Cultural island of Holmen, Risør, Norway

-- Cultural Centre --

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Master thesis

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I. introduction

1. synopsis

This master thesis concerns the design and organization of a cultural island in Risør, Norway. The island, called Holmen, has been subject for an urban design competition in 2008 and the winning project has been very little implemented so far.

In addition to the theoretical definition and interpretation of the contextual architecture (tectonic/ nordic/ timber architecture), presentation of the process and the final design, the report also contains a thorough analysis of the location, its history and traditions in an attempt to better understand its sense of place. These aspects are particularly important because the community has pronounced conservative values, which strongly define the uniqueness of the place. However there is a determined general wish (and need) for further urban, social and cultural development within the traditional guidelines.

Therefore, the project aims to participate in the community's development architecturally, socially and culturally by supporting the traditional values and respecting the aspirations of the locals.

ill.1 Skagerrak strait

It is actually the choice of the location which will define the project as I am set to follow the *genius loci* concept in order to outline the architectural program only after deciding on its necessity within the context I am working with. The project derives from the community's needs, wishes and traditions as well as from the site's topographical qualities and spatial atmosphere. Aiming to fit within the nordic context of a small norwegian town, the project becomes even more challenging when stronger limitations are imposed by the kommune's specific building regulations regarding the central protected area of the town. With a very distinctive character, which the municipality wants to preserve, the central area is prone to change because of on-going projects which might be in contradiction with the conservation ideology.

After the Holmen competition in 2008 which demanded a new urban development on the Holmen island in Risør, the winning project has been very little implemented so far. On the spot of a current shipyard, the winning architects' design suggests a residential area of dwellings together with a fish restaurant. At the moment only the fish restaurant has been built, the solution being quite controversed in the small town of Risør, many opinioning that it might not fit the character of the place. In this regard, my aim is to suggest a n alternative option for the island of Holmen, which would better fit the contextual character and the community's needs.

The choice of the location was purely intuitive, based on own preferences. Long family friendship connects me to the small town of Risør and its charm was undisputable from my very first visit there. The visit has been done long before I started my master degree and it was actually one of the motifs that triggered my interest in nordic and tectonic design. At first I was drawned by the way people inhabit their own houses, both from an organizational and conceptual point of view. Thus I realized how important it is the interior space within nordic culture. Climatic conditions are quite harsh and spending time outdoors often becomes restrictive, thus interior spaces are meant to give a cozy, better alternative to the cold and unfriendly weather. It is a commonly agreed statement that scandinavian prefer a welcoming indoor environment. The poor weather conditions make them appreciate even more a perfectly sunny weather and, as I was able to witness during my stay in Denmark and visits in Norway, the squares, streets, boulevards are being exploited at maximum once the sun is up. Nordic people love spending time outdoors, a fact which is enhanced by climatic limitations and boundless natural landscape. Thus, thourgh my design I also am attempting to give importance to outdoor, indoor or in-between spaces.

3. methodology

The methodology implemented in our master degree deals with the integrated design process which supports a constant interaction between research, empirical studies and synthesis. This process is based on PBL (problem-based-learning), which represents the main educational model used in Aalborg University. Therefore, the main focus is identifing key points and situations that need further research, studies and solutions.

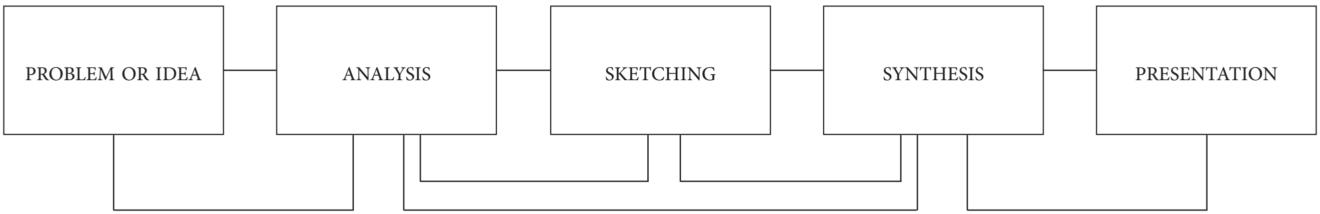
As a first part, the problem formulation is essential in outlining the actual idea of the project. Following is the analysis phase which includes the site, possible urban development plans, architectural programme and approach principles. During the design phase several options are being studied and reflected upon until reaching a reasonable solution.

