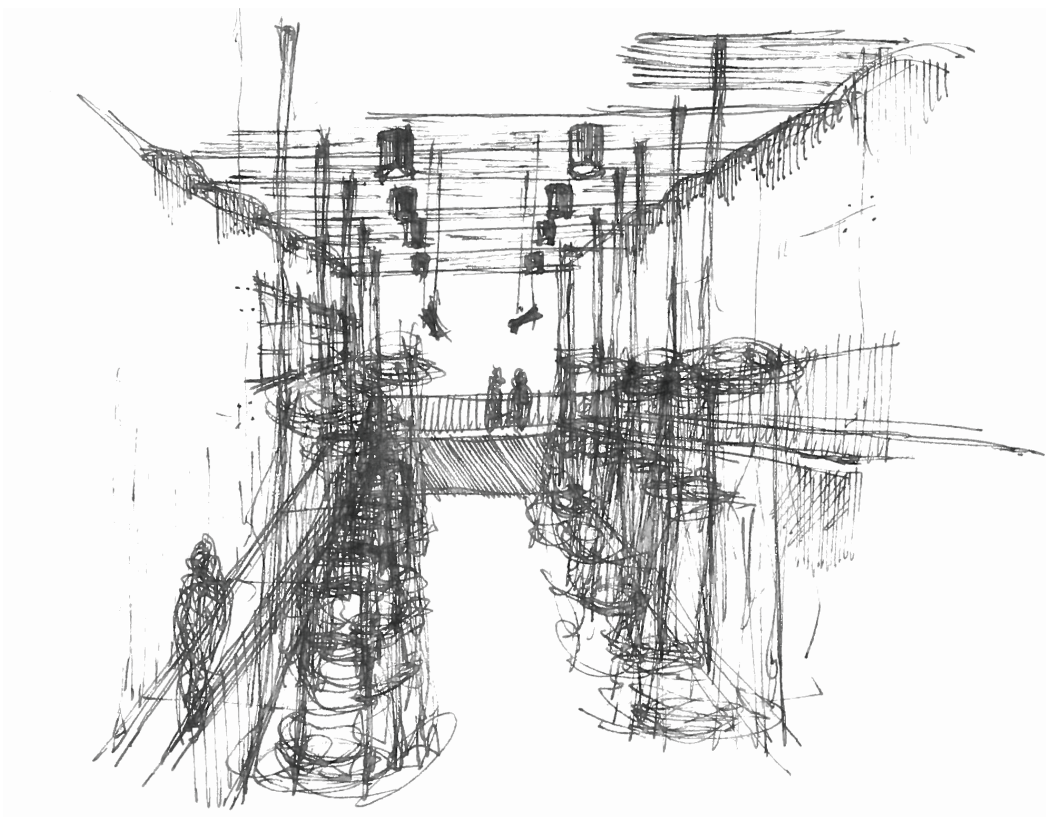
DAYLIGHT

A certain interior light quality is fundamental for working areas to be efficient. Light is in fact the source of work and, together with a view to the outside, can considerably improve the quality of the indoor areas. The study of this relevant issue focused on the two zones with permanent workers: the Fermentation Room in the north wing and the offices spaces in the south wing.

The final window, a square of two by two metres, as seen in the illustration, granted more than enough daylight factor in the office spaces and the possibility of providing beautiful views of the surrounding vineyards.
In the other wing, due to the fact that the building is partially underground, the natural illumination through windows on the walls was not enough. The choice was therefore to use the roof manholes for grape processing as skylights and to add a window on the side of the ramp that descends from the roof to the Reception. In this way the daylight factor resulted higher than the minimum 2% requested. Additionally, the skylights contribute, together with the columns, to create a certain atmosphere in the room, which will be explained later.



Ill.81 Working Areas Daylight Factor Visualisation, Own illustration



PART V - DESIGN PROCESS

BUILDING SHAPE & LOCATION

VOLTINA SYSTEM

TERRACE “NOTES”

ACOUSTIC ITERATIONS

WINDOWS & FACADE

COLUMNS

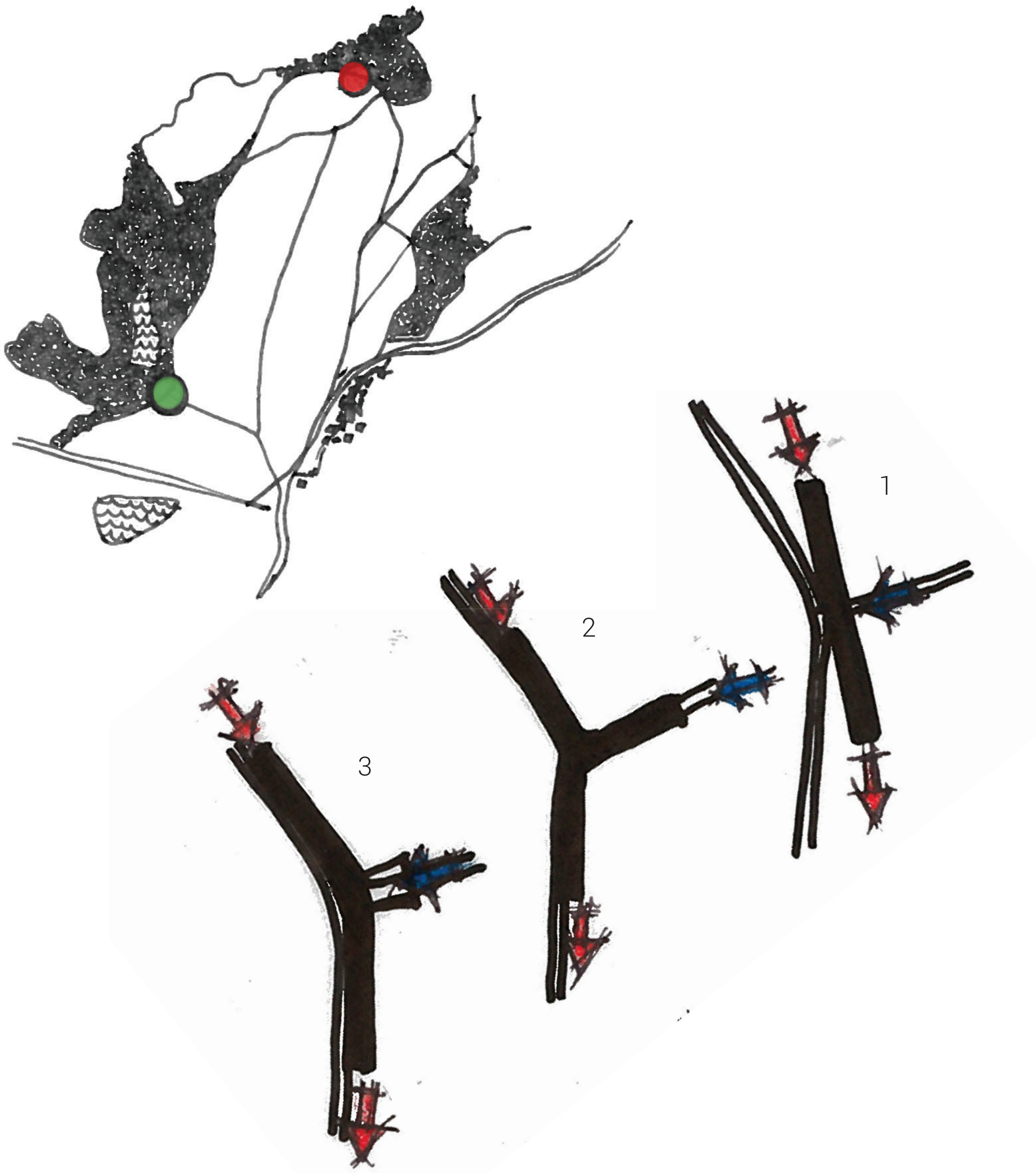
Ill.82 Fermentation Room sketch, Own illustration

BUILDING SHAPE AND LOCATION

The building location was dictated by three criteria: minimising the impact of the built area on the vines, exploiting the slope of the site, and being visible from the principal road connecting Montalcino to the geographical area of the Maremma.
These aspects brought to two options: locating the building uphill, in a dominant position towards the vineyards and the property; positioning the establishment central to the land and to the west, longing the limits of the property.
The second option was preferred for different reasons. The vines are respected as the building, running by a road, occupies a perimeter area, which is barely cultivated. The slope of the site is exploited in the production process of the winery and in the treatment of the volume. Visibility also marked a difference in the choice of the final placement. In fact, placing the building uphill, would have meant to hide it from the visitors driving down the department road from Montalcino. In the chosen solution, the building is visible from the road looking on the west direction, and stands proud on top of the steepest slope on the south, well perceivable from the southern road. Now, the winery is a landmark.

Discussing the shape of the proper building, the process was less intuitive but driven by rationality, a capital aspect while designing a winery. The first idea was to have a straight building, a very strong stretched parallelepiped positioned along the dirt road running north-south. The slope would have been followed in order for the grapes to be brought onto the roof on the north side during harvesting and for the bottled wine to leave the building at the natural ground altitude on the other extremity. This solution appeared very efficient, but implied some restraint, as the building did not follow the curve of the East road and a deviation of the road was required, with the result of destroying part of the vines. Then, an iteration generated from an increased consideration of the three roads meeting, was produced. The iteration saw a building composed of three branches embracing the direction of the three roads. The branches were meeting in the node between them, in what was the heart of the project, most likely occupied by the music hall.
The last shape is at the same time an evolution and the combination between the two ideas presented above. A parallelepiped building stretches longing the east slope. The geometry is broken in its middle, provoking a bending pleasing the direction of the roads. The deviation of the building generates a trapezoidal room in the middle, which will become the Music Hall. From there, an access ramp spreads out, welcoming and embracing the visitors arriving from the street crossing the site from east to west.

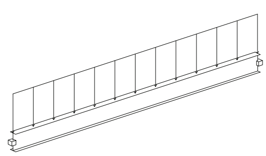
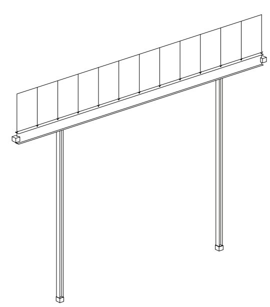
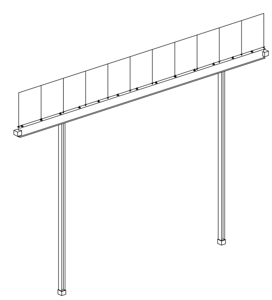
The final shape is the result of a rational work, considering the integration within the context, the visibility of the establishment, the consideration of the terrain slope having in mind the efficient functioning of the winery.



Ill.83 Building Location Diagrams, Own illustration

VOLTINA SYSTEM

The traditional technology the structure is based on was firstly used in the first half of the XIX century and combined double-T cross-section beams with bricks in order to realize big span rooms (Barbisan in Benvenuto et al., 1994). In the project this technology is optimised with the addition of a concrete slab on top with the aim of reinforcing the structure.
Two types of slabs are designed depending on the pitch of the steel beams: in normal height spaces the beams are 122,5 centimetres apart; while in taller spaces, such as fermentation room, the pitch is 225 centimetres.
Consequently the cross-sections of the beams vary between the two options (ill. 76). The same were later optimised with the addition of steel stud connectors between the beams and the welded mesh of the reinforced concrete. With the use of these elements mechanically attached to the beams, the latter ones were reduced from IPE 500 to IPE 400 cross-sections. The dimensioning of the beams was first obtained with the use of the software Robot, whereas the calculations of the collaborating concrete-steel slab were later made with using a software developed by the Italian company Tecnaria, which is specialised in building with historical techniques (Tecnaria, 2018).
Additionally, in the Fermentation Room, which represents the worst case in terms of loads, span and pitch, two rows of columns are added in order to reduce the span of the beams and utilise smaller cross-sections (IPE 450 instead of IPE 750). For these columns few iterations with different materials were made: finally steel HEA columns were preferred to concrete and to brick elements (see page xx).

	Without Columns	With Columns	With Columns and Connectors
Diagram			
Span [m]	12,5	8,0	8,0
Cross-section [mm]	IPE 750	IPE 450	IPE 400
Slab Thickness [mm]	850	550	525

Ill.84 Fermentation Room Beam Dimensioning Table, Own illustration

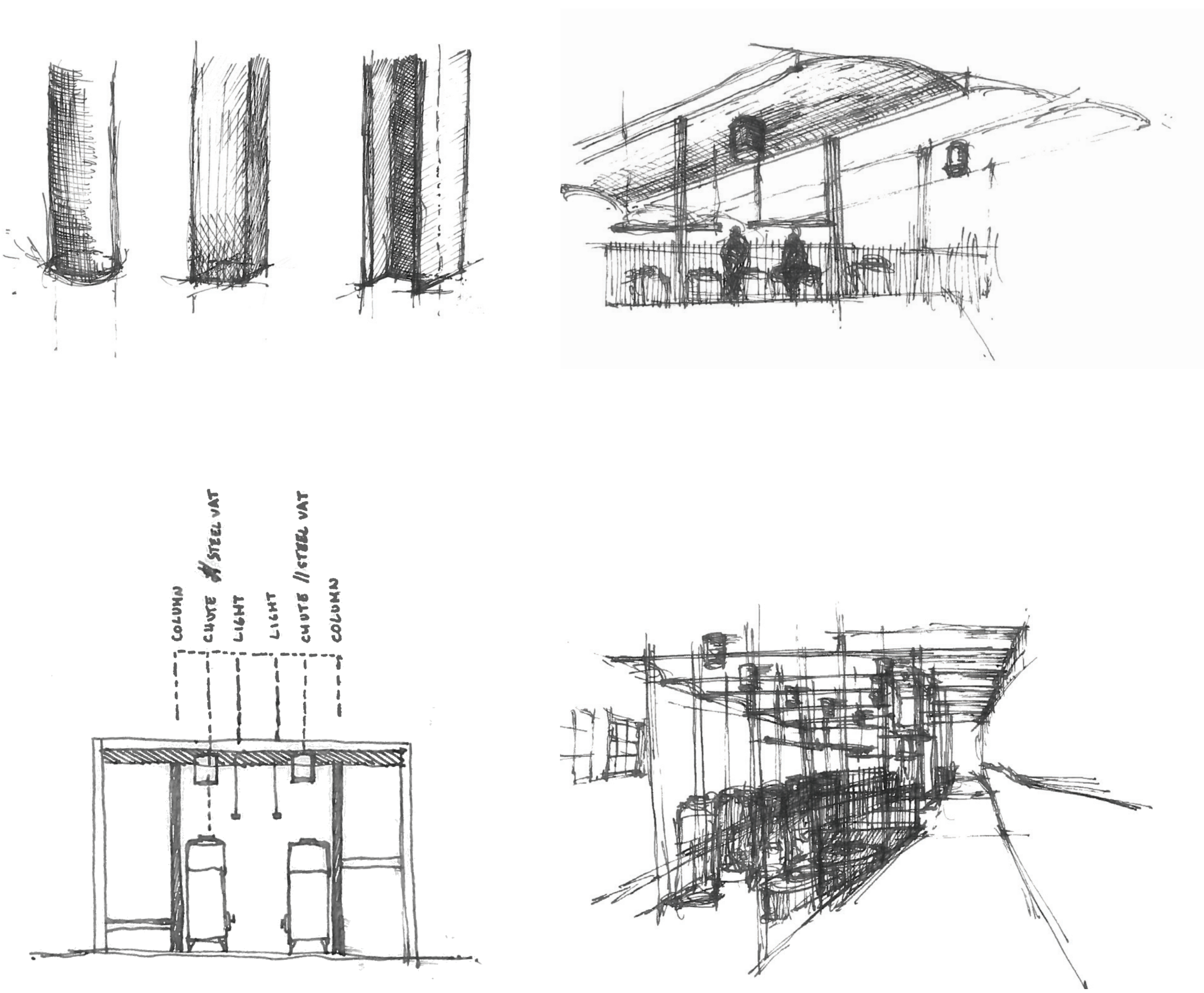
COLUMNS

Two rows of columns are to be disposed into the fermentation room in order to reduce the span the steel beams have to cover. Now, a column is a structural element for its bearing role. However, it should also express the architectural language that an architect wants his building to speak. What if the columns of the Greek temple of the Parthenon were reduced to mere regular smooth cylinders without a base or capitals on its top? An architectural style carries columns and columns carry architecture.

The considered materials for the columns are steel and concrete. Their cross-section shape can vary from circular to squared or the several profiles allowed by the steel. The walls are already in concrete, and the concrete is a very good material working in compression but it requires important sections regarding the dimensioning. The visual impact that concrete columns being placed every 2.25 metres from each other would confer the room, for the visitor contemplating it from the reception, is one of as opaque a surface as a wall.

Steel instead allows smaller sections. The assembling between the already existing double-T cross-section beams and steel columns reveals to be very easy, as it would speak the same structural language through the use of the same material. Moreover, steel is the material of the factory par excellence. The idea of the design of these columns is merely functional: it is for this reason that the columns - just as the beams for this room - must be standing there, rough, almost non-treated just as if the construction site was suspended a couple of weeks before the delivery, avoiding additional, unnecessary details.

A standard HEA profile is preferred to a rounded section column. The aim is to have it straight and simple. “Steel was born straight (...) It comes out straight from the drawing.”, claims Mies Van der Rohe. Moreover, the HEA profile has different faces that vibrate with light creating effects of light and shadows. Also, they are elements of the empty and plain, just as the treatment of the cylindric chute. The choice of the right-angled profile is also motivated by the willing of balancing the geometrical dialogue between curved shapes and straight ones. It seems to be the right choice in a room in which steel is the protagonist.



Ill.85 Fermentation Room columns iteration sketches, Own illustration

TERRACE "NOTES"

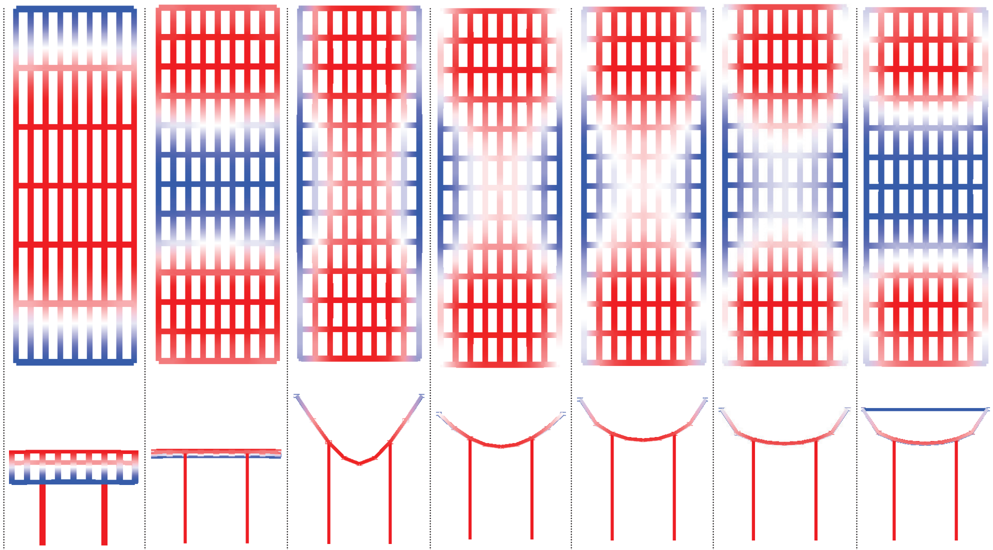
The design of the wooden structures on the roof started with the idea of creating an architectural element that could contrast the rigidity of the rest of the building, attract visitors and be the landmark of the wine "factory". As previously explained, the inspiration was drawn on the image of light musical notes laid on the stiff musical score.

In order to reach the wished result, different iterations regarding material, shape and composition were made.

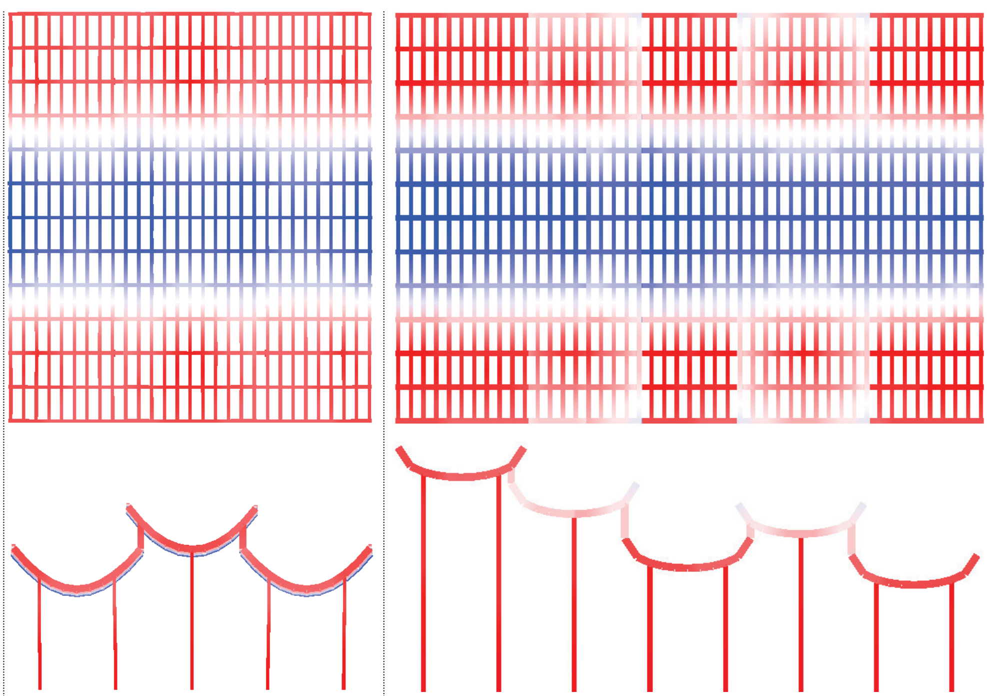
First of all, the chosen material was timber. This was preferred to concrete because of its light weight and ease of assembling with dry mortarless construction techniques.

The shape of the structure was therefore studied with Karamba, software for preliminary structure analysis, starting from one curvature. The aim was to reach a curved surface supported by few slender columns. Various curvatures with multiple supports were tried. Finally, a symmetric curved grid of ten by twelve divisions supported by two columns with 225 centimetres pitch, accordingly with the steel beams of the roof construction, was chosen. The same was then used in composition with other grids, first in the same way and later with different pattern in height. Grids supported by two columns and are connected to other grids supported by one column in the middle: in this way the grids work together and variations in elevation enable light to travel through in between the structures.

The elements were then dimensioned to resist snow load from above and wind load from top and two sides. Aiming at having as slender elements as possible, the columns were set back two metres from the end of the curvature so that the span could be reduced from twelve to eight metres. The final results are circular wooden columns of 225 millimetres diameter. The grid elements were divided into main ones, the curved glulam beams, and secondary ones, straight glulam elements that connect the beams. Finally the main beams were dimensioned as 180 wide by 260 tall millimetres cross-section and the secondary elements as 160 by 160 millimetres cross-section. These dimensions resulted from the compromise between thin secondary elements and not over-dimensioned main beams. The solution also enabled the wished result of the wooden cladding to create a smooth surface on the top of the grid and leave the main beams visible on the lower side. Joints' studies can be seen in Appendix 2 at page xx. Dimensioning results obtained with Robot Structural Analysis can be seen in Appendix 4 at page xx.



Maximum Displacement	5299 mm	1158 mm	368 mm	300 mm	279 mm	270 mm	190 mm



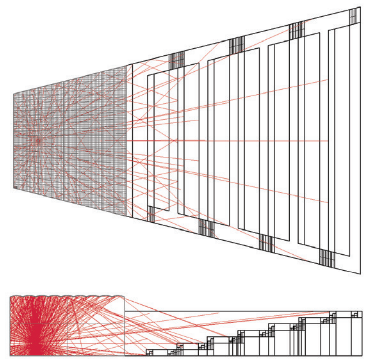
Maximum Displacement	147 mm	163 mm

Ill.86 Roof Wooden Structures Design Iterations, Own illustration

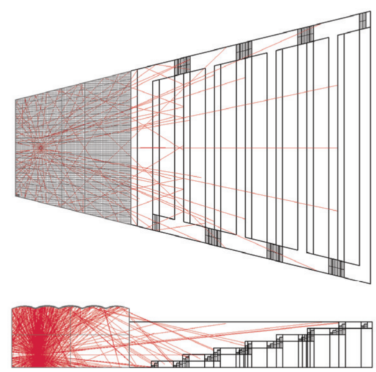
ACOUSTIC ITERATIONS

Acoustical studies have been crucial to the design of the main Hall and have focused on finding a solution for diffusing sound in two main directions: outwards towards the audience and downwards towards the *Barriquerie*.

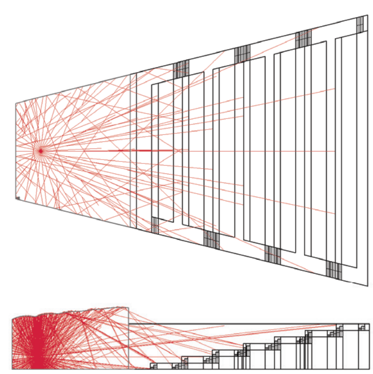
The process started with the aim of integrating the bearing structure within the acoustic surface, using a repetition of *voltina* shapes. This brought to unifying ceiling and roof, but did not lead to satisfactory acoustics. Concave shapes, as expected, facilitated the convergence of sound rather than its diffusion.

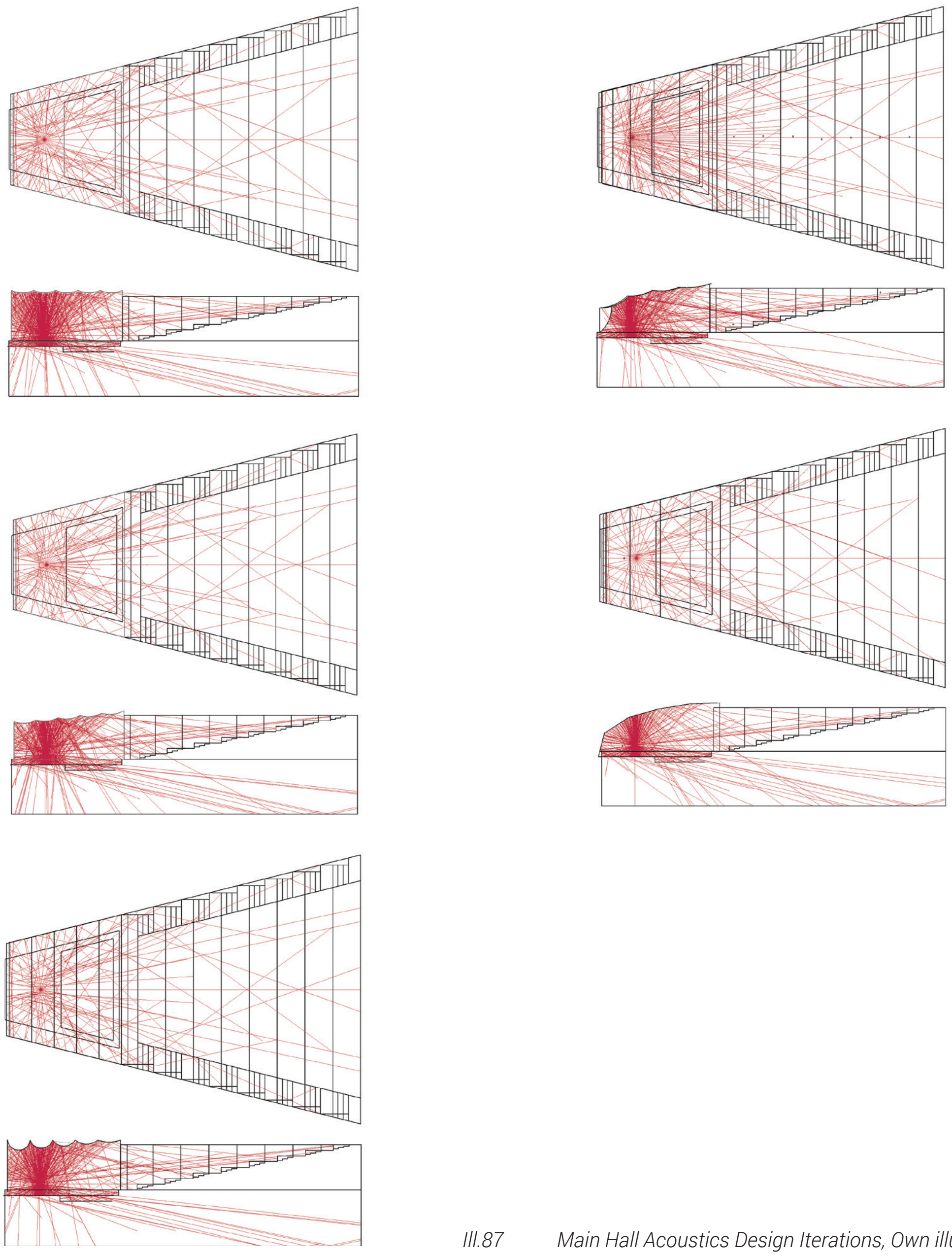


The second step was therefore overturning the concave shapes into convex ones. After a sequence of iterations, varying both depth and width of the curves to facilitate sound diffusion outwards, the best option was to separate ceiling and roof structures and to use large and shallow curved surfaces that progressively changed their inclination.



The final step of the process tried to merge the qualities from the previous ones: roof and ceiling were separated, the latter following the slope of the former. Using different levels in elevation enabled the sound to travel vertically, reaching the Oak Room at the lower level, and granted a number of seats around the stage, as well as a division between stage and access corridors. Work in Section was followed by adjustments in Floor Plan: the fan shape of the stage was changed at the sides of the staircase with improvements in sound reflections towards the central part of the audience.





Ill.87 *Main Hall Acoustics Design Iterations, Own illustration*

WINDOWS & FACADE

The window is a crucial element while designing architecture. Indeed, a window presents characteristics that remarkably influence it. They mostly appeal to the sense of sight through the visual relation between the interior and the exterior. They shape the interior space and represent the eyes of the building considering its facade, in its dialogue between the vacuous and the solid. In addition, they can act on what is called the kinaesthetic sense, defining the sense of the mental feeling through the physical one delivered by space. Last but not least, windows also mean light. Indeed, natural light is of a capital importance in such areas of the building as the employee's area and the fermentation room. Thus, the design of the windows has to depend on the amount and quality of light they invite inside the space.

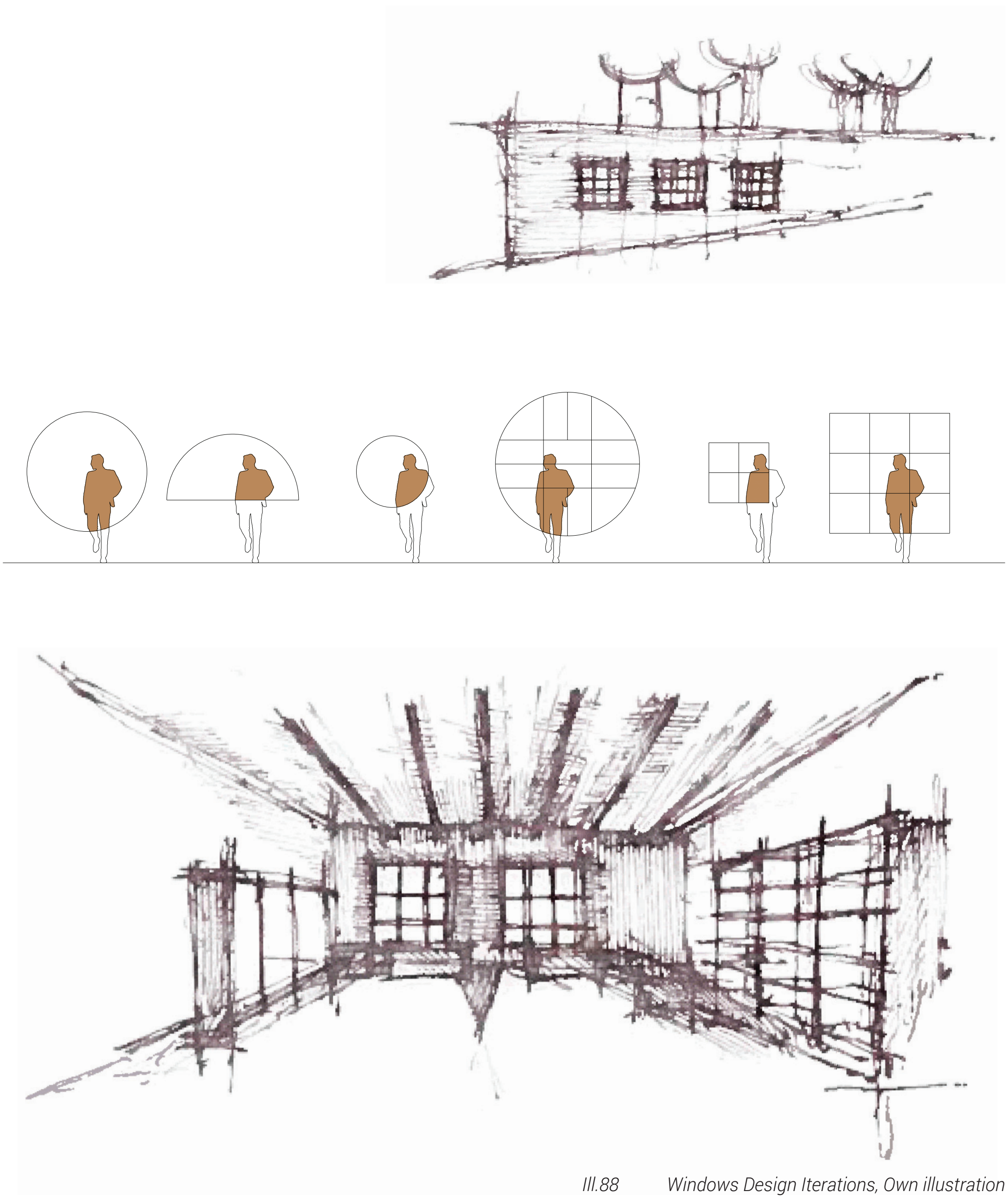
Some diverse iterations considering these aspects were produced, all of them speaking the same architectural facade language of regularity, simplicity and geometry, reminding of the establishment's industrial nature.

The sizes were investigated, with their corresponding light supply and views delivery from the inside. Another parameter of the process was the shape of the window. Rectangular as to remind of the typical factory windows; squared, in order to reinforce this strong idea and give it a "modern touch"; circular and half-circular that could also remind of some older days industrial architectural language. The glass partition is also a relevant detail.

Regarding the interior feeling translated by the kinaesthetic sense and the proper and pleasant supply of light delivered, the bigger sizes of windows (two metres wide by two metres tall) were preferred to the small ones that translated a sensation of enclosure, feeling which is to avoid while working into a building plunged into the harmonious landscapes of Tuscany.

Regarding the shape of the windows, in the whole facade, the curvy elements came to pervert the strong and massive block are the light structures on the roof. The thought of circular windows stealing the show from these curvy tall elements standing on the terrace forced the choice of big squared windows to dispose everywhere wherever the building is not excavated under the ground. On the Southern facade, a large window is opened offering an enlightened space for the employees' restoration.

The chosen windows allow the employees to work in a bright environment, as seen in the daylight factor studies, and to take contemplative breaks through glimpses of the unique Tuscan landscape.



Ill.88 *Windows Design Iterations, Own illustration*

PART VI - EPILOGUE

Ill.89 Wine Tasting, Own illustration

CONCLUSION

A passion for wine, the wish of designing a unique place in Tuscany, the fascination for the challenging theory of music and wine: these were the very first and true design drivers for the project of an incomparable place in the chalice-shape world. The site asked for a winery close to its *terroir*, for a building that could breathe Tuscany and respect tradition and the values of the rituals of wine-making. Finally, everything is included. Indeed, the winery designed is a hybrid building in which the theme of Music is grafted onto the mere stem of the wine-making function. A Music Hall offers the possibility of hosting concerts, from which the ageing wine can only benefit, and hence attracting a mixed group of users, from wine lovers to music enthusiasts. The locals are in this way more involved in what are usually establishments aiming to invite a wealthy oenotourism.
Tectonics is searched for in the reutilisation of typical ancient Tuscan techniques and construction materials and in their adaptation to our times, other than in the curvy structures shading the rooftop. In these terms, tectonics reveals its poetic face becoming the writer of diverse ambiances that appeal to all senses.
The design is driven both by aesthetics and functionality, thus following the production steps of the product and always trying to adhere to sustainability principles in terms of energy consumption.
The new winery leans with linearity and elegance on the site and clearly stands as a recognizable landmark for its curvy wooden structures on the roof that represent the notes in the powerful metaphor of the music sheet.
In conclusion, the dream comes true: in the glass, seeing the colour of the grapes; in the hall, hearing the sound of a delightful classical music; in the cellar, feeling the cool temperature and smelling the materiality of the winery; in the terrace, tasting the product of the earth with an aftertaste of Architecture. This is Tasting Music and Listening to Wine.

REFLECTION

When it comes to reflect on this thesis project, we must admit that we are quite satisfied with the final result. "Listening to Wine and Tasting Music" is the project of a unique winery. Indeed, merging the theme of wine and music did not come out of spontaneity, especially considering that the two topics were never so close in the field of Architecture. However, our interest in the ownership's fascinating theory of plants receiving the continuous and beneficial intake of Mozart music from speakers spread into the vineyards, has moved us to bring the project further. Matching music and wine through Architecture was our challenge. We chose to take it up and confront it by designing a winery which is not only a wine factory or an exercise of style about mere "architainment" (Tatano in Rossetti, 2011), but a hybrid building producing wine in a rational way while inviting to the poetic intervention of music. The project also aims to be a place where locals, deeply rooted in their culture and traditions, can find their land reflected in Architecture, can enjoy musical performances and get delight from the product of the *terroir*.

The efforts concerning tectonic architecture, thus to integrate structure and architecture, were fundamental: the structure speaks a precise architectural language that creates different atmospheres. Furthermore, we used a structural system to express, as explained, a metaphor regarding the facade expression.

Time management was, obviously, an issue to deal with. Designing a 5000-square metre winery in four months can result overwhelming, but we strongly believe we have done our best to achieve the highest level of detail possible, working simultaneously on the architectural and technical parts, for the studies on the *voltine* and the wooden structures on the roof.

Acoustics is a theme we have developed along the project as well, achieving satisfying results thanks to a work on the shape and the materials of the Music Hall.

Undoubtedly, a project is a never-ending process, a looping system bringing us to always reconsider some elements and to elevate the level of detail. Time limit has set an end to this process and has left the designers with ideas for further development. One of these desires concerns the terrace. The glass and steel boxes created on the Roof hosting functions of wine tasting, wine shop and wine bar, should be dealt with more carefully in detail. Additionally, some systems, like the one operating the opening and closing of the Main Hall in the cold days could be further detailed.

The theme of sustainability has been treated considering passive strategies, designing a building that is environmentally friendly but not self-sustainable. In order to obtain this last quality, active strategies could have been investigated and their efficiency proved by calculations.

A unique establishment of its kind also deserves a singular or at least a furniture design that fits the architecture and the ambiances of the place: colours, materials, style and texture of the furniture of a space can remarkably enhance the atmospheres of the spaces. Designing furniture is one aspect that we would not have missed if the process of the project had had a longer roll over.

This thesis has represented for us an unforgettable experience: an experience of friendship, of hard work and collaboration in the name of Architecture; a last bridge on a fjord to cross against the wind, towards our professional life, that we will kick-off with a good glass of wine in our hands.