A deeper research has been made through a data collection trip on the site, which was essential for gaining an awarness of the sense of place. Several meetings with locals, urban developers and the mayor helped in contouring an better image of the site's characteristics. The scale and the local atmosphere were essential for my project theme.

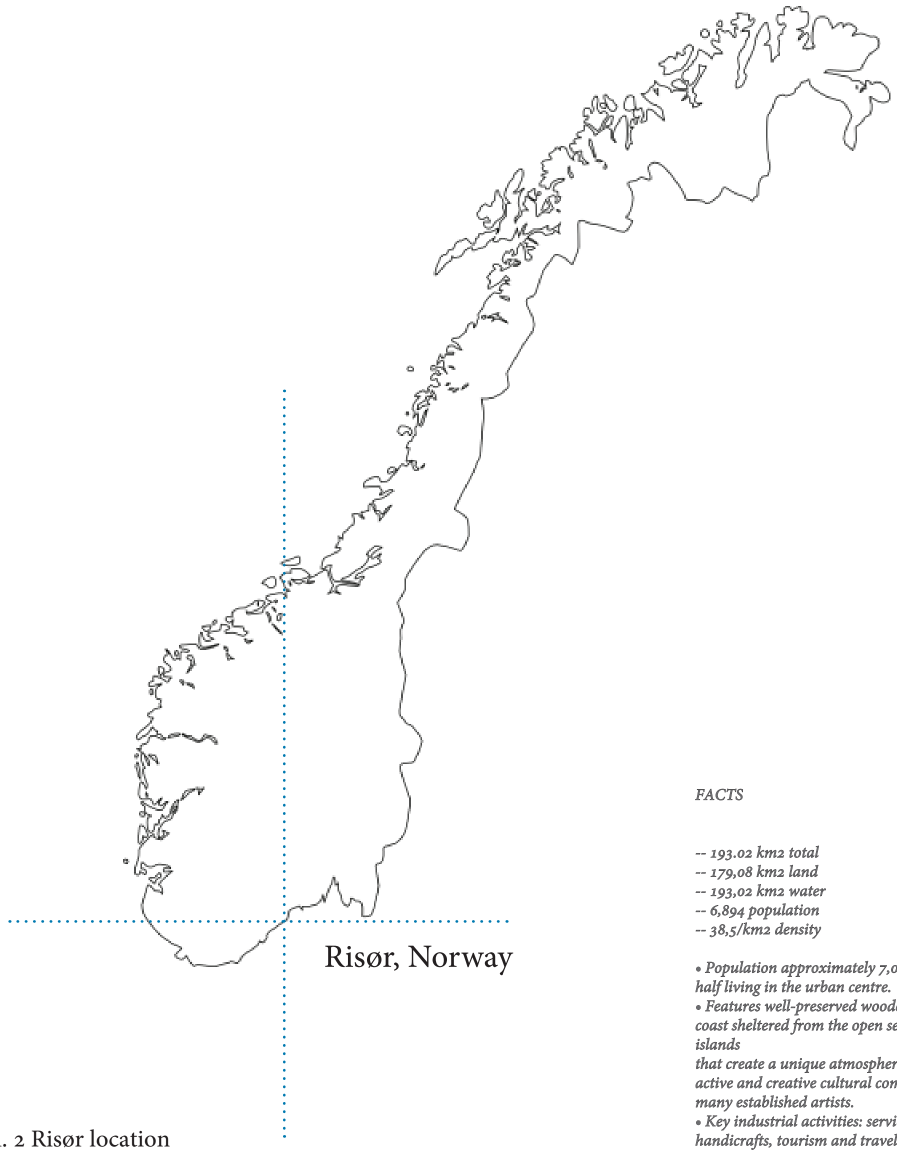
Following the research part which included also history, architectural context, site and climatic conditions, the sketching phase started which was conducted simultanously with 3D visualizations of the possible space. Later on in the process, 3D studies were conducted simultanously with technical detailing, etc.