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ILLUSTRATION LIST

PART VII - APPENDICES

Ill.90 Terracotta Lamps, Own illustration

1 - WINERY SYSTEMS DIMENSIONING

PRODUCTION YIELD PER HECTARE

According to Brunello di Montalcino disciplinary regulations, the maximum limit of production in order to get certified producers is 8 tons of grapes per hectare of vineyard (Consorzio Brunello di Montalcino, 2018). However, the owner, a biological wine producer, usually produces 4 tons per hectare. The winery is therefore dimensioned following these lower numbers. The project site is 50 hectares of vineyard, consequently the production can be simplified as following:

- Grapes: 4000 kg / ha -> 200.000 kg
- Must: grapes - 5 % -> 190.000 kg = 1900 hL

  - Steel vats: 35 vats (60 hL each)

- Raw wine: must - 30 % -> 1330 hL

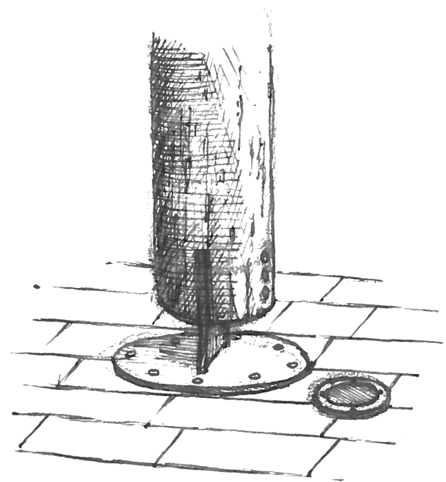
  - Concrete vat: one container (480 hL)
  - Wooden oaks: 378 barriques (2,25 hL each); or 189 tonneau (4,50 hL each)

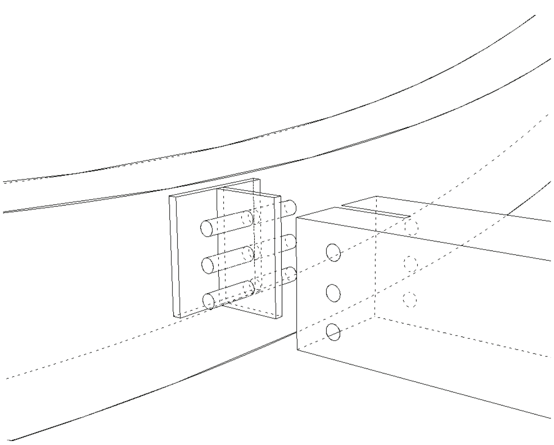
- Wine: raw wine - 6 % -> 1330 hL

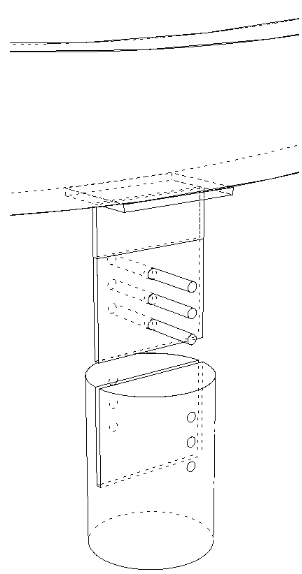
  - Bottles: 166.250 bottles (0,75 L each)
  - Metal chest: 260 chests (640 bottles each)

2- ROOF STRUCTURE JOINTS

Special attention was dedicated to the joints between the elements of the wooden structures standing on the Roof. Focus was on the way their columns relate to the floor, the way the curvy primary beams attach to the same columns and finally the link between these beams and the secondary beams running longitudinally to the light structure. All joints are made of steel, with a thin plate crossing the long section of the wooden elements. The wood is cut to allow the blade to divide it in its middle axis (diameter for the columns). The steel plate and the wooden element are then linked by screws and bolts creating a fixed joint. The steel plate cutting the wood is welded to another perpendicular steel plate that connects this system together with another component, being the latter the clay-tiled floor of the terrace or another beam of the structural system of these shading wooden elements.







Ill.91 Roof Wooden Structure Joints, Own illustration

3- LOAD CALCULATIONS

SNOW LOAD

The Snow Load is calculated using the following formula from Eurocode 1.3 (DS/EN 1991-1-3, 2003):

$s = \mu_i \cdot c_e \cdot c_t \cdot s_k = 1{,}35\ kN/m^2$

where

$\mu_i = 0.8$	= shape coefficient
$c_e = 1.1$	= exposure coefficient
$c_t = 1$	= thermal coefficient
$s_k = 1.53\ kN/m^2$	= characteristic snow load on the ground

$\Rightarrow s = 0.8 \cdot 1.1 \cdot 1 \cdot 1.53 = 1{,}35\ kN/m^2$

WIND LOAD

The Wind Load is calculated using the Eurocode 1.4 (DS/EN 1991-1-4, 2003) with the following formula:

$we = qp(z) \cdot c_{pe,10}$

where

$qp(z) = 0.6\ kN/m^2$ = peak velocity pressure (for basic wind velocity, $v_b = 24$ m/s, from EN 1991-1-4)

$cp_{e,10}$ = external pressure coefficient, calculated for every side of the building, including the roof

Based on Eurocode 1.4 7.2.2, c_{pe} has been calculated for four different zones.

Roof: A = -1.3 ; B = -0.95 => Average = -1.125

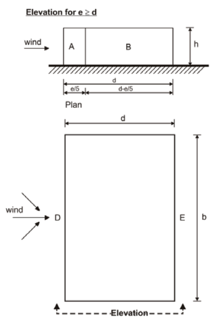
$\Rightarrow w_e = 0.6\ kN/m^2 \cdot (-1.125) = -\ 0.68\ kN/m^2$ (pressure)

Front: D = 0.54

$\Rightarrow w_e = 0.6\ kN/m^2 \cdot (+0.9) = 1.73\ kN/m^2$ (pressure)

Rear: E = -0.3

$\Rightarrow w_e = 0.6\ kN/m^2 \cdot (-0.3) = -\ 0.18\ kN/m^2$ (suction)



Ill.92 Wind factors diagrams, Eurocode 1.4

LOAD COMBINATION

The load combination has been calculated for both SLS and ULS cases, using the Snow Load and Wind Load calculated above. The worst case, ULS Dominant Snow Load, has been used in Robot.

SLS

Dominant Snow Load:
$1.35\ kN/m^2 + 0.5\ (0.68\ kN/m^2) = 1.69\ kN/m^2$

Dominant Wind Load:
$0{,}5\ (1.35\ kN/m^2) + 0.68\ kN/m^2 = 1.35\ kN/m^2$

ULS

Dominant Snow Load:
$1.5\ (1.35\ kN/m^2) + 0.75\ (0.68\ kN/m^2)= 2.53\ kN/m^2$

Dominant Wind Load:
$0{,}75\ (1.35\ kN/m^2) + 1.5\ (0.68\ kN/m^2) = 2.03\ kN/m^2$

ROOF DEAD LOAD

The Roof Dead Load has been calculated based on the stratigraphy of the construction as shown in the table below. The final Load is 5.56 kN/m^2.

Layer	Thickness (m)	Weight (volume)	Weight (area)
Masonry floor	0.02	25.00 kN/m^3	0.50 kN/m^2
Mortar bedding	0.05	20.00 kN/m^3	0.40 kN/m^2
Reinforced concrete	0.06	26.00 kN/m^3	1.56 kN/m^2
Insulation	0.20	0.30kN/m^3	0.06 kN/m^2
Filling	0.10	16.00 kN/m^3	1.60 kN/m^2
Masonry finishing	0.03	30.00 kN/m^3	0.90 kN/m^2

ROOF LIVE LOAD

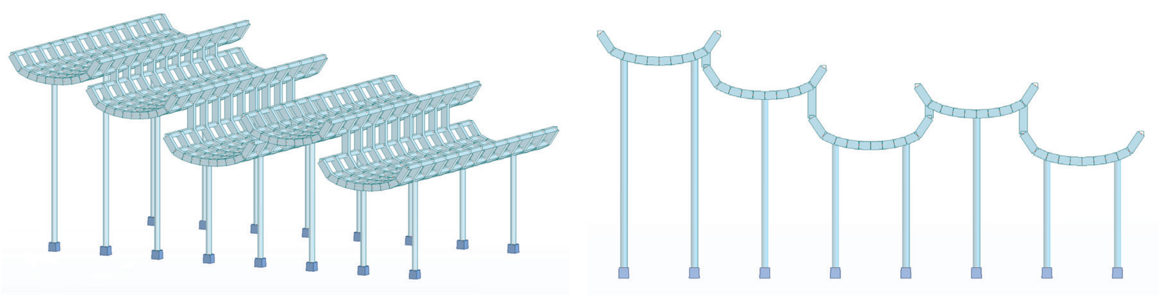
The Roof Live Load is characterised by two components: people live load and tractor live load. The first one has been taken from the Italian Legislation in which the project variable live load of commercial buildings is 4 kN/m^2. This load has been applied as a uniform load on the structure. The second one has been calculated for a vineyard tractor of around 5 tons. The load calculated is therefore estimated of 50 kN. This load has been applied as a point load on the structure.

4 - ROBOT CALCULATIONS

TERRACE WOODEN STRUCTURES

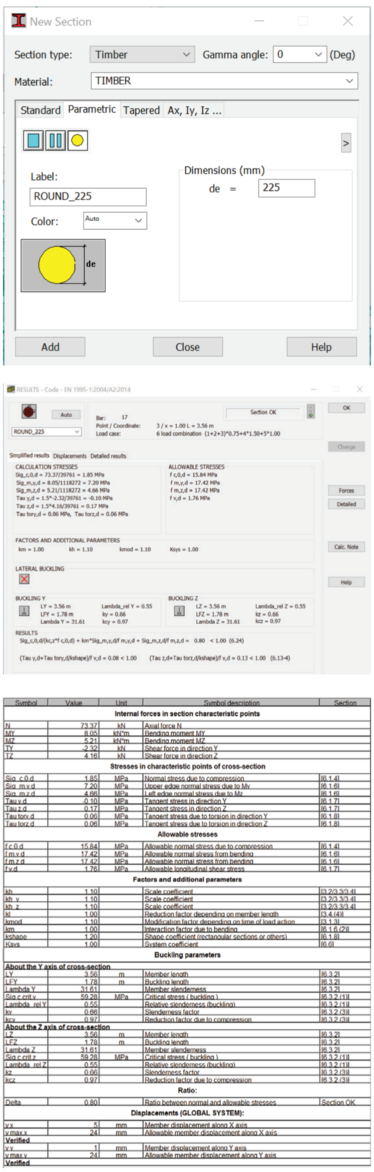
After the preliminary structural studies made in Karamba for Grasshopper, which are shown in the Design Process section, the structure was dimensioned using the Finite Element Method (FEM) and the software Autodesk Robot.
The load combination used took into account Self Load, Snow Load and Wind Load. As explained previously, the worst case was ULS with dominant Snow Load.

In the illustrations below the dimensioned structure is visible. Final dimensions of the cross-sections are visible in the tables on the right and Member Verification tables are shown in the following pages.

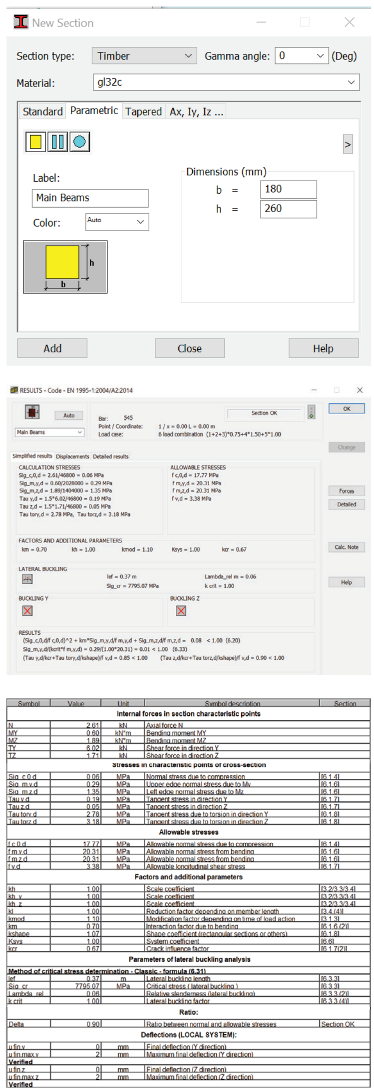


Ill.93 Robot 3D model views, Own illustration

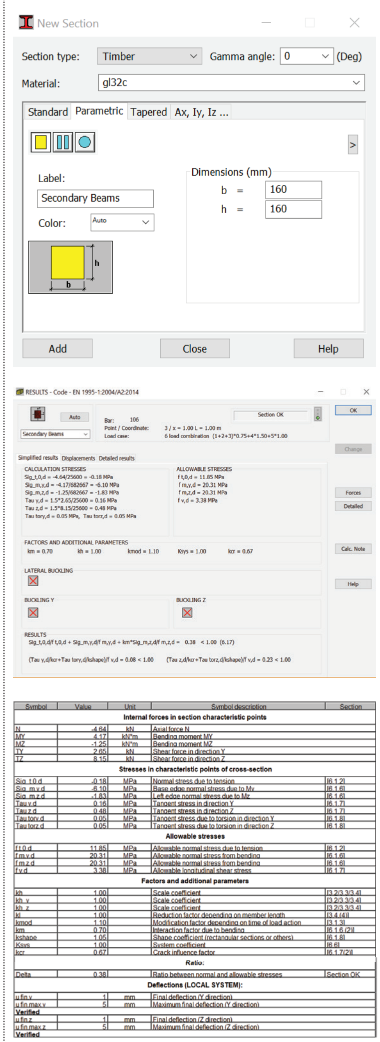
COLUMNS
diameter = 225 mm



MAIN BEAMS
length = 180 mm
height = 260 mm



SECONDARY ELEMENTS
length = 180 mm
height = 260 mm



Ill.94 Robot results, detailed tables, Own illustration

Member	Section	Material	Lay	Laz	Ratio	Case
1	Main Beams	gl32c	6.88	9.93	0.16	6 load combination
2	ROUND_225	TIMBER	48.89	48.89	0.54	6 load combination
3	ROUND_225	TIMBER	48.89	48.89	0.54	6 load combination
4	ROUND_225	TIMBER	60.05	60.05	0.65	6 load combination
5	ROUND_225	TIMBER	60.06	60.06	0.36	6 load combination
6	ROUND_225	TIMBER	60.05	60.05	0.65	6 load combination
7	ROUND_225	TIMBER	60.06	60.06	0.36	6 load combination
8	ROUND_225	TIMBER	36.05	36.05	0.67	6 load combination
9	ROUND_225	TIMBER	36.06	36.06	0.62	6 load combination
10	ROUND_225	TIMBER	36.05	36.05	0.67	6 load combination
11	ROUND_225	TIMBER	36.06	36.06	0.59	6 load combination
12	ROUND_225	TIMBER	43.63	43.63	0.41	6 load combination
13	ROUND_225	TIMBER	43.63	43.63	0.41	6 load combination
14	ROUND_225	TIMBER	31.61	31.61	0.38	6 load combination
15	ROUND_225	TIMBER	31.61	31.61	0.79	6 load combination
16	ROUND_225	TIMBER	31.61	31.61	0.39	6 load combination
17	ROUND_225	TIMBER	31.61	31.61	0.80	6 load combination
18	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
19	Main Beams	gl32c	6.88	9.93	0.91	6 load combination
20	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
21	Main Beams	gl32c	6.88	9.93	0.71	6 load combination
22	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
23	Main Beams	gl32c	6.88	9.93	0.37	6 load combination
24	Secondary Bea	gl32c	21.65	21.65	0.37	6 load combination
25	Main Beams	gl32c	6.88	9.93	0.01	6 load combination
26	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
27	Main Beams	gl32c	6.88	9.93	0.36	6 load combination
28	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
29	Main Beams	gl32c	6.88	9.93	0.71	6 load combination
30	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
31	Main Beams	gl32c	6.88	9.93	0.91	6 load combination
32	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
33	Main Beams	gl32c	6.88	9.93	0.16	6 load combination
34	Secondary Bea	gl32c	21.65	21.65	0.37	6 load combination
35	Main Beams	gl32c	13.91	20.09	0.16	6 load combination
36	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
37	Main Beams	gl32c	13.91	20.09	0.63	6 load combination
38	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
39	Main Beams	gl32c	13.91	20.09	0.47	6 load combination
40	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
41	Main Beams	gl32c	13.91	20.09	0.24	6 load combination
42	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
43	Main Beams	gl32c	13.91	20.09	0.04	6 load combination
44	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
45	Main Beams	gl32c	13.91	20.09	0.24	6 load combination
46	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
47	Main Beams	gl32c	13.91	20.09	0.47	6 load combination
48	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
49	Main Beams	gl32c	13.91	20.09	0.63	6 load combination
50	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
51	Main Beams	gl32c	13.91	20.09	0.16	6 load combination
52	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
53	Main Beams	gl32c	6.06	8.76	1.00	6 load combination
54	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
55	Main Beams	gl32c	6.06	8.76	0.75	6 load combination
56	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
57	Main Beams	gl32c	6.06	8.76	0.38	6 load combination
58	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
59	Main Beams	gl32c	6.06	8.76	0.03	6 load combination
60	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
61	Main Beams	gl32c	6.06	8.76	0.38	6 load combination
62	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
63	Main Beams	gl32c	6.06	8.76	0.76	6 load combination
64	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
65	Main Beams	gl32c	6.06	8.76	1.00	6 load combination
66	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
67	Main Beams	gl32c	6.06	8.76	0.32	6 load combination
68	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
69	Main Beams	gl32c	6.06	8.76	0.32	6 load combination
70	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
71	Main Beams	gl32c	12.86	18.58	0.20	6 load combination
72	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
73	Main Beams	gl32c	12.86	18.58	0.68	6 load combination
74	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
75	Main Beams	gl32c	12.86	18.58	0.52	6 load combination
76	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
77	Main Beams	gl32c	12.86	18.58	0.27	6 load combination
78	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
79	Main Beams	gl32c	12.86	18.58	0.03	6 load combination
80	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
81	Main Beams	gl32c	12.86	18.58	0.27	6 load combination
82	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
83	Main Beams	gl32c	12.86	18.58	0.52	6 load combination
84	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
85	Main Beams	gl32c	12.86	18.58	0.69	6 load combination
86	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
87	Main Beams	gl32c	12.86	18.58	0.20	6 load combination
88	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
89	Main Beams	gl32c	8.96	12.94	0.09	6 load combination
90	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
91	Main Beams	gl32c	5.47	7.90	0.11	6 load combination
92	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
93	Main Beams	gl32c	5.15	7.44	0.06	6 load combination
94	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
95	Main Beams	gl32c	5.04	7.28	0.03	6 load combination
96	Secondary Bea	gl32c	21.65	21.65	0.38	6 load combination
97	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
98	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
99	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
100	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
101	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
102	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
103	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
104	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
105	Main Beams	gl32c	5.47	7.91	0.14	6 load combination
106	Secondary Bea	gl32c	21.65	21.65	0.38	6 load combination
107	Main Beams	gl32c	8.97	12.95	0.11	6 load combination
108	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
109	Main Beams	gl32c	8.96	12.94	0.22	6 load combination
110	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
111	Main Beams	gl32c	5.47	7.90	0.21	6 load combination
112	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
113	Main Beams	gl32c	5.15	7.44	0.08	6 load combination
114	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
115	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
116	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
117	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
118	Secondary Bea	gl32c	21.65	21.65	0.49	6 load combination
119	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
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121	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
122	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
123	Main Beams	gl32c	5.15	7.44	0.12	6 load combination
124	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
125	Main Beams	gl32c	5.47	7.91	0.22	6 load combination
126	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
127	Main Beams	gl32c	8.97	12.95	0.21	6 load combination
128	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
129	Main Beams	gl32c	8.96	12.94	0.19	6 load combination
130	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
131	Main Beams	gl32c	5.47	7.90	0.66	6 load combination
132	Secondary Bea	gl32c	21.65	21.65	0.49	6 load combination
133	Main Beams	gl32c	5.15	7.44	0.57	6 load combination
134	Secondary Bea	gl32c	21.65	21.65	0.39	6 load combination
135	Main Beams	gl32c	5.04	7.28	0.29	6 load combination
136	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
137	Main Beams	gl32c	5.00	7.22	0.09	6 load combination
138	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
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141	Main Beams	gl32c	5.04	7.28	0.28	6 load combination
142	Secondary Bea	gl32c	21.65	21.65	0.34	6 load combination
143	Main Beams	gl32c	5.15	7.44	0.53	6 load combination
144	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
145	Main Beams	gl32c	5.47	7.91	0.38	6 load combination
146	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
147	Main Beams	gl32c	8.97	12.95	0.07	6 load combination
148	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
149	Main Beams	gl32c	8.96	12.94	0.85	6 load combination
150	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
151	Main Beams	gl32c	5.47	7.90	0.74	6 load combination
152	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
153	Main Beams	gl32c	5.15	7.44	0.37	6 load combination
154	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
155	Main Beams	gl32c	5.04	7.28	0.15	6 load combination
156	Secondary Bea	gl32c	21.65	21.65	0.34	6 load combination
157	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
158	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
159	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
160	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
161	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
162	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
163	Main Beams	gl32c	5.15	7.44	0.22	6 load combination
164	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
165	Main Beams	gl32c	5.47	7.91	0.43	6 load combination
166	Secondary Bea	gl32c	21.65	21.65	0.38	6 load combination
167	Main Beams	gl32c	8.97	12.95	0.39	6 load combination
168	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
169	Main Beams	gl32c	8.96	12.94	0.60	6 load combination
170	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
171	Main Beams	gl32c	5.47	7.90	0.56	6 load combination
172	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
173	Main Beams	gl32c	5.15	7.44	0.36	6 load combination
174	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
175	Main Beams	gl32c	5.04	7.28	0.21	6 load combination
176	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
177	Main Beams	gl32c	5.00	7.22	0.12	6 load combination
178	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
179	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
180	Secondary Bea	gl32c	21.65	21.65	0.38	6 load combination
181	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
182	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
183	Main Beams	gl32c	5.15	7.44	0.19	6 load combination
184	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
185	Main Beams	gl32c	5.47	7.91	0.34	6 load combination
186	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
187	Main Beams	gl32c	8.97	12.95	0.29	6 load combination
188	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
189	Main Beams	gl32c	8.96	12.94	0.30	6 load combination
190	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
191	Main Beams	gl32c	5.47	7.90	0.28	6 load combination
192	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
193	Main Beams	gl32c	5.15	7.44	0.19	6 load combination
194	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
195	Main Beams	gl32c	5.04	7.28	0.12	6 load combination
196	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
197	Main Beams	gl32c	5.00	7.22	0.07	6 load combination
198	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
199	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
200	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
201	Main Beams	gl32c	5.04	7.28	0.04	6 load combination
202	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
203	Main Beams	gl32c	5.15	7.44	0.09	6 load combination
204	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
205	Main Beams	gl32c	5.47	7.91	0.17	6 load combination
206	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
207	Main Beams	gl32c	8.97	12.95	0.15	6 load combination
208	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
209	Main Beams	gl32c	8.96	12.94	0.02	6 load combination
210	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination
211	Main Beams	gl32c	5.47	7.90	0.03	6 load combination
212	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
213	Main Beams	gl32c	5.15	7.44	0.03	6 load combination
214	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
215	Main Beams	gl32c	5.04	7.28	0.03	6 load combination
216	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
217	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
218	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
219	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
220	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
221	Main Beams	gl32c	5.04	7.28	0.02	6 load combination
222	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
223	Main Beams	gl32c	5.15	7.44	0.02	6 load combination
224	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
225	Main Beams	gl32c	5.47	7.91	0.02	6 load combination
226	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
227	Main Beams	gl32c	8.97	12.95	0.02	6 load combination
228	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
229	Main Beams	gl32c	8.96	12.94	0.30	6 load combination
230	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
231	Main Beams	gl32c	5.47	7.90	0.28	6 load combination
232	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination

233	OK	Main Beams	gl32c	5.15	7.44	0.19	6 load combination
234	OK	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
235	OK	Main Beams	gl32c	5.04	7.28	0.12	6 load combination
236	OK	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
237	OK	Main Beams	gl32c	5.00	7.22	0.07	6 load combination
238	OK	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
239	OK	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
240	OK	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
241	OK	Main Beams	gl32c	5.04	7.28	0.04	6 load combination
242	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
243	OK	Main Beams	gl32c	5.15	7.44	0.09	6 load combination
244	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
245	OK	Main Beams	gl32c	5.47	7.91	0.17	6 load combination
246	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
247	OK	Main Beams	gl32c	8.97	12.95	0.15	6 load combination
248	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
249	OK	Main Beams	gl32c	8.96	12.94	0.60	6 load combination
250	OK	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
251	OK	Main Beams	gl32c	5.47	7.90	0.55	6 load combination
252	OK	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
253	OK	Main Beams	gl32c	5.15	7.44	0.36	6 load combination
254	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
255	OK	Main Beams	gl32c	5.04	7.28	0.21	6 load combination
256	OK	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
257	OK	Main Beams	gl32c	5.00	7.22	0.12	6 load combination
258	OK	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination
259	OK	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
260	OK	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
261	OK	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
262	OK	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
263	OK	Main Beams	gl32c	5.15	7.44	0.19	6 load combination
264	OK	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
265	OK	Main Beams	gl32c	5.47	7.91	0.34	6 load combination
266	OK	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
267	OK	Main Beams	gl32c	8.97	12.95	0.29	6 load combination
268	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
269	OK	Main Beams	gl32c	8.96	12.94	0.85	6 load combination
270	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
271	OK	Main Beams	gl32c	5.47	7.90	0.74	6 load combination
272	OK	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
273	OK	Main Beams	gl32c	5.15	7.44	0.37	6 load combination
274	OK	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
275	OK	Main Beams	gl32c	5.04	7.28	0.15	6 load combination
276	OK	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
277	OK	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
278	OK	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
279	OK	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
280	OK	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination
281	OK	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
282	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
283	OK	Main Beams	gl32c	5.15	7.44	0.21	6 load combination
284	OK	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
285	OK	Main Beams	gl32c	5.47	7.91	0.43	6 load combination
286	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
287	OK	Main Beams	gl32c	8.97	12.95	0.38	6 load combination
288	OK	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
289	OK	Main Beams	gl32c	8.96	12.94	0.19	6 load combination
290	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
291	OK	Main Beams	gl32c	5.47	7.90	0.65	6 load combination
292	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
293	OK	Main Beams	gl32c	5.15	7.44	0.57	6 load combination
294	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
295	OK	Main Beams	gl32c	5.04	7.28	0.29	6 load combination
296	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
297	OK	Main Beams	gl32c	5.00	7.22	0.09	6 load combination
298	OK	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
299	OK	Main Beams	gl32c	5.00	7.22	0.09	6 load combination
300	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
301	OK	Main Beams	gl32c	5.04	7.28	0.27	6 load combination
302	OK	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
303	OK	Main Beams	gl32c	5.15	7.44	0.52	6 load combination
304	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
305	OK	Main Beams	gl32c	5.47	7.91	0.37	6 load combination
306	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
307	OK	Main Beams	gl32c	8.97	12.95	0.07	6 load combination
308	OK	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
309	OK	Main Beams	gl32c	8.96	12.94	0.22	6 load combination
310	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
311	OK	Main Beams	gl32c	5.47	7.90	0.22	6 load combination
312	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
313	OK	Main Beams	gl32c	5.15	7.44	0.08	6 load combination
314	OK	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
315	OK	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
316	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
317	OK	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
318	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
319	OK	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
320	OK	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
321	OK	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
322	OK	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
323	OK	Main Beams	gl32c	5.15	7.44	0.12	6 load combination
324	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
325	OK	Main Beams	gl32c	5.47	7.91	0.22	6 load combination
326	OK	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
327	OK	Main Beams	gl32c	8.97	12.95	0.21	6 load combination
328	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
329	OK	Main Beams	gl32c	8.96	12.94	0.09	6 load combination
330	OK	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
331	OK	Main Beams	gl32c	5.47	7.90	0.11	6 load combination
332	OK	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
333	OK	Main Beams	gl32c	5.15	7.44	0.06	6 load combination
334	OK	Secondary Bea	gl32c	21.65	21.65	0.32	6 load combination
335	OK	Main Beams	gl32c	5.04	7.28	0.03	6 load combination
336	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
337	OK	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
338	OK	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
339	OK	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
340	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
341	OK	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
342	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
343	OK	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
344	OK	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
345	OK	Main Beams	gl32c	5.47	7.91	0.14	6 load combination
346	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
347	OK	Main Beams	gl32c	8.97	12.95	0.11	6 load combination
348	OK	Secondary Bea	gl32c	21.65	21.65	0.32	6 load combination

349	OK	Main Beams	gl32c	9.08	13.12	0.09	6 load combination
350	OK	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
351	OK	Main Beams	gl32c	5.49	7.93	0.13	6 load combination
352	OK	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
353	OK	Main Beams	gl32c	5.16	7.45	0.10	6 load combination
354	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
355	OK	Main Beams	gl32c	5.04	7.29	0.06	6 load combination
356	OK	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
357	OK	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
358	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
359	OK	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
360	OK	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
361	OK	Main Beams	gl32c	5.04	7.28	0.06	6 load combination
362	OK	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
363	OK	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
364	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
365	OK	Main Beams	gl32c	5.47	7.91	0.13	6 load combination
366	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
367	OK	Main Beams	gl32c	9.00	13.00	0.09	6 load combination
368	OK	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
369	OK	Main Beams	gl32c	9.08	13.12	0.17	6 load combination
370	OK	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
371	OK	Main Beams	gl32c	5.49	7.93	0.23	6 load combination
372	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
373	OK	Main Beams	gl32c	5.16	7.45	0.18	6 load combination
374	OK	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
375	OK	Main Beams	gl32c	5.04	7.29	0.13	6 load combination
376	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
377	OK	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
378	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
379	OK	Main Beams	gl32c	5.00	7.22	0.07	6 load combination
380	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
381	OK	Main Beams	gl32c	5.04	7.28	0.14	6 load combination
382	OK	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
383	OK	Main Beams	gl32c	5.15	7.44	0.18	6 load combination
384	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
385	OK	Main Beams	gl32c	5.47	7.91	0.22	6 load combination
386	OK	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
387	OK	Main Beams	gl32c	9.00	13.00	0.16	6 load combination
388	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
389	OK	Main Beams	gl32c	9.08	13.12	0.07	6 load combination
390	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
391	OK	Main Beams	gl32c	5.49	7.93	0.24	6 load combination
392	OK	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
393	OK	Main Beams	gl32c	5.16	7.45	0.04	6 load combination
394	OK	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
395	OK	Main Beams	gl32c	5.04	7.29	0.27	6 load combination
396	OK	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
397	OK	Main Beams	gl32c	5.00	7.22	0.55	6 load combination
398	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
399	OK	Main Beams	gl32c	5.00	7.22	0.59	6 load combination
400	OK	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
401	OK	Main Beams	gl32c	5.04	7.28	0.32	6 load combination
402	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
403	OK	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
404	OK	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
405	OK	Main Beams	gl32c	5.47	7.91	0.13	6 load combination
406	OK	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
407	OK	Main Beams	gl32c	9.00	13.00	0.10	6 load combination
408	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
409	OK	Main Beams	gl32c	9.08	13.12	0.26	6 load combination
410	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
411	OK	Main Beams	gl32c	5.49	7.93	0.88	6 load combination
412	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
413	OK	Main Beams	gl32c	5.16	7.45	0.57	6 load combination
414	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
415	OK	Main Beams	gl32c	5.04	7.29	0.35	6 load combination
416	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
417	OK	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
418	OK	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
419	OK	Main Beams	gl32c	5.00	7.22	0.19	6 load combination
420	OK	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
421	OK	Main Beams	gl32c	5.04	7.28	0.41	6 load combination
422	OK	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
423	OK	Main Beams	gl32c	5.15	7.44	0.61	6 load combination
424	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
425	OK	Main Beams	gl32c	5.47	7.91	0.90	6 load combination
426	OK	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
427	OK	Main Beams	gl32c	9.00	13.00	0.31	6 load combination
428	OK	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
429	OK	Main Beams	gl32c	9.08	13.12	0.23	6 load combination
430	OK	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
431	OK	Main Beams	gl32c	5.49	7.93	0.66	6 load combination
432	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
433	OK	Main Beams	gl32c	5.16	7.45	0.40	6 load combination
434	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
435	OK	Main Beams	gl32c	5.04	7.29	0.21	6 load combination
436	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
437	OK	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
438	OK	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
439	OK	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
440	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
441	OK	Main Beams	gl32c	5.04	7.28	0.25	6 load combination
442	OK	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
443	OK	Main Beams	gl32c	5.15	7.44	0.43	6 load combination
444	OK	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
445	OK	Main Beams	gl32c	5.47	7.91	0.67	6 load combination
446	OK	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
447	OK	Main Beams	gl32c	9.00	13.00	0.26	6 load combination
448	OK	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
449	OK	Main Beams	gl32c	9.08	13.12	0.12	6 load combination
450	OK	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
451	OK	Main Beams	gl32c	5.49	7.93	0.34	6 load combination
452	OK	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
453	OK	Main Beams	gl32c	5.16	7.45	0.20	6 load combination
454	OK	Secondary Bea	gl32c	21.65	21.65	0.26	6 load combination
455	OK	Main Beams	gl32c	5.04	7.29	0.10	6 load combination
456	OK	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
457	OK	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
458	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
459	OK	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
460	OK	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
461	OK	Main Beams	gl32c	5.04	7.28	0.12	6 load combination
462	OK	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
463	OK	Main Beams	gl32c	5.15	7.44	0.21	6 load combination
464	OK	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination

Ill.95 Robot Member Verification tables, Own illustration

Member	Section	Material	Lay	Laz	Ratio	Case
465	Main Beams	gl32c	5.47	7.91	0.34	6 load combination
466	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
467	Main Beams	gl32c	9.00	13.00	0.14	6 load combination
468	Secondary Bea	gl32c	21.65	21.65	0.26	6 load combination
469	Main Beams	gl32c	9.08	13.12	0.01	6 load combination
470	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
471	Main Beams	gl32c	5.49	7.93	0.03	6 load combination
472	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
473	Main Beams	gl32c	5.16	7.45	0.02	6 load combination
474	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
475	Main Beams	gl32c	5.04	7.29	0.02	6 load combination
476	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
477	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
478	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
479	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
480	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
481	Main Beams	gl32c	5.04	7.28	0.02	6 load combination
482	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
483	Main Beams	gl32c	5.15	7.44	0.01	6 load combination
484	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
485	Main Beams	gl32c	5.47	7.91	0.01	6 load combination
486	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
487	Main Beams	gl32c	9.00	13.00	0.01	6 load combination
488	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
489	Main Beams	gl32c	9.08	13.12	0.12	6 load combination
490	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
491	Main Beams	gl32c	5.49	7.93	0.35	6 load combination
492	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
493	Main Beams	gl32c	5.16	7.45	0.20	6 load combination
494	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
495	Main Beams	gl32c	5.04	7.29	0.10	6 load combination
496	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
497	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
498	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
499	Main Beams	gl32c	5.00	7.22	0.06	6 load combination
500	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
501	Main Beams	gl32c	5.04	7.28	0.13	6 load combination
502	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
503	Main Beams	gl32c	5.15	7.44	0.21	6 load combination
504	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
505	Main Beams	gl32c	5.47	7.91	0.34	6 load combination
506	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
507	Main Beams	gl32c	9.00	13.00	0.14	6 load combination
508	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
509	Main Beams	gl32c	9.08	13.12	0.23	6 load combination
510	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
511	Main Beams	gl32c	5.49	7.93	0.66	6 load combination
512	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
513	Main Beams	gl32c	5.16	7.45	0.40	6 load combination
514	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
515	Main Beams	gl32c	5.04	7.29	0.21	6 load combination
516	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
517	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
518	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
519	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
520	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
521	Main Beams	gl32c	5.04	7.28	0.25	6 load combination
522	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
523	Main Beams	gl32c	5.15	7.44	0.43	6 load combination
524	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
525	Main Beams	gl32c	5.47	7.91	0.68	6 load combination
526	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
527	Main Beams	gl32c	9.00	13.00	0.26	6 load combination
528	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
529	Main Beams	gl32c	9.08	13.12	0.26	6 load combination
530	Secondary Bea	gl32c	21.65	21.65	0.12	6 load combination
531	Main Beams	gl32c	5.49	7.93	0.87	6 load combination
532	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
533	Main Beams	gl32c	5.16	7.45	0.57	6 load combination
534	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
535	Main Beams	gl32c	5.04	7.29	0.35	6 load combination
536	Secondary Bea	gl32c	21.65	21.65	0.12	6 load combination
537	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
538	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
539	Main Beams	gl32c	5.00	7.22	0.19	6 load combination
540	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
541	Main Beams	gl32c	5.04	7.28	0.41	6 load combination
542	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
543	Main Beams	gl32c	5.15	7.44	0.61	6 load combination
544	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
545	Main Beams	gl32c	5.47	7.91	0.90	6 load combination
546	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
547	Main Beams	gl32c	9.00	13.00	0.31	6 load combination
548	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
549	Main Beams	gl32c	9.08	13.12	0.07	6 load combination
550	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
551	Main Beams	gl32c	5.49	7.93	0.23	6 load combination
552	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
553	Main Beams	gl32c	5.16	7.45	0.04	6 load combination
554	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
555	Main Beams	gl32c	5.04	7.29	0.28	6 load combination
556	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
557	Main Beams	gl32c	5.00	7.22	0.56	6 load combination
558	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
559	Main Beams	gl32c	5.00	7.22	0.60	6 load combination
560	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
561	Main Beams	gl32c	5.04	7.28	0.32	6 load combination
562	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
563	Main Beams	gl32c	5.15	7.44	0.11	6 load combination
564	Secondary Bea	gl32c	21.65	21.65	0.25	6 load combination
565	Main Beams	gl32c	5.47	7.91	0.12	6 load combination
566	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
567	Main Beams	gl32c	9.00	13.00	0.10	6 load combination
568	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
569	Main Beams	gl32c	9.08	13.12	0.17	6 load combination
570	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
571	Main Beams	gl32c	5.49	7.93	0.23	6 load combination
572	Secondary Bea	gl32c	21.65	21.65	0.42	6 load combination
573	Main Beams	gl32c	5.16	7.45	0.18	6 load combination
574	Secondary Bea	gl32c	21.65	21.65	0.48	6 load combination
575	Main Beams	gl32c	5.04	7.29	0.13	6 load combination
576	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
577	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
578	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
579	Main Beams	gl32c	5.00	7.22	0.07	6 load combination
580	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
581	Main Beams	gl32c	5.04	7.28	0.14	6 load combination
582	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
583	Main Beams	gl32c	5.15	7.44	0.18	6 load combination
584	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
585	Main Beams	gl32c	5.47	7.91	0.22	6 load combination
586	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
587	Main Beams	gl32c	9.00	13.00	0.16	6 load combination
588	Secondary Bea	gl32c	21.65	21.65	0.48	6 load combination
589	Main Beams	gl32c	9.08	13.12	0.09	6 load combination
590	Secondary Bea	gl32c	21.65	21.65	0.42	6 load combination
591	Main Beams	gl32c	5.49	7.93	0.13	6 load combination
592	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
593	Main Beams	gl32c	5.16	7.45	0.10	6 load combination
594	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
595	Main Beams	gl32c	5.04	7.29	0.06	6 load combination
596	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
597	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
598	Secondary Bea	gl32c	21.65	21.65	0.34	6 load combination
599	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
600	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
601	Main Beams	gl32c	5.04	7.28	0.06	6 load combination
602	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
603	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
604	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
605	Main Beams	gl32c	5.47	7.91	0.13	6 load combination
606	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
607	Main Beams	gl32c	9.00	13.00	0.09	6 load combination
608	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
609	Main Beams	gl32c	8.97	12.95	0.11	6 load combination
610	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
611	Main Beams	gl32c	5.47	7.91	0.13	6 load combination
612	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
613	Main Beams	gl32c	5.15	7.44	0.08	6 load combination
614	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
615	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
616	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
617	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
618	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
619	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
620	Secondary Bea	gl32c	21.65	21.65	0.32	6 load combination
621	Main Beams	gl32c	5.04	7.28	0.05	6 load combination
622	Secondary Bea	gl32c	21.65	21.65	0.41	6 load combination
623	Main Beams	gl32c	5.15	7.44	0.08	6 load combination
624	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
625	Main Beams	gl32c	5.47	7.90	0.12	6 load combination
626	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
627	Main Beams	gl32c	8.96	12.94	0.10	6 load combination
628	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
629	Main Beams	gl32c	8.97	12.95	0.24	6 load combination
630	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
631	Main Beams	gl32c	5.47	7.91	0.25	6 load combination
632	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
633	Main Beams	gl32c	5.15	7.44	0.11	6 load combination
634	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
635	Main Beams	gl32c	5.04	7.28	0.03	6 load combination
636	Secondary Bea	gl32c	21.65	21.65	0.41	6 load combination
637	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
638	Secondary Bea	gl32c	21.65	21.65	0.32	6 load combination
639	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
640	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
641	Main Beams	gl32c	5.04	7.28	0.04	6 load combination
642	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
643	Main Beams	gl32c	5.15	7.44	0.11	6 load combination
644	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
645	Main Beams	gl32c	5.47	7.90	0.21	6 load combination
646	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
647	Main Beams	gl32c	8.96	12.94	0.21	6 load combination
648	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
649	Main Beams	gl32c	8.97	12.95	0.18	6 load combination
650	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
651	Main Beams	gl32c	5.47	7.91	0.61	6 load combination
652	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
653	Main Beams	gl32c	5.15	7.44	0.56	6 load combination
654	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
655	Main Beams	gl32c	5.04	7.28	0.29	6 load combination
656	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
657	Main Beams	gl32c	5.00	7.22	0.10	6 load combination
658	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
659	Main Beams	gl32c	5.00	7.22	0.07	6 load combination
660	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
661	Main Beams	gl32c	5.04	7.28	0.25	6 load combination
662	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
663	Main Beams	gl32c	5.15	7.44	0.49	6 load combination
664	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
665	Main Beams	gl32c	5.47	7.90	0.59	6 load combination
666	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
667	Main Beams	gl32c	8.96	12.94	0.18	6 load combination
668	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
669	Main Beams	gl32c	8.97	12.95	0.81	6 load combination
670	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
671	Main Beams	gl32c	5.47	7.91	0.70	6 load combination
672	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
673	Main Beams	gl32c	5.15	7.44	0.33	6 load combination
674	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
675	Main Beams	gl32c	5.04	7.28	0.10	6 load combination
676	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
677	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
678	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
679	Main Beams	gl32c	5.00	7.22	0.08	6 load combination
680	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
681	Main Beams	gl32c	5.04	7.28	0.17	6 load combination
682	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
683	Main Beams	gl32c	5.15	7.44	0.37	6 load combination
684	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
685	Main Beams	gl32c	5.47	7.90	0.71	6 load combination
686	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
687	Main Beams	gl32c	8.96	12.94	0.84	6 load combination
688	Secondary Bea	gl32c	21.65	21.65	0.02	6 load combination
689	Main Beams	gl32c	8.97	12.95	0.56	6 load combination
690	Secondary Bea	gl32c	21.65	21.65	0.03	6 load combination
691	Main Beams	gl32c	5.47	7.91	0.50	6 load combination
692	Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
693	Main Beams	gl32c	5.15	7.44	0.30	6 load combination
694	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
695	Main Beams	gl32c	5.04	7.28	0.14	6 load combination
696	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination

697	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
698	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
699	OK	Main Beams	al32c	5.00	7.22	0.08	6 load combination
700	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
701	OK	Main Beams	al32c	5.04	7.28	0.18	6 load combination
702	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
703	OK	Main Beams	al32c	5.15	7.44	0.32	6 load combination
704	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
705	OK	Main Beams	al32c	5.47	7.90	0.52	6 load combination
706	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
707	OK	Main Beams	al32c	8.96	12.94	0.59	6 load combination
708	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
709	OK	Main Beams	al32c	8.97	12.95	0.28	6 load combination
710	OK	Secondary Bea	al32c	21.65	21.65	0.16	6 load combination
711	OK	Main Beams	al32c	5.47	7.91	0.25	6 load combination
712	OK	Secondary Bea	al32c	21.65	21.65	0.03	6 load combination
713	OK	Main Beams	al32c	5.15	7.44	0.15	6 load combination
714	OK	Secondary Bea	al32c	21.65	21.65	0.05	6 load combination
715	OK	Main Beams	al32c	5.04	7.28	0.07	6 load combination
716	OK	Secondary Bea	al32c	21.65	21.65	0.26	6 load combination
717	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
718	OK	Secondary Bea	al32c	21.65	21.65	0.32	6 load combination
719	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
720	OK	Secondary Bea	al32c	21.65	21.65	0.12	6 load combination
721	OK	Main Beams	al32c	5.04	7.28	0.09	6 load combination
722	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
723	OK	Main Beams	al32c	5.15	7.44	0.16	6 load combination
724	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
725	OK	Main Beams	al32c	5.47	7.90	0.26	6 load combination
726	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
727	OK	Main Beams	al32c	8.96	12.94	0.30	6 load combination
728	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
729	OK	Main Beams	al32c	8.97	12.95	0.02	6 load combination
730	OK	Secondary Bea	al32c	21.65	21.65	0.12	6 load combination
731	OK	Main Beams	al32c	5.47	7.91	0.02	6 load combination
732	OK	Secondary Bea	al32c	21.65	21.65	0.32	6 load combination
733	OK	Main Beams	al32c	5.15	7.44	0.02	6 load combination
734	OK	Secondary Bea	al32c	21.65	21.65	0.26	6 load combination
735	OK	Main Beams	al32c	5.04	7.28	0.02	6 load combination
736	OK	Secondary Bea	al32c	21.65	21.65	0.05	6 load combination
737	OK	Main Beams	al32c	5.00	7.22	0.02	6 load combination
738	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
739	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
740	OK	Secondary Bea	al32c	21.65	21.65	0.15	6 load combination
741	OK	Main Beams	al32c	5.04	7.28	0.03	6 load combination
742	OK	Secondary Bea	al32c	21.65	21.65	0.31	6 load combination
743	OK	Main Beams	al32c	5.15	7.44	0.03	6 load combination
744	OK	Secondary Bea	al32c	21.65	21.65	0.19	6 load combination
745	OK	Main Beams	al32c	5.47	7.90	0.03	6 load combination
746	OK	Secondary Bea	al32c	21.65	21.65	0.15	6 load combination
747	OK	Main Beams	al32c	8.96	12.94	0.03	6 load combination
748	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
749	OK	Main Beams	al32c	8.97	12.95	0.27	6 load combination
750	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
751	OK	Main Beams	al32c	5.47	7.91	0.24	6 load combination
752	OK	Secondary Bea	al32c	21.65	21.65	0.15	6 load combination
753	OK	Main Beams	al32c	5.15	7.44	0.15	6 load combination
754	OK	Secondary Bea	al32c	21.65	21.65	0.19	6 load combination
755	OK	Main Beams	al32c	5.04	7.28	0.07	6 load combination
756	OK	Secondary Bea	al32c	21.65	21.65	0.30	6 load combination
757	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
758	OK	Secondary Bea	al32c	21.65	21.65	0.15	6 load combination
759	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
760	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
761	OK	Main Beams	al32c	5.04	7.28	0.09	6 load combination
762	OK	Secondary Bea	al32c	21.65	21.65	0.13	6 load combination
763	OK	Main Beams	al32c	5.15	7.44	0.16	6 load combination
764	OK	Secondary Bea	al32c	21.65	21.65	0.34	6 load combination
765	OK	Main Beams	al32c	5.47	7.90	0.26	6 load combination
766	OK	Secondary Bea	al32c	21.65	21.65	0.40	6 load combination
767	OK	Main Beams	al32c	8.96	12.94	0.30	6 load combination
768	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
769	OK	Main Beams	al32c	8.97	12.95	0.55	6 load combination
770	OK	Secondary Bea	al32c	21.65	21.65	0.21	6 load combination
771	OK	Main Beams	al32c	5.47	7.91	0.50	6 load combination
772	OK	Secondary Bea	al32c	21.65	21.65	0.11	6 load combination
773	OK	Main Beams	al32c	5.15	7.44	0.29	6 load combination
774	OK	Secondary Bea	al32c	21.65	21.65	0.11	6 load combination
775	OK	Main Beams	al32c	5.04	7.28	0.14	6 load combination
776	OK	Secondary Bea	al32c	21.65	21.65	0.21	6 load combination
777	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
778	OK	Secondary Bea	al32c	21.65	21.65	0.28	6 load combination
779	OK	Main Beams	al32c	5.00	7.22	0.08	6 load combination
780	OK	Secondary Bea	al32c	21.65	21.65	0.40	6 load combination
781	OK	Main Beams	al32c	5.04	7.28	0.18	6 load combination
782	OK	Secondary Bea	al32c	21.65	21.65	0.34	6 load combination
783	OK	Main Beams	al32c	5.15	7.44	0.32	6 load combination
784	OK	Secondary Bea	al32c	21.65	21.65	0.13	6 load combination
785	OK	Main Beams	al32c	5.47	7.90	0.52	6 load combination
786	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
787	OK	Main Beams	al32c	8.96	12.94	0.59	6 load combination
788	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
789	OK	Main Beams	al32c	8.97	12.95	0.81	6 load combination
790	OK	Secondary Bea	al32c	21.65	21.65	0.22	6 load combination
791	OK	Main Beams	al32c	5.47	7.91	0.70	6 load combination
792	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
793	OK	Main Beams	al32c	5.15	7.44	0.33	6 load combination
794	OK	Secondary Bea	al32c	21.65	21.65	0.13	6 load combination
795	OK	Main Beams	al32c	5.04	7.28	0.10	6 load combination
796	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
797	OK	Main Beams	al32c	5.00	7.22	0.05	6 load combination
798	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
799	OK	Main Beams	al32c	5.00	7.22	0.09	6 load combination
800	OK	Secondary Bea	al32c	21.65	21.65	0.13	6 load combination
801	OK	Main Beams	al32c	5.04	7.28	0.17	6 load combination
802	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
803	OK	Main Beams	al32c	5.15	7.44	0.37	6 load combination
804	OK	Secondary Bea	al32c	21.65	21.65	0.22	6 load combination
805	OK	Main Beams	al32c	5.47	7.90	0.71	6 load combination
806	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
807	OK	Main Beams	al32c	8.96	12.94	0.84	6 load combination
808	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
809	OK	Main Beams	al32c	8.97	12.95	0.18	6 load combination
810	OK	Secondary Bea	al32c	21.65	21.65	0.16	6 load combination
811	OK	Main Beams	al32c	5.47	7.91	0.60	6 load combination
812	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
813	OK	Main Beams	al32c	5.15	7.44	0.54	6 load combination
814	OK	Secondary Bea	al32c	21.65	21.65	0.30	6 load combination
815	OK	Main Beams	al32c	5.04	7.28	0.28	6 load combination
816	OK	Secondary Bea	al32c	21.65	21.65	0.27	6 load combination
817	OK	Main Beams	al32c	5.00	7.22	0.10	6 load combination
818	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
819	OK	Main Beams	al32c	5.00	7.22	0.07	6 load combination
820	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
821	OK	Main Beams	al32c	5.04	7.28	0.24	6 load combination
822	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
823	OK	Main Beams	al32c	5.15	7.44	0.48	6 load combination
824	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
825	OK	Main Beams	al32c	5.47	7.90	0.57	6 load combination
826	OK	Secondary Bea	al32c	21.65	21.65	0.27	6 load combination
827	OK	Main Beams	al32c	8.96	12.94	0.18	6 load combination
828	OK	Secondary Bea	al32c	21.65	21.65	0.30	6 load combination
829	OK	Main Beams	al32c	8.97	12.95	0.25	6 load combination
830	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
831	OK	Main Beams	al32c	5.47	7.91	0.25	6 load combination
832	OK	Secondary Bea	al32c	21.65	21.65	0.16	6 load combination
833	OK	Main Beams	al32c	5.15	7.44	0.11	6 load combination
834	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
835	OK	Main Beams	al32c	5.04	7.28	0.03	6 load combination
836	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
837	OK	Main Beams	al32c	5.00	7.22	0.05	6 load combination
838	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
839	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
840	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
841	OK	Main Beams	al32c	5.04	7.28	0.04	6 load combination
842	OK	Secondary Bea	al32c	21.65	21.65	0.19	6 load combination
843	OK	Main Beams	al32c	5.15	7.44	0.10	6 load combination
844	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
845	OK	Main Beams	al32c	5.47	7.90	0.21	6 load combination
846	OK	Secondary Bea	al32c	21.65	21.65	0.07	6 load combination
847	OK	Main Beams	al32c	8.96	12.94	0.21	6 load combination
848	OK	Secondary Bea	al32c	21.65	21.65	0.19	6 load combination
849	OK	Main Beams	al32c	8.97	12.95	0.11	6 load combination
850	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
851	OK	Main Beams	al32c	5.47	7.91	0.13	6 load combination
852	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
853	OK	Main Beams	al32c	5.15	7.44	0.08	6 load combination
854	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
855	OK	Main Beams	al32c	5.04	7.28	0.05	6 load combination
856	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
857	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
858	OK	Secondary Bea	al32c	21.65	21.65	0.09	6 load combination
859	OK	Main Beams	al32c	5.00	7.22	0.03	6 load combination
860	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
861	OK	Main Beams	al32c	5.04	7.28	0.05	6 load combination
862	OK	Secondary Bea	al32c	21.65	21.65	0.21	6 load combination
863	OK	Main Beams	al32c	5.15	7.44	0.08	6 load combination
864	OK	Secondary Bea	al32c	21.65	21.65	0.21	6 load combination
865	OK	Main Beams	al32c	5.47	7.90	0.12	6 load combination
866	OK	Secondary Bea	al32c	21.65	21.65	0.12	6 load combination
867	OK	Main Beams	al32c	8.96	12.94	0.10	6 load combination
868	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
869	OK	Main Beams	al32c	9.00	13.00	0.10	6 load combination
870	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
871	OK	Main Beams	al32c	5.47	7.91	0.14	6 load combination
872	OK	Secondary Bea	al32c	21.65	21.65	0.12	6 load combination
873	OK	Main Beams	al32c	5.15	7.44	0.10	6 load combination
874	OK	Secondary Bea	al32c	21.65	21.65	0.21	6 load combination
875	OK	Main Beams	al32c	5.04	7.28	0.07	6 load combination
876	OK	Secondary Bea	al32c	21.65	21.65	0.22	6 load combination
877	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
878	OK	Secondary Bea	al32c	21.65	21.65	0.14	6 load combination
879	OK	Main Beams	al32c	5.00	7.22	0.04	6 load combination
880	OK	Secondary Bea	al32c	21.65	21.65	0.09	6 load combination
881	OK	Main Beams	al32c	5.04	7.29	0.07	6 load combination
882	OK	Secondary Bea	al32c	21.65	21.65	0.09	6 load combination
883	OK	Main Beams	al32c	5.16	7.45	0.09	6 load combination
884	OK	Secondary Bea	al32c	21.65	21.65	0.24	6 load combination
885	OK	Main Beams	al32c	5.49	7.93	0.11	6 load combination
886	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
887	OK	Main Beams	al32c	9.08	13.12	0.07	6 load combination
888	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
889	OK	Main Beams	al32c	9.00	13.00	0.18	6 load combination
890	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
891	OK	Main Beams	al32c	5.47	7.91	0.24	6 load combination
892	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
893	OK	Main Beams	al32c	5.15	7.44	0.20	6 load combination
894	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
895	OK	Main Beams	al32c	5.04	7.28	0.14	6 load combination
896	OK	Secondary Bea	al32c	21.65	21.65	0.10	6 load combination
897	OK	Main Beams	al32c	5.00	7.22	0.05	6 load combination
898	OK	Secondary Bea	al32c	21.65	21.65	0.18	6 load combination
899	OK	Main Beams	al32c	5.00	7.22	0.11	6 load combination
900	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
901	OK	Main Beams	al32c	5.04	7.29	0.18	6 load combination
902	OK	Secondary Bea	al32c	21.65	21.65	0.24	6 load combination
903	OK	Main Beams	al32c	5.16	7.45	0.19	6 load combination
904	OK	Secondary Bea	al32c	21.65	21.65	0.09	6 load combination
905	OK	Main Beams	al32c	5.49	7.93	0.17	6 load combination
906	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
907	OK	Main Beams	al32c	9.08	13.12	0.12	6 load combination
908	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
909	OK	Main Beams	al32c	9.00	13.00	0.06	6 load combination
910	OK	Secondary Bea	al32c	21.65	21.65	0.32	6 load combination
911	OK	Main Beams	al32c	5.47	7.91	0.20	6 load combination
912	OK	Secondary Bea	al32c	21.65	21.65	0.11	6 load combination
913	OK	Main Beams	al32c	5.15	7.44	0.07	6 load combination
914	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
915	OK	Main Beams	al32c	5.04	7.28	0.31	6 load combination
916	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
917	OK	Main Beams	al32c	5.00	7.22	0.59	6 load combination
918	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination
919	OK	Main Beams	al32c	5.00	7.22	0.56	6 load combination
920	OK	Secondary Bea	al32c	21.65	21.65	0.08	6 load combination
921	OK	Main Beams	al32c	5.04	7.29	0.30	6 load combination
922	OK	Secondary Bea	al32c	21.65	21.65	0.11	6 load combination
923	OK	Main Beams	al32c	5.16	7.45	0.10	6 load combination
924	OK	Secondary Bea	al32c	21.65	21.65	0.32	6 load combination
925	OK	Main Beams	al32c	5.49	7.93	0.10	6 load combination
926	OK	Secondary Bea	al32c	21.65	21.65	0.29	6 load combination
927	OK	Main Beams	al32c	9.08	13.12	0.14	6 load combination
928	OK	Secondary Bea	al32c	21.65	21.65	0.06	6 load combination

Ill.96 Robot Member Verification tables, Own illustration

Member	Section	Material	Lay	Laz	Ratio	Case
929	Main Beams	gl32c	9.00	13.00	0.24	6 load combination
930	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination
931	Main Beams	gl32c	5.47	7.91	0.89	6 load combination
932	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
933	Main Beams	gl32c	5.15	7.44	0.60	6 load combination
934	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
935	Main Beams	gl32c	5.04	7.28	0.37	6 load combination
936	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
937	Main Beams	gl32c	5.00	7.22	0.12	6 load combination
938	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
939	Main Beams	gl32c	5.00	7.22	0.19	6 load combination
940	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
941	Main Beams	gl32c	5.04	7.29	0.39	6 load combination
942	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
943	Main Beams	gl32c	5.16	7.45	0.53	6 load combination
944	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
945	Main Beams	gl32c	5.49	7.93	0.71	6 load combination
946	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
947	Main Beams	gl32c	9.08	13.12	0.74	6 load combination
948	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
949	Main Beams	gl32c	9.00	13.00	0.21	6 load combination
950	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
951	Main Beams	gl32c	5.47	7.91	0.65	6 load combination
952	Secondary Bea	gl32c	21.65	21.65	0.04	6 load combination
953	Main Beams	gl32c	5.15	7.44	0.40	6 load combination
954	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
955	Main Beams	gl32c	5.04	7.28	0.21	6 load combination
956	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
957	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
958	Secondary Bea	gl32c	21.65	21.65	0.37	6 load combination
959	Main Beams	gl32c	5.00	7.22	0.09	6 load combination
960	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
961	Main Beams	gl32c	5.04	7.29	0.22	6 load combination
962	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
963	Main Beams	gl32c	5.16	7.45	0.36	6 load combination
964	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
965	Main Beams	gl32c	5.49	7.93	0.52	6 load combination
966	Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
967	Main Beams	gl32c	9.08	13.12	0.56	6 load combination
968	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
969	Main Beams	gl32c	9.00	13.00	0.11	6 load combination
970	Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
971	Main Beams	gl32c	5.47	7.91	0.33	6 load combination
972	Secondary Bea	gl32c	21.65	21.65	0.37	6 load combination
973	Main Beams	gl32c	5.15	7.44	0.20	6 load combination
974	Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
975	Main Beams	gl32c	5.04	7.28	0.10	6 load combination
976	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
977	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
978	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
979	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
980	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
981	Main Beams	gl32c	5.04	7.29	0.10	6 load combination
982	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
983	Main Beams	gl32c	5.16	7.45	0.17	6 load combination
984	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
985	Main Beams	gl32c	5.49	7.93	0.26	6 load combination
986	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
987	Main Beams	gl32c	9.08	13.12	0.29	6 load combination
988	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
989	Main Beams	gl32c	9.00	13.00	0.01	6 load combination
990	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
991	Main Beams	gl32c	5.47	7.91	0.03	6 load combination
992	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
993	Main Beams	gl32c	5.15	7.44	0.02	6 load combination
994	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
995	Main Beams	gl32c	5.04	7.28	0.02	6 load combination
996	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
997	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
998	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
999	Main Beams	gl32c	5.00	7.22	0.02	6 load combination
1000	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1001	Main Beams	gl32c	5.04	7.29	0.02	6 load combination
1002	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1003	Main Beams	gl32c	5.16	7.45	0.02	6 load combination
1004	Secondary Bea	gl32c	21.65	21.65	0.12	6 load combination
1005	Main Beams	gl32c	5.49	7.93	0.02	6 load combination
1006	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
1007	Main Beams	gl32c	9.08	13.12	0.02	6 load combination
1008	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
1009	Main Beams	gl32c	9.00	13.00	0.11	6 load combination
1010	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1011	Main Beams	gl32c	5.47	7.91	0.33	6 load combination
1012	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1013	Main Beams	gl32c	5.15	7.44	0.20	6 load combination
1014	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1015	Main Beams	gl32c	5.04	7.28	0.10	6 load combination
1016	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1017	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
1018	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
1019	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
1020	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
1021	Main Beams	gl32c	5.04	7.29	0.10	6 load combination
1022	Secondary Bea	gl32c	21.65	21.65	0.12	6 load combination
1023	Main Beams	gl32c	5.16	7.45	0.17	6 load combination
1024	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1025	Main Beams	gl32c	5.49	7.93	0.26	6 load combination
1026	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1027	Main Beams	gl32c	9.08	13.12	0.28	6 load combination
1028	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1029	Main Beams	gl32c	9.00	13.00	0.21	6 load combination
1030	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1031	Main Beams	gl32c	5.47	7.91	0.65	6 load combination
1032	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1033	Main Beams	gl32c	5.15	7.44	0.40	6 load combination
1034	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1035	Main Beams	gl32c	5.04	7.28	0.21	6 load combination
1036	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1037	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
1038	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1039	Main Beams	gl32c	5.00	7.22	0.09	6 load combination
1040	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1041	Main Beams	gl32c	5.04	7.29	0.22	6 load combination
1042	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1043	Main Beams	gl32c	5.16	7.45	0.35	6 load combination
1044	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1045	Main Beams	gl32c	5.49	7.93	0.52	6 load combination
1046	Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1047	Main Beams	gl32c	9.08	13.12	0.56	6 load combination
1048	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1049	Main Beams	gl32c	9.00	13.00	0.24	6 load combination
1050	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
1051	Main Beams	gl32c	5.47	7.91	0.89	6 load combination
1052	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1053	Main Beams	gl32c	5.15	7.44	0.60	6 load combination
1054	Secondary Bea	gl32c	21.65	21.65	0.31	6 load combination
1055	Main Beams	gl32c	5.04	7.28	0.37	6 load combination
1056	Secondary Bea	gl32c	21.65	21.65	0.34	6 load combination
1057	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1058	Secondary Bea	gl32c	21.65	21.65	0.24	6 load combination
1059	Main Beams	gl32c	5.00	7.22	0.19	6 load combination
1060	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1061	Main Beams	gl32c	5.04	7.29	0.39	6 load combination
1062	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1063	Main Beams	gl32c	5.16	7.45	0.53	6 load combination
1064	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
1065	Main Beams	gl32c	5.49	7.93	0.71	6 load combination
1066	Secondary Bea	gl32c	21.65	21.65	0.34	6 load combination
1067	Main Beams	gl32c	9.08	13.12	0.74	6 load combination
1068	Secondary Bea	gl32c	21.65	21.65	0.31	6 load combination
1069	Main Beams	gl32c	9.00	13.00	0.07	6 load combination
1070	Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1071	Main Beams	gl32c	5.47	7.91	0.20	6 load combination
1072	Secondary Bea	gl32c	21.65	21.65	0.20	6 load combination
1073	Main Beams	gl32c	5.15	7.44	0.06	6 load combination
1074	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
1075	Main Beams	gl32c	5.04	7.28	0.30	6 load combination
1076	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
1077	Main Beams	gl32c	5.00	7.22	0.57	6 load combination
1078	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1079	Main Beams	gl32c	5.00	7.22	0.54	6 load combination
1080	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1081	Main Beams	gl32c	5.04	7.29	0.29	6 load combination
1082	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1083	Main Beams	gl32c	5.16	7.45	0.10	6 load combination
1084	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1085	Main Beams	gl32c	5.49	7.93	0.10	6 load combination
1086	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1087	Main Beams	gl32c	9.08	13.12	0.14	6 load combination
1088	Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1089	Main Beams	gl32c	9.00	13.00	0.18	6 load combination
1090	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1091	Main Beams	gl32c	5.47	7.91	0.24	6 load combination
1092	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1093	Main Beams	gl32c	5.15	7.44	0.20	6 load combination
1094	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
1095	Main Beams	gl32c	5.04	7.28	0.14	6 load combination
1096	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
1097	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
1098	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1099	Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1100	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
1101	Main Beams	gl32c	5.04	7.29	0.18	6 load combination
1102	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1103	Main Beams	gl32c	5.16	7.45	0.19	6 load combination
1104	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1105	Main Beams	gl32c	5.49	7.93	0.17	6 load combination
1106	Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1107	Main Beams	gl32c	9.08	13.12	0.12	6 load combination
1108	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1109	Main Beams	gl32c	9.00	13.00	0.10	6 load combination
1110	Secondary Bea	gl32c	21.65	21.65	0.11	6 load combination
1111	Main Beams	gl32c	5.47	7.91	0.14	6 load combination
1112	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
1113	Main Beams	gl32c	5.15	7.44	0.10	6 load combination
1114	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1115	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
1116	Secondary Bea	gl32c	21.65	21.65	0.28	6 load combination
1117	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1118	Secondary Bea	gl32c	21.65	21.65	0.22	6 load combination
1119	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1120	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1121	Main Beams	gl32c	5.04	7.29	0.07	6 load combination
1122	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1123	Main Beams	gl32c	5.16	7.45	0.09	6 load combination
1124	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1125	Main Beams	gl32c	5.49	7.93	0.11	6 load combination
1126	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
1127	Main Beams	gl32c	9.08	13.12	0.07	6 load combination
1128	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
1129	Main Beams	gl32c	8.97	12.95	0.10	6 load combination
1130	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1131	Main Beams	gl32c	5.47	7.91	0.13	6 load combination
1132	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1133	Main Beams	gl32c	5.15	7.44	0.09	6 load combination
1134	Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1135	Main Beams	gl32c	5.04	7.28	0.07	6 load combination
1136	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1137	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1138	Secondary Bea	gl32c	21.65	21.65	0.17	6 load combination
1139	Main Beams	gl32c	5.00	7.22	0.03	6 load combination
1140	Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
1141	Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1142	Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1143	Main Beams	gl32c	5.15	7.44	0.07	6 load combination
1144	Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1145	Main Beams	gl32c	5.47	7.90	0.12	6 load combination
1146	Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
1147	Main Beams	gl32c	8.96	12.94	0.09	6 load combination
1148	Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
1149	Main Beams	gl32c	8.97	12.95	0.21	6 load combination
1150	Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1151	Main Beams	gl32c	5.47	7.91	0.21	6 load combination
1152	Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1153	Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1154	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1155	Main Beams	gl32c	5.04	7.28	0.06	6 load combination
1156	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1157	Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1158	Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1159	Main Beams	gl32c	5.00	7.22	0.05	6 load combination
1160	Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination

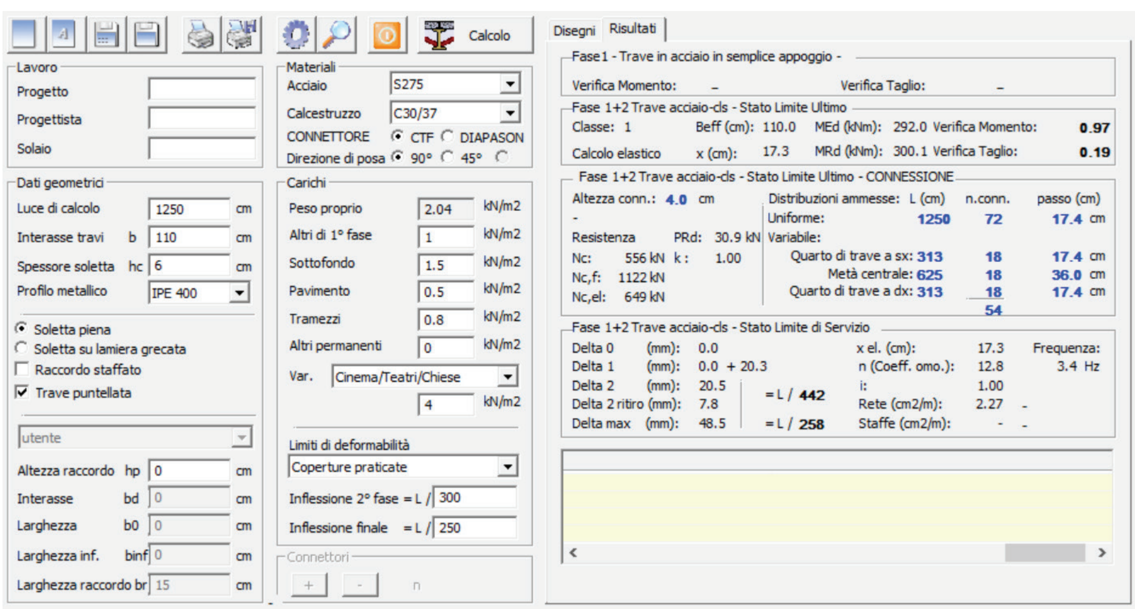
1161		Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1162		Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1163		Main Beams	gl32c	5.15	7.44	0.09	6 load combination
1164		Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1165		Main Beams	gl32c	5.47	7.90	0.23	6 load combination
1166		Secondary Bea	gl32c	21.65	21.65	0.23	6 load combination
1167		Main Beams	gl32c	8.96	12.94	0.21	6 load combination
1168		Secondary Bea	gl32c	21.65	21.65	0.05	6 load combination
1169		Main Beams	gl32c	8.97	12.95	0.08	6 load combination
1170		Secondary Bea	gl32c	21.65	21.65	0.03	6 load combination
1171		Main Beams	gl32c	5.47	7.91	0.38	6 load combination
1172		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1173		Main Beams	gl32c	5.15	7.44	0.48	6 load combination
1174		Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1175		Main Beams	gl32c	5.04	7.28	0.24	6 load combination
1176		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1177		Main Beams	gl32c	5.00	7.22	0.07	6 load combination
1178		Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1179		Main Beams	gl32c	5.00	7.22	0.09	6 load combination
1180		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1181		Main Beams	gl32c	5.04	7.28	0.26	6 load combination
1182		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1183		Main Beams	gl32c	5.15	7.44	0.49	6 load combination
1184		Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1185		Main Beams	gl32c	5.47	7.90	0.64	6 load combination
1186		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1187		Main Beams	gl32c	8.96	12.94	0.11	6 load combination
1188		Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1189		Main Beams	gl32c	8.97	12.95	0.34	6 load combination
1190		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1191		Main Beams	gl32c	5.47	7.91	0.35	6 load combination
1192		Secondary Bea	gl32c	21.65	21.65	0.03	6 load combination
1193		Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1194		Secondary Bea	gl32c	21.65	21.65	0.03	6 load combination
1195		Main Beams	gl32c	5.04	7.28	0.09	6 load combination
1196		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1197		Main Beams	gl32c	5.00	7.22	0.14	6 load combination
1198		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1199		Main Beams	gl32c	5.00	7.22	0.20	6 load combination
1200		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1201		Main Beams	gl32c	5.04	7.28	0.32	6 load combination
1202		Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1203		Main Beams	gl32c	5.15	7.44	0.56	6 load combination
1204		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1205		Main Beams	gl32c	5.47	7.90	0.94	6 load combination
1206		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1207		Main Beams	gl32c	8.96	12.94	0.27	6 load combination
1208		Secondary Bea	gl32c	21.65	21.65	0.07	6 load combination
1209		Main Beams	gl32c	8.97	12.95	0.25	6 load combination
1210		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1211		Main Beams	gl32c	5.47	7.91	0.28	6 load combination
1212		Secondary Bea	gl32c	21.65	21.65	0.16	6 load combination
1213		Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1214		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1215		Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1216		Secondary Bea	gl32c	21.65	21.65	0.03	6 load combination
1217		Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1218		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1219		Main Beams	gl32c	5.00	7.22	0.19	6 load combination
1220		Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1221		Main Beams	gl32c	5.04	7.28	0.30	6 load combination
1222		Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
1223		Main Beams	gl32c	5.15	7.44	0.47	6 load combination
1224		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1225		Main Beams	gl32c	5.47	7.90	0.71	6 load combination
1226		Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1227		Main Beams	gl32c	8.96	12.94	0.24	6 load combination
1228		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1229		Main Beams	gl32c	8.97	12.95	0.13	6 load combination
1230		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1231		Main Beams	gl32c	5.47	7.91	0.15	6 load combination
1232		Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1233		Main Beams	gl32c	5.15	7.44	0.07	6 load combination
1234		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1235		Main Beams	gl32c	5.04	7.28	0.03	6 load combination
1236		Secondary Bea	gl32c	21.65	21.65	0.18	6 load combination
1237		Main Beams	gl32c	5.00	7.22	0.06	6 load combination
1238		Secondary Bea	gl32c	21.65	21.65	0.21	6 load combination
1239		Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1240		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1241		Main Beams	gl32c	5.04	7.28	0.16	6 load combination
1242		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1243		Main Beams	gl32c	5.15	7.44	0.24	6 load combination
1244		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1245		Main Beams	gl32c	5.47	7.90	0.37	6 load combination
1246		Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
1247		Main Beams	gl32c	8.96	12.94	0.12	6 load combination
1248		Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1249		Main Beams	gl32c	8.97	12.95	0.02	6 load combination
1250		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1251		Main Beams	gl32c	5.47	7.91	0.02	6 load combination
1252		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1253		Main Beams	gl32c	5.15	7.44	0.02	6 load combination
1254		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1255		Main Beams	gl32c	5.04	7.28	0.02	6 load combination
1256		Secondary Bea	gl32c	21.65	21.65	0.10	6 load combination
1257		Main Beams	gl32c	5.00	7.22	0.02	6 load combination
1258		Secondary Bea	gl32c	21.65	21.65	0.14	6 load combination
1259		Main Beams	gl32c	5.00	7.22	0.02	6 load combination
1260		Secondary Bea	gl32c	21.65	21.65	0.27	6 load combination
1261		Main Beams	gl32c	5.04	7.28	0.02	6 load combination
1262		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1263		Main Beams	gl32c	5.15	7.44	0.03	6 load combination
1264		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1265		Main Beams	gl32c	5.47	7.90	0.03	6 load combination
1266		Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1267		Main Beams	gl32c	8.96	12.94	0.01	6 load combination
1268		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1269		Main Beams	gl32c	8.97	12.95	0.13	6 load combination
1270		Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1271		Main Beams	gl32c	5.47	7.91	0.15	6 load combination
1272		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1273		Main Beams	gl32c	5.15	7.44	0.07	6 load combination
1274		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1275		Main Beams	gl32c	5.04	7.28	0.03	6 load combination

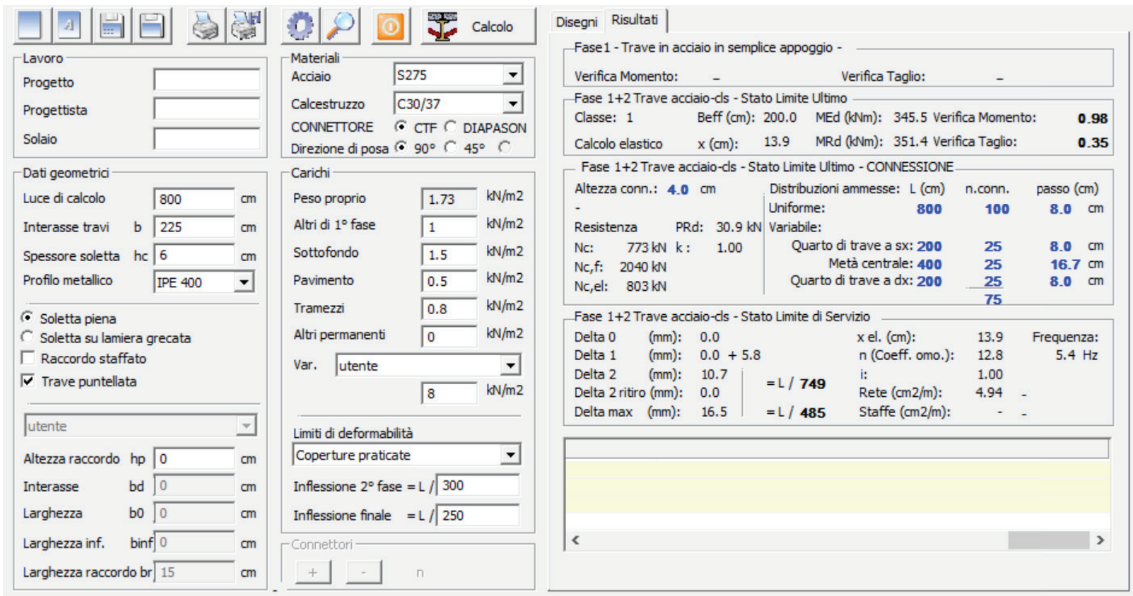
1275		Main Beams	gl32c	5.04	7.28	0.03	6 load combination
1276		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1277		Main Beams	gl32c	5.00	7.22	0.06	6 load combination
1278		Secondary Bea	gl32c	21.65	21.65	0.06	6 load combination
1279		Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1280		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1281		Main Beams	gl32c	5.04	7.28	0.16	6 load combination
1282		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1283		Main Beams	gl32c	5.15	7.44	0.25	6 load combination
1284		Secondary Bea	gl32c	21.65	21.65	0.30	6 load combination
1285		Main Beams	gl32c	5.47	7.90	0.37	6 load combination
1286		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1287		Main Beams	gl32c	8.96	12.94	0.13	6 load combination
1288		Secondary Bea	gl32c	21.65	21.65	0.09	6 load combination
1289		Main Beams	gl32c	8.97	12.95	0.25	6 load combination
1290		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1291		Main Beams	gl32c	5.47	7.91	0.28	6 load combination
1292		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1293		Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1294		Secondary Bea	gl32c	21.65	21.65	0.40	6 load combination
1295		Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1296		Secondary Bea	gl32c	21.65	21.65	0.31	6 load combination
1297		Main Beams	gl32c	5.00	7.22	0.11	6 load combination
1298		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1299		Main Beams	gl32c	5.00	7.22	0.19	6 load combination
1300		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1301		Main Beams	gl32c	5.04	7.28	0.31	6 load combination
1302		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1303		Main Beams	gl32c	5.15	7.44	0.47	6 load combination
1304		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1305		Main Beams	gl32c	5.47	7.90	0.71	6 load combination
1306		Secondary Bea	gl32c	21.65	21.65	0.31	6 load combination
1307		Main Beams	gl32c	8.96	12.94	0.24	6 load combination
1308		Secondary Bea	gl32c	21.65	21.65	0.40	6 load combination
1309		Main Beams	gl32c	8.97	12.95	0.34	6 load combination
1310		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1311		Main Beams	gl32c	5.47	7.91	0.35	6 load combination
1312		Secondary Bea	gl32c	21.65	21.65	0.13	6 load combination
1313		Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1314		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1315		Main Beams	gl32c	5.04	7.28	0.09	6 load combination
1316		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1317		Main Beams	gl32c	5.00	7.22	0.14	6 load combination
1318		Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
1319		Main Beams	gl32c	5.00	7.22	0.20	6 load combination
1320		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1321		Main Beams	gl32c	5.04	7.28	0.32	6 load combination
1322		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1323		Main Beams	gl32c	5.15	7.44	0.56	6 load combination
1324		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1325		Main Beams	gl32c	5.47	7.90	0.94	6 load combination
1326		Secondary Bea	gl32c	21.65	21.65	0.08	6 load combination
1327		Main Beams	gl32c	8.96	12.94	0.27	6 load combination
1328		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1329		Main Beams	gl32c	8.97	12.95	0.09	6 load combination
1330		Secondary Bea	gl32c	21.65	21.65	0.29	6 load combination
1331		Main Beams	gl32c	5.47	7.91	0.40	6 load combination
1332		Secondary Bea	gl32c	21.65	21.65	0.33	6 load combination
1333		Main Beams	gl32c	5.15	7.44	0.49	6 load combination
1334		Secondary Bea	gl32c	21.65	21.65	0.19	6 load combination
1335		Main Beams	gl32c	5.04	7.28	0.25	6 load combination
1336		Secondary Bea	gl32c	21.65	21.65	0.15	6 load combination
1337		Main Beams	gl32c	5.00	7.22	0.07	6 load combination
1338		Main Beams	gl32c	5.00	7.22	0.09	6 load combination
1339		Main Beams	gl32c	5.04	7.28	0.26	6 load combination
1340		Main Beams	gl32c	5.15	7.44	0.50	6 load combination
1341		Main Beams	gl32c	5.47	7.90	0.66	6 load combination
1342		Main Beams	gl32c	8.96	12.94	0.11	6 load combination
1343		Main Beams	gl32c	8.97	12.95	0.21	6 load combination
1344		Main Beams	gl32c	5.47	7.91	0.21	6 load combination
1345		Main Beams	gl32c	5.15	7.44	0.12	6 load combination
1346		Main Beams	gl32c	5.04	7.28	0.06	6 load combination
1347		Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1348		Main Beams	gl32c	5.00	7.22	0.05	6 load combination
1349		Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1350		Main Beams	gl32c	5.15	7.44	0.10	6 load combination
1351		Main Beams	gl32c	5.47	7.90	0.23	6 load combination
1352		Main Beams	gl32c	8.96	12.94	0.21	6 load combination
1353		Main Beams	gl32c	8.97	12.95	0.10	6 load combination
1354		Main Beams	gl32c	5.47	7.91	0.13	6 load combination
1355		Main Beams	gl32c	5.15	7.44	0.09	6 load combination
1356		Main Beams	gl32c	5.04	7.28	0.07	6 load combination
1357		Main Beams	gl32c	5.00	7.22	0.04	6 load combination
1358		Main Beams	gl32c	5.00	7.22	0.03	6 load combination
1359		Main Beams	gl32c	5.04	7.28	0.04	6 load combination
1360		Main Beams	gl32c	5.15	7.44	0.07	6 load combination
1361		Main Beams	gl32c	5.47	7.90	0.12	6 load combination
1362		Main Beams	gl32c	8.96	12.94	0.09	6 load combination

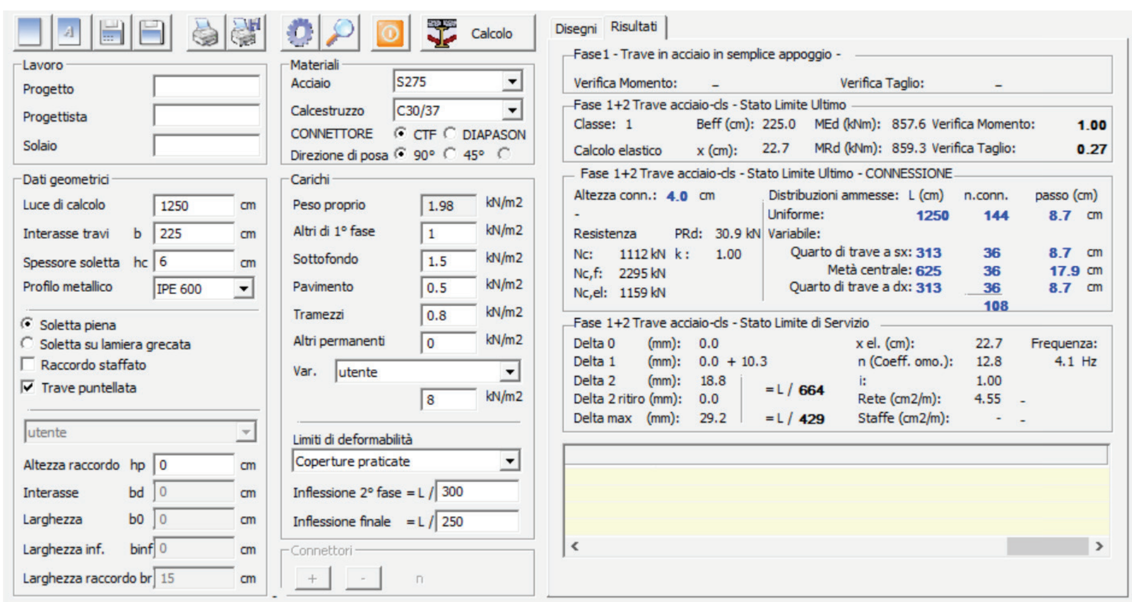
Ill.97 Robot Member Verification tables, Own illustration

5 - *VOLTINE* SLAB OPTIMISATION

The building's slab system is a collaborating steel-concrete structure. The lower finishing is, as presented, created with the masonry *voltine*, as a choice of style.
As explained in the Design Process section, after the dimensioning of the beams with the FEM, a further optimisation was obtained with the use of a calculation software developed by Tecnaria (Tecnaria, 2018), an Italian steel connectors producer and building contractor. In the images below the calculation pages from the aforementioned software are visible. The use of connectors between steel beam and reinforced concrete granted a decrease of the beams' cross-sections of around 15% and the use half the amount of concrete on top of the beams, since the height of the beam is filled with light material. Calculations have been made for the Oak Room voltine (1,125 metre pitch) and for the Fermentation Room ones (2,25 metre pitch) for the cases with and without columns.