The simultanous interaction between the design phases provoked a back-and-forth process which has as a result an integrated design. Aalborg University has a very stong focus in introducing engineering studies at a very early stage of an architectural design in order to solve some of the actual problems connected to the design of buildings.

Although not having the main focus on sustainability (technic) but rather more on tectonics (aesthetic) the outlined proposal has been developed through several structural and acoustic studies, constantly reflecting towards the initial architectural concept.



ill. 1.1 design process manp according to *Integrated Design Process in PBL by Knudstrup*, Mary-Ann. article in The Aalborg PBL Model, red. Annette
Kolmoes, Flemming K. Fink, and Lone Krogh. Aalborg University Press 2004. Denmark.



ill. 2 Risør location

FACTS

-- 193.02 km2 total
-- 179,08 km2 land
-- 193,02 km2 water
-- 6,894 population
-- 38,5/km2 density

• Population approximately 7,000, with roughly half living in the urban centre.
• Features well-preserved wooden houses along a coast sheltered from the open sea by small islands
that create a unique atmosphere around an active and creative cultural community with many established artists.
• Key industrial activities: services, industry, handicrafts, tourism and travel.

II. site and context

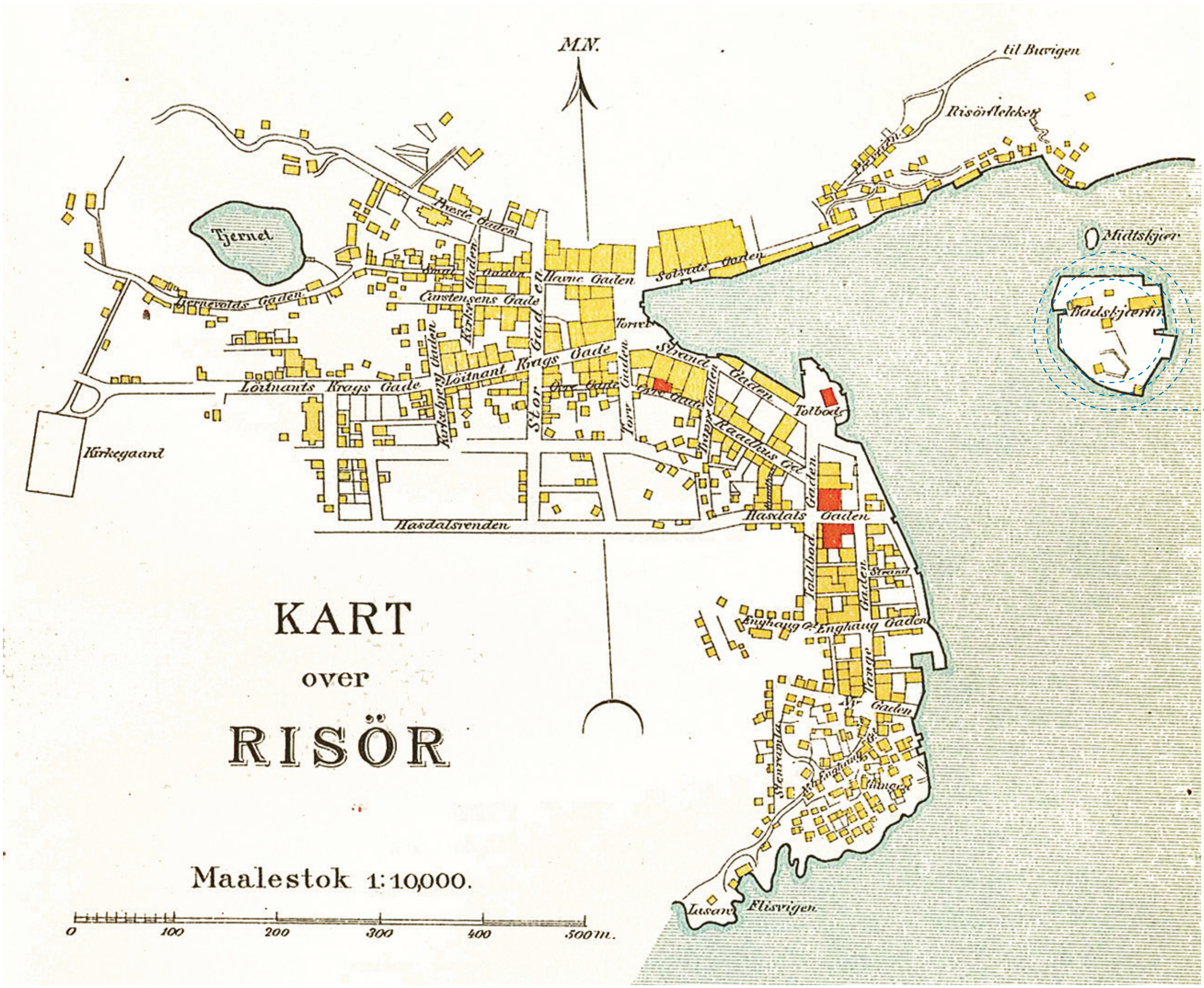
1. Risørholmen, Norway - location, history and traditions