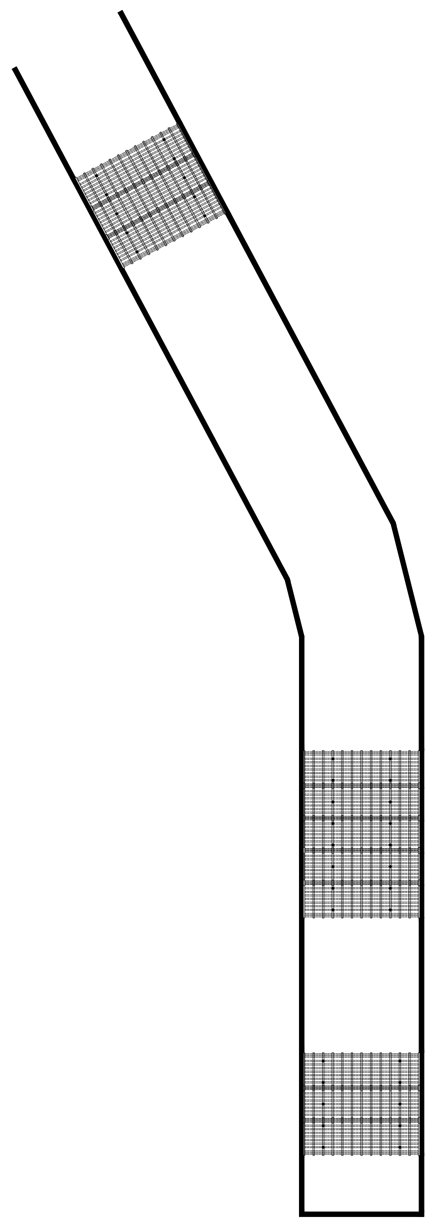




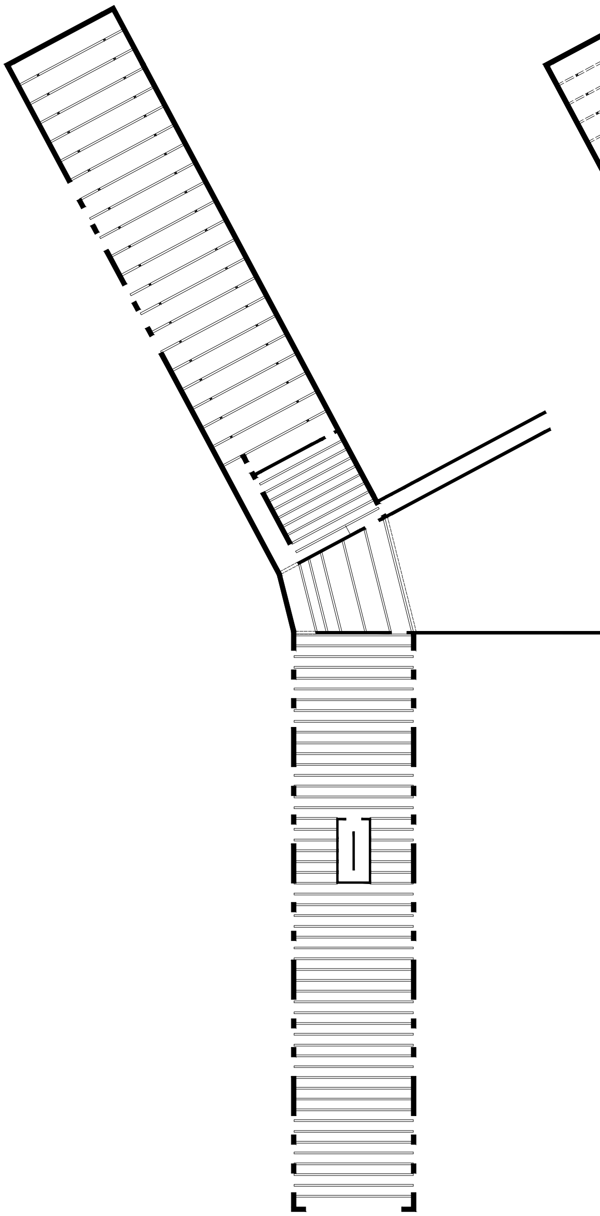
Ill.98 Tecnaria results tables, Own illustration

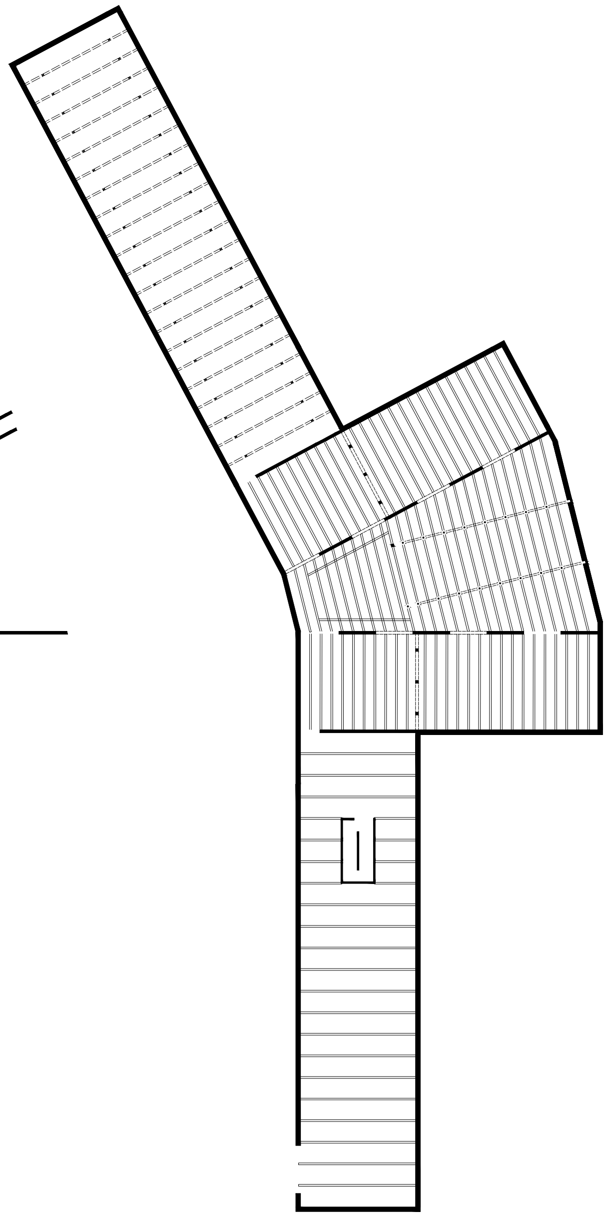
6 - STRUCTURAL SCHEMES

The structural system bearing the building is the same for most of the establishment. Double-T steel beams cross the building from one concrete wall to the other and, in the case of the fermentation room, are also supported by HEA profiled steel columns. Pitches vary from 2250 millimetres, 1125 millimetres and 1000 millimetres; the beams' span is 12.5 metres in the two wings; in the ageing room the spans are reduced to 9 or 6 metres with the use of concrete walls that run along the room.
The structures on the terrace are four metres wooden shells formed by a frame of curved glue-laminated beams crossed by smaller longitudinal elements. Depending on the case, the whole curvature is supported by one or two wooden circular columns with 225 millimetres thick cross-section, spaced 2.25 metres between each other.



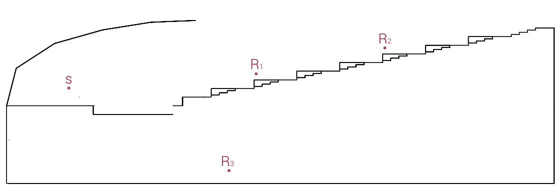
Ill.99 Structural Schemes, Own illustration





7 - ACOUSTIC CALCULATIONS

The auditorium, which functions as Entrance Hall as well, is intended as a “sounding box” to diffuse sound both horizontally to the audience/staircase and vertically to the Oak Room. For this purpose, the ceiling of the Auditorium is shaped with a composed curvature that increases sound reflections outwards; while, in section, sound that would be “lost” inside the stage can travel vertically through splits in the rise of the step that divides the stage from the audience (ill. 100).
The acoustic calculations are meant to test out both intentions. Therefore, Receivers were located both in the staircase (Receiver 1 and 2) and in the Oak Room (Receiver 3). The source is located in the middle of the stage and is simulated to be an omnidirectional source.
In the tables on the right final results for Sound Pressure Level, Reverberation Time, Early Decay Time and Clarity are visible. As expected, sound quality decreases going further up in the staircase. Levels of Clarity C80, to be considered for music-related spaces, are yet acceptable for Receiver 2. As regards the diffusion of sound in the lower floor, the strength is considerable but, as expected, intelligibility is not optimal (Ahnert et al., 2016).



Ill.100 Main Hall Source - Receivers Diagrams, Own illustration

	Sound Pressure Level [dB]		
Frequency [Hz]	Receiver 1	Receiver 2	Receiver 3
62.5	104,92	99,84	103,18
125	104,92	99,83	103,17
250	104,91	99,82	103,15
500	104,90	99,80	103,13
1000	104,89	99,78	103,09
2000	104,85	99,72	103,00
4000	104,70	99,48	102,66
8000	104,20	98,67	101,46

Frequency [Hz]	Reverberation Time [s]		
	Receiver 1	Receiver 2	Receiver 3
62.5	1,79	2,71	3,12
125	1,79	2,71	3,12
250	1,80	2,71	3,12
500	1,80	2,71	3,11
1000	1,81	2,71	3,11
2000	1,83	2,72	3,09
4000	1,90	2,73	3,03
8000	2,15	2,67	2,79

Frequency [Hz]	Early Decay Time [s]		
	Receiver 1	Receiver 2	Receiver 3
62.5	3,79	4,68	5,67
125	3,78	4,67	5,67
250	3,77	4,67	5,66
500	3,75	4,65	5,65
1000	3,73	4,63	5,64
2000	3,66	4,58	5,60
4000	3,39	4,39	5,47
8000	2,56	3,66	4,93

Frequency [Hz]	Clarity C50 [dB]		
	Receiver 1	Receiver 2	Receiver 3
62.5	0,90	-3,40	-7,02
125	0,91	-3,40	-7,01
250	0,92	-3,39	-7,00
500	0,93	-3,37	-6,97
1000	0,96	-3,34	-6,94
2000	1,02	-3,28	-6,84
4000	1,26	-3,03	-6,49
8000	2,08	-2,14	-5,21

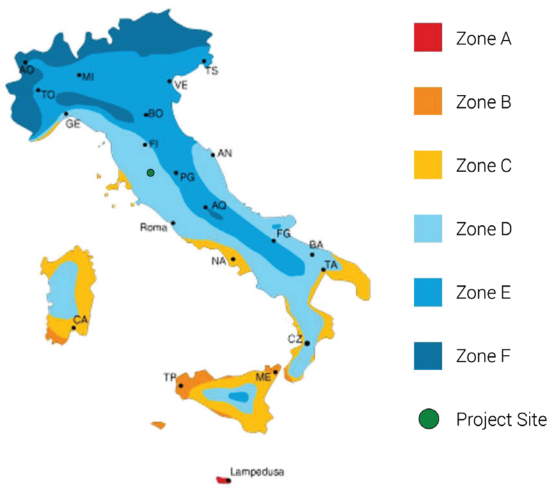
Frequency [Hz]	Clarity C80 [dB]		
	Receiver 1	Receiver 2	Receiver 3
62.5	1,53	-1,62	-6,67
125	1,53	-1,61	-6,66
250	1,55	-1,60	-6,64
500	1,56	-1,58	-6,62
1000	1,59	-1,55	-6,58
2000	1,66	-1,48	-6,49
4000	1,91	-1,20	-6,13
8000	2,79	-0,22	-4,85

Ill.101 Main Hall Acoustic Results tables, Own illustration

8 - U-VALUE CALCULATIONS

U Values have been calculated for external partitions: walls, roof, basement slab (see tables below). All these have been designed to reach and exceed the Italian legislation limits for the climatic zone of the project, Zone D (ill. 102). The limits are set to 0.29 W/m²K for exterior walls and basement slabs and to 0.26 W/m²K for roofs (DM 06-2015).

Walls and Roof are thought to have a high level of thermal inertia in order to have big thermal displacements (time that occurs before passive heating reaches indoor environment). This helps the building to be cooler in hot months and warmer in the cold season.



Ill.102 Italian Climatic Zones Map, Own illustration

EXTERIOR WALL							
Layer		**Thickness**	**Thermal Conductivity**	**Specific Heat**	**Density**	**Thermal Resistance**	**Air Gap**
		d	***λ***	***c***	***ρ***	***R***	
		mm	W/(m·K)	J/(kg·K)	kg/m³	m²·K/W	
interior						0,171	x
1	Reinforced Concrete	200	0,800	960	2400	0,250	
2	Kingspan Thermawall	150	0,022	840	100	6,818	
3	Air Gap	25				0,160	x
4	Brick Finishing	125	0,600	900	1900	0,208	
exterior						0,171	x

Total R	**U value (1/R)**
m²·K/W	W/m²· K
7,570	0,132

ROOF							
Layer		Thickness	Thermal Conductivity	Specific Heat	Density	Thermal Resistance	Air Gap
-		***d*** mm	***λ*** W/(m·K)	***c*** J/(kg·K)	***ρ*** kg/m³	***R*** m²·K/W	-
interior						0,171	1
1	Masonry Finishing	30	0,6	900	1900	0,050	
2	Gravel Filling	100	0,8	1000	1500	0,125	
3	Kingspan Thermaroof	200	0,024	840	100	9,091	
4	Reinforced Concrete	60	0,800	960	2400	0,075	
5	Screed	50	0,800	960	2400	0,063	
6	Masonry Finishing	25	0,600	900	1900	0,042	
exterior						0,171	x

Total R	U value (1/R)
m²·K/W	W/m²· K
9,788	0,102

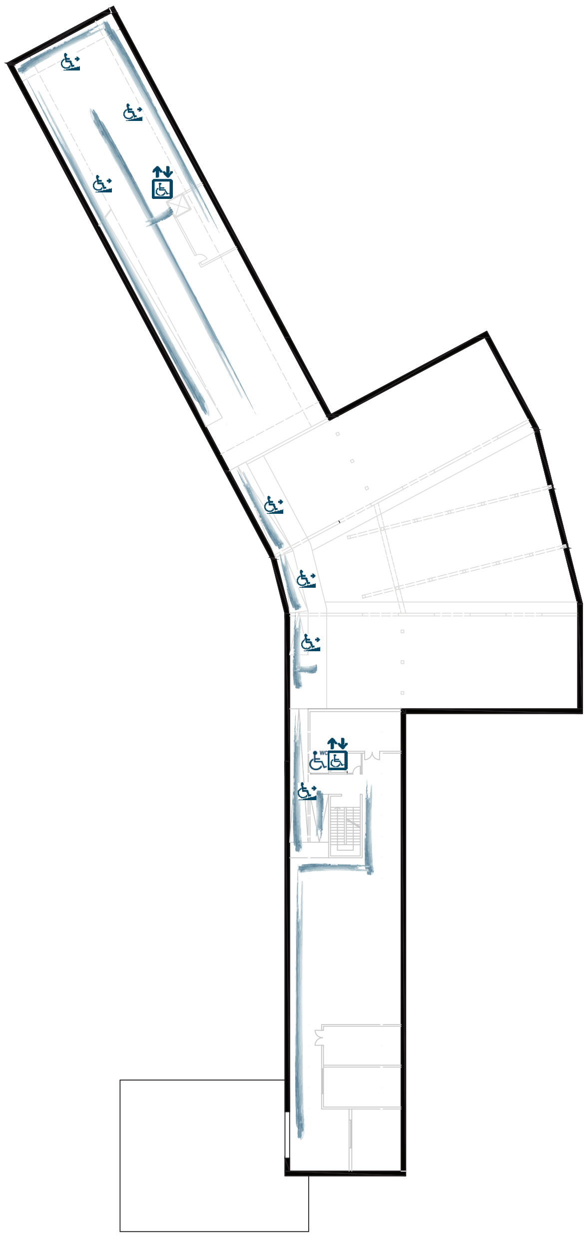
GROUND FLOOR SLAB							
Layer		Thickness	Thermal Conductivity	Specific Heat	Density	Thermal Resistance	Air Gap
-		***d*** mm	***λ*** W/(m·K)	***c*** J/(kg·K)	***ρ*** kg/m³	***R*** m²·K/W	-
interior						0,171	x
1	Concrete Floor	25	0,8	960	2200	0,075	
2	Bedding	50	0,800	900	1900	0,063	
3	Kingspan Thermafloor	150	0,022	840	100	6,818	x
4	Reinforced Concrete	200	0,800	960	2400	0,250	
5	Screed	100	0,800	960	2400	0,125	
exterior						0,171	x

Total R	U value (1/R)
m²·K/W	W/m²· K
7,673	0,130

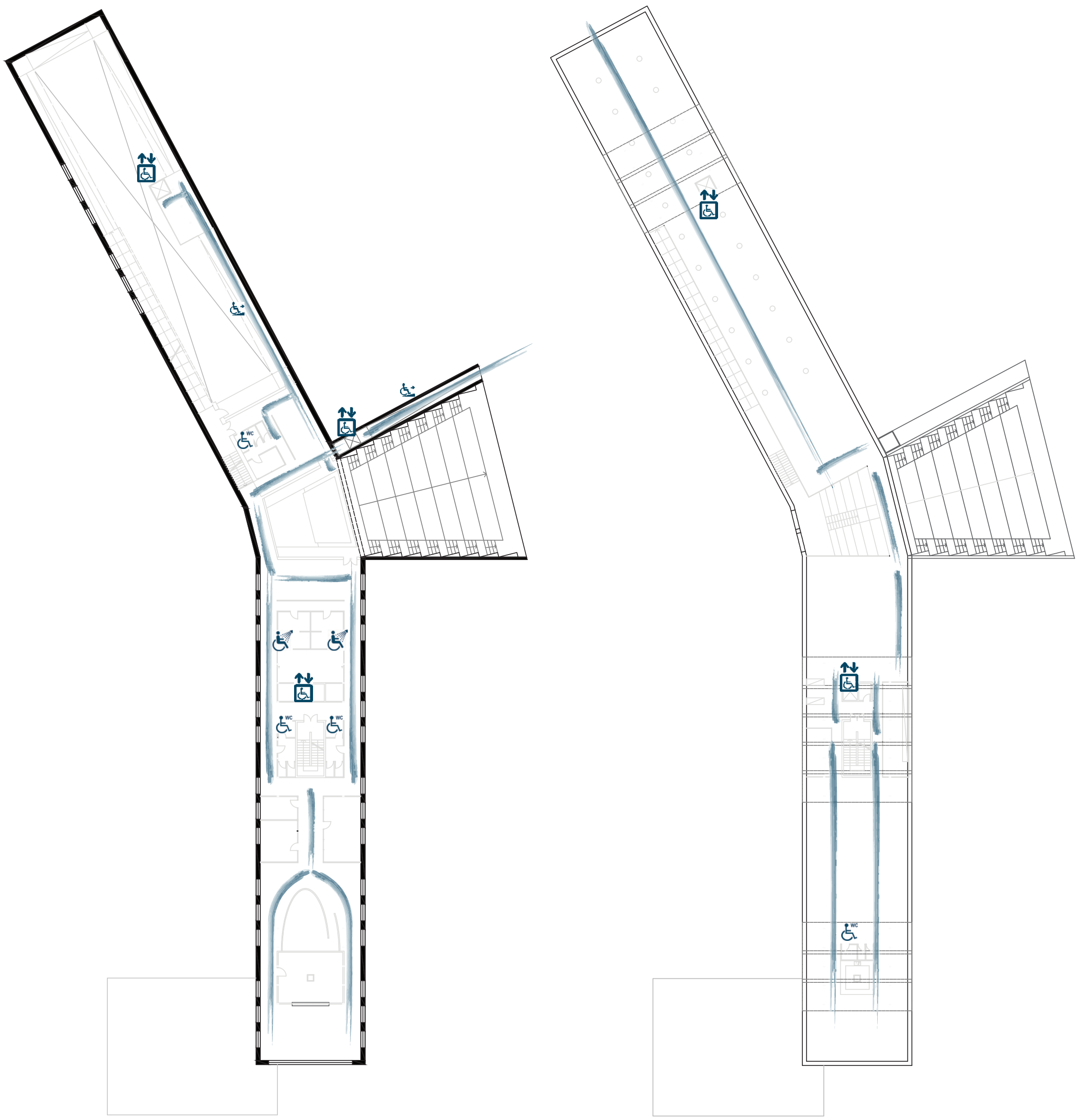
Ill.103 Wall, Roof, Ground Floor Slab U-value tables, Own illustration

9 - ACCESSIBILITY SCHEMES

A few parking spots for the disabled allow close access to the building, so that the reception area can get easily accessed by means of a ramp and a lift. From the reception area, people with disability can start their visit through the building. Large corridors, generous spaces are thought to make their journey pleasant and most of the time hands in hands with the other visitors. Likewise, accessible bathrooms, ramps, lifts, and showers were considered in the design of a winery according to universal design standards.



Ill.104 Accessibility Schemes, Own illustration



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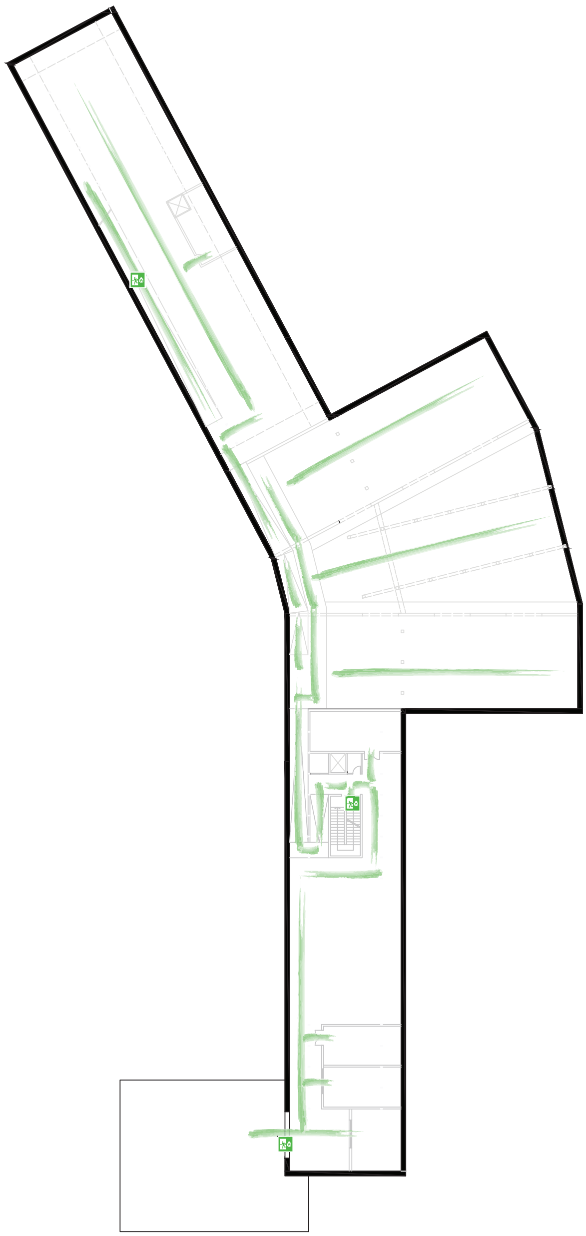
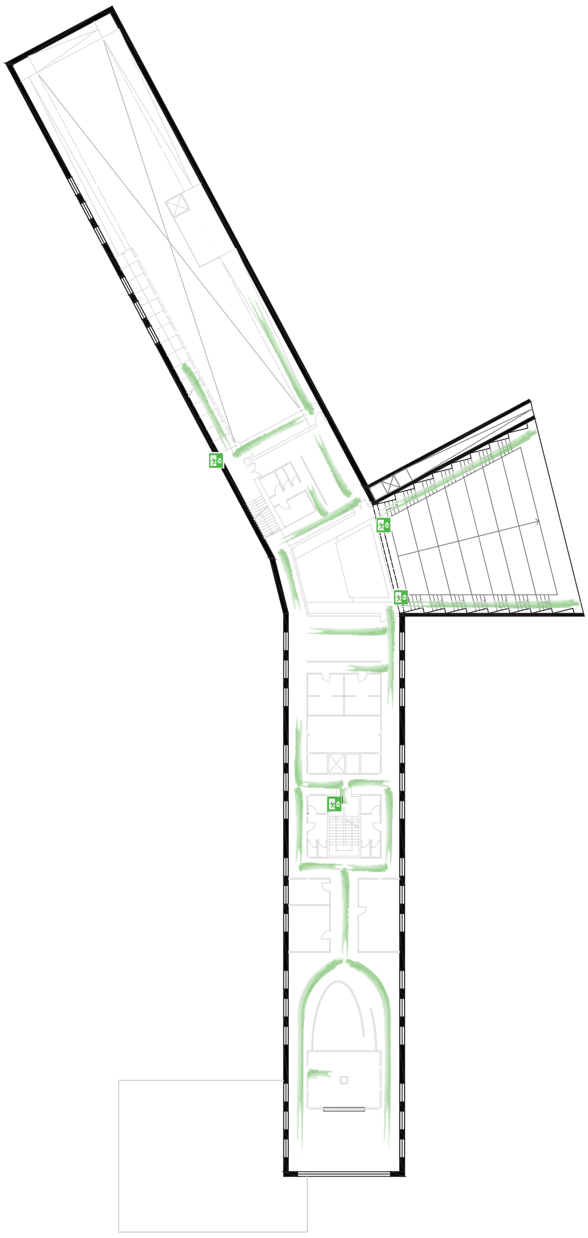
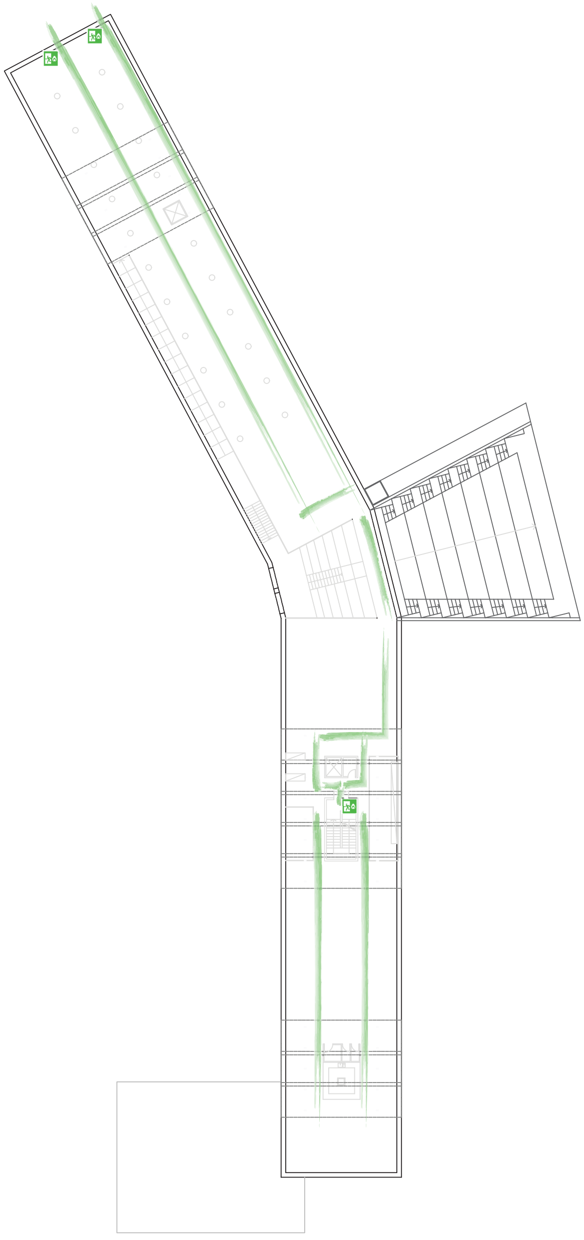
10 - FIRE ESCAPE SCHEMES

Precautions were taken in the design as regards fire incidents. The Fire Schemes show the direction to take in case of fire. Three evacuation routes are set in the building to three distinct points: one to the north, one in the middle of the establishment and one to the south. The first escape route is located on the terrace, from which people can reach the vineyards. The main access to the building through the music hall stairs constitutes the central way out. The third safety route is the one from the logistic area: the flows are evacuated through the large gate and gathered on the manoeuvre parking. The flows of visitors are rationally gathered and collected to these exits following proximity criteria. The way-out path is made fluid and always available no matter where the fire starts from.



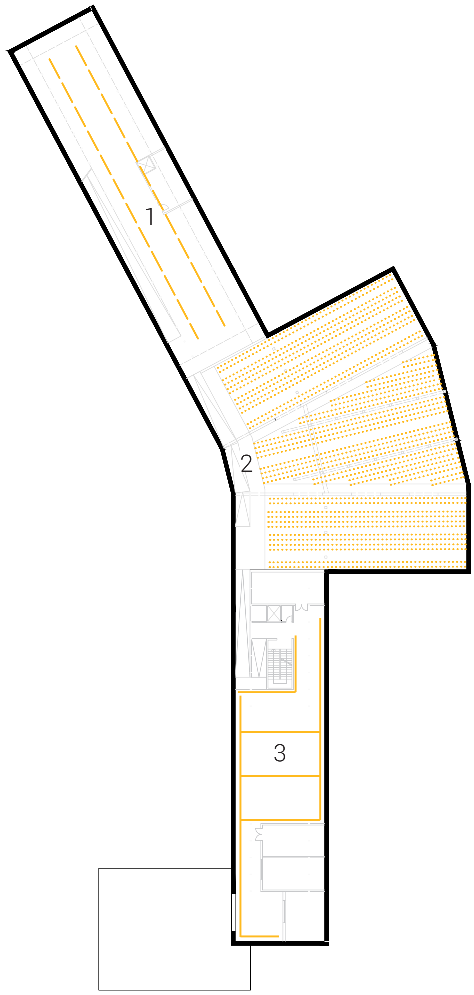
Ill.105 Fire Escape Schemes, Own illustration

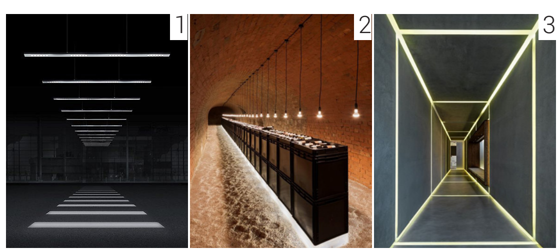




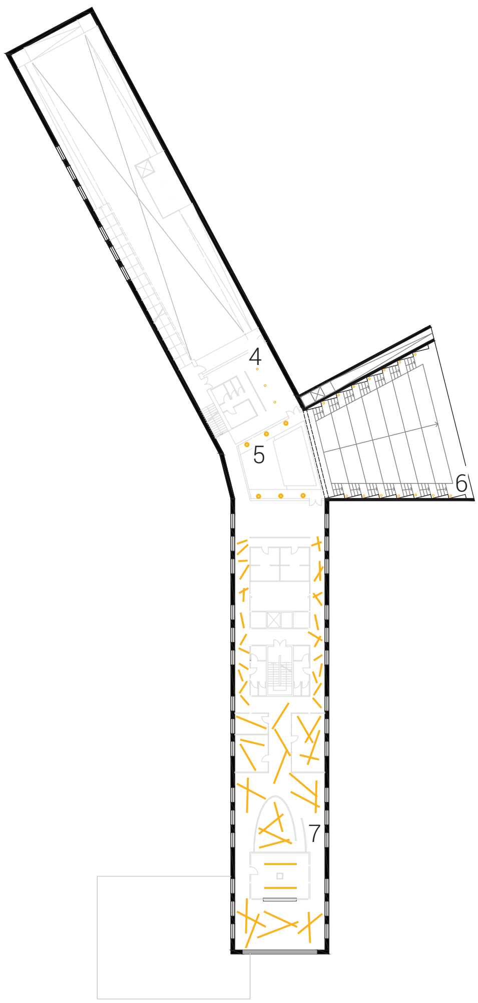
11 - LIGHT FIXTURES SCHEMES

Artificial lightening is an indispensable piece when it comes to the intricate puzzle of an ambiance. Here is an idea of how it is to be treated in the project.
The Fermentation Room is enlightened by two lines of long medium temperature neon bars, arranged in the long direction, enhancing the industrial atmosphere of the impressive room.
In the Ageing Room, lanes of hung LEDs confer to the room warmth and a dim light effect, whilst marking the deep perspectives of the softly enlightened oaks.
Long stripes of light run both on the floor and the ceiling and uniting transversally in the Refinement Room, drawing long geometrical figures that enlighten the glass tower room.
Looking at the floor upstairs, in the Reception area, design terracotta lamps can be located hanging over the desk, reminding of the important presence of the clay in the project.
The Music Hall is the room of the spotlights and the floor lights for the ramp. The warm lights will fire up the clear *travertino* creating an attractive and embracing atmosphere for visitors as well as the audience during a concert.
Looking up at the ceiling of the Employees' wing, an effect of movement is delivered by a chaotic pattern of tube-lamps.
Walking in the evening on the terrace may be a unique experience: wall-integrated lamps accompany the ascent of the stair and along the terrace, the light shell-structures are enlightened by spotlights similar to the ones of the Music Hall, therefore this curvy element can vibrate with light demonstrating its architectural lightness.





Ill.106 Light Fixtures Schemes, Own illustration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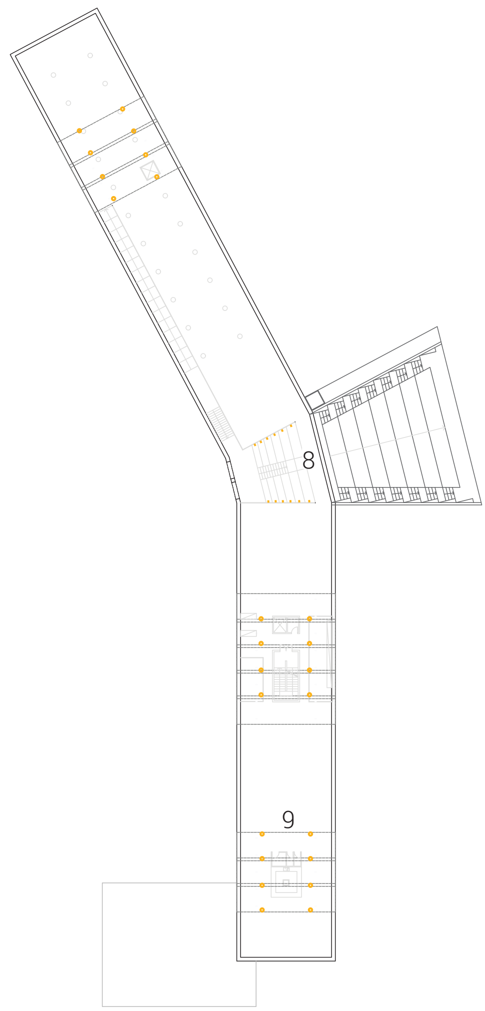
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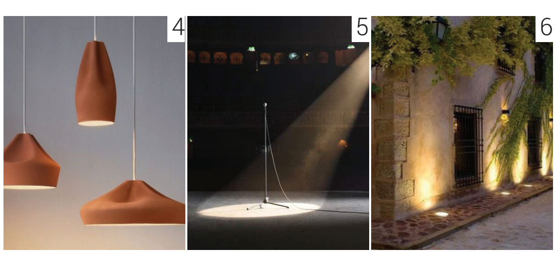
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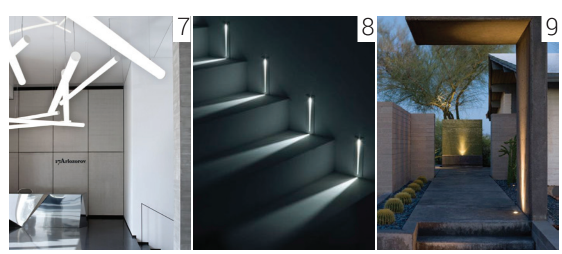
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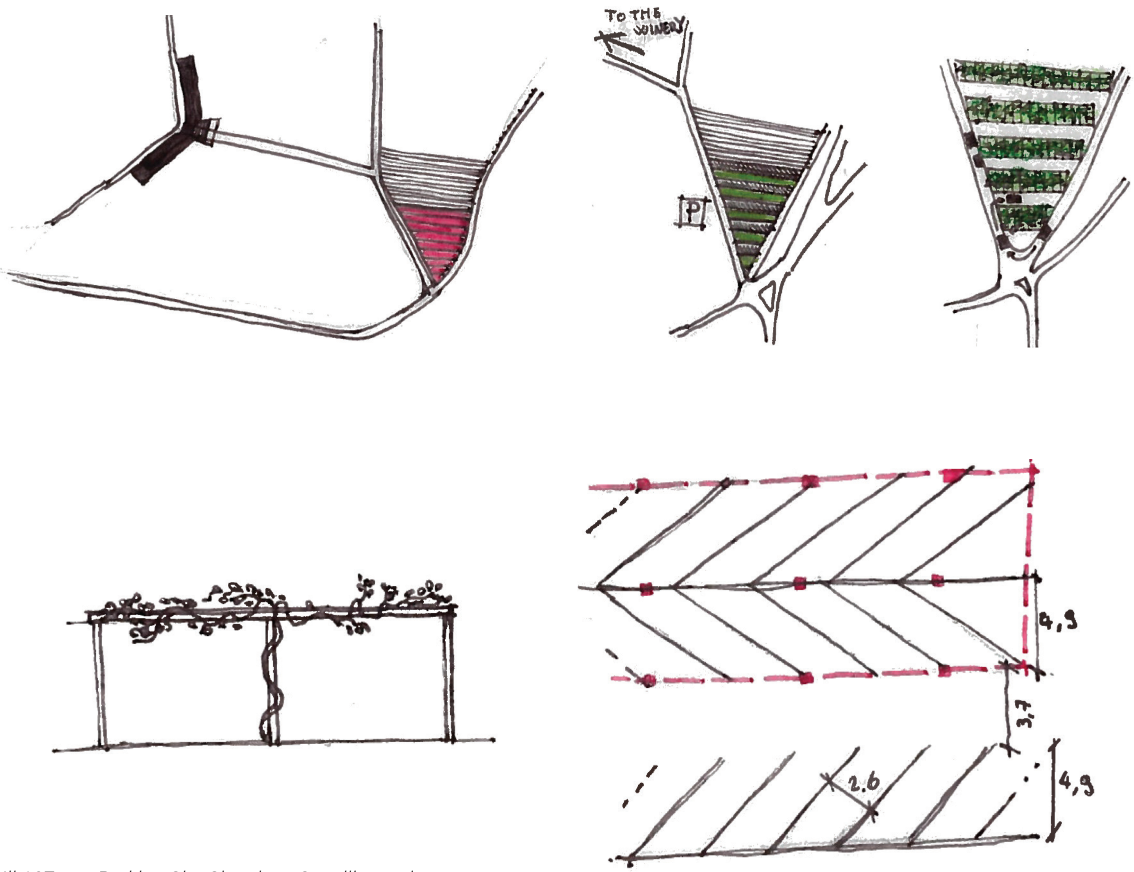
12 - PARKING SITE

A totality of around 100 parking spots are imagined in the triangular area drawn between the interior road leading to the winery and the border road of the vines to the east. The idea is to locate the parking site in an area that, being on the side of the road to the winery, is easily accessible for the visitors, who are also invited to a pleasant walk to the building.
The triangle of land comprises a fallow cultivated area, which minimising the eradication of vines. Moreover, the impact of the parking is smoothed by a system of wooden carports covered with vegetation, in particular with the climbing species called American vine. The structures run between one road and the other in parallel with the rows of vines, integrating the parking area in the perspective game, in a camouflage interplay which prevents sight from aerial viewpoint. Under each canopy, two rows of cars rest following a fishbone pattern.



Ill.107 Parking Site Sketches, Own illustration

APPENDICES REFERENCE LIST

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APPENDICES ILLUSTRATION LIST

TOMA Architecture