Risør

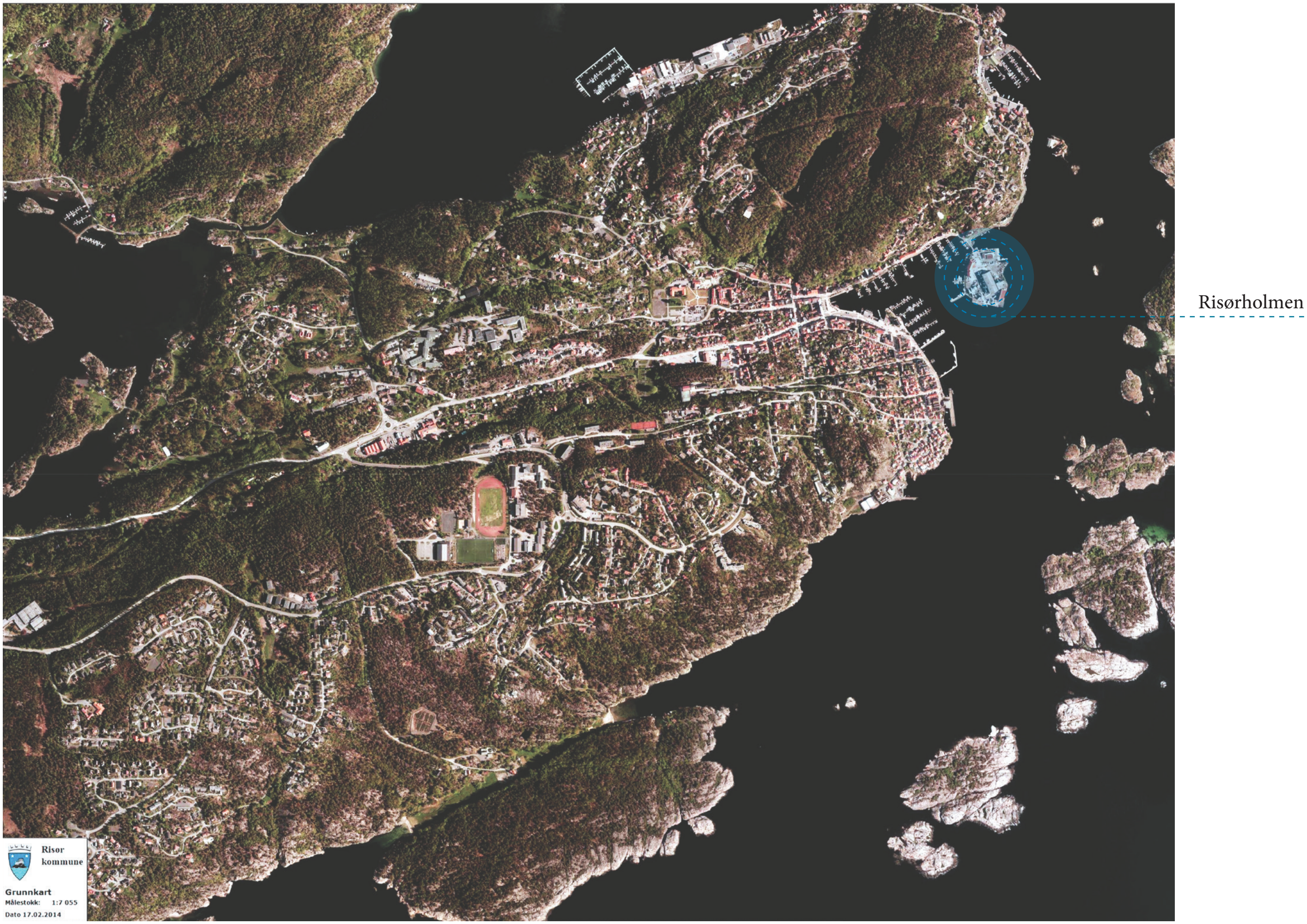
Risør is a town situated by the south-east coast of Norway, part of the Aust-Agder conty and the traditional region of Sørlandet. It was an important harbor from the 1500s because of its particularly sheltered location by Skagerrak. The name "Risør" means - rice or bush covered islands - and it was originally a term for the archipelago of the city. Large quantities of timber from hinterland were carried out through the fjords, sold and exported in Risør. Although being considered a city, Risør has been established as a municipality on 1st of January 1838, at the moment being one of the oldest cities by the south coast of Norway.Before the dutch vessels began to come here in order to purchase timber, Risør was merely a fishing village. Thus it opened its harbour and allowed for merchants to come while the inns were serving the dutch sailors. In 1630, it became a market town and by the end of the 18th century, 96 sailing vessels were owned by Risør merchants. Thus it became the 6th largest shipping town and one of the four shipbuilding centers in Norway (repairment of sjøskadde ships and construction of many types of vessels). Risør also played an important role in the Napoleonic Wars in 1807-1814 when Denmark - Norway took France's side and therefore became the enemy of Norway's most important trading-partner: Great Britain.
Because of its wooden houses built close together and the common use of open fires by burning wood, candles or oil lamps, several fires took place in the town. The first big fire was in 1716 when 70 houses burned down to the ground.
However, a critical moment in history for the small town of Risør turned out to be the year of 1861 when the biggest fire the town has ever seen wiped off the map 248 buildings while the population managed to save 81 buildings in the area around Vollen , Kamperhaug and Tangen. Although ironic to say, but the unfortunate event happened in a fortunate moment, when Risør was benefiting from the golden age of shipbuilding and people had insurance and finance to new and updated houses. Therefore, the fire generated a reconstruction of the whole town, the engineer who was comissioned with this assignment giving the name for the current Krags gate (Løytnant Krag). The great fire of 1861 signifies a re-birth of the city as well as a regenerated urban plan. The former town hall in Tollbodgaten was one of the many buildings that fell victim to the flames. Øvregaten, which before the fire was called Smalgaten, was 436 feet long and 3 to 6 feet wide (1 feet = 0.3048 m). The old town square used to lay where Carstensens gate is right now. This was 72 cubits long and 34 cubits wide (1 cubit = 45.72 cm) and formerly used to be the private garden belonging to N. Steen and N. Houge. On the north side laid a canal called Bommen. On the south side of the old square laid Øvre Bommens gate. The fire naturally destroyed the ancient alleyways and streets which were replaced with the current street network, nonetheless the town did not lose it's unmistakable initimacy and charm.

ill. 3 old Risør

ill. 4 map of Risør, Norway, 1904



ill. 5 map of Risør, Norway, 2014



ill. 6 building density in Risør centre

ill. 7 view over Risørholmen

Risørholmen - former fortress

Holmen consisted originally two islands, "Mid Cut" and "Badskjærholmen". The area between the islands was in 1895 filled in and formed Holmen as it is today. In 1955, the island linked to the mainland by a bridge on the north side of the island. There have been various industrial activities at Holmen over the years, but essentially it has been shipbuilding and construction cranes to vessels and offshore. From 1800 - ca. 1930 was built and made repairs and overhauls of wooden boats on the island.
Until 1970, Holmen Shipyard their business here. They performed maintenance on smaller vessels while they had mechanical activities on the site. The yard had a drop where the fish reception is today, and a dock in the inner harbor to the west. 1970 - approx. 1980 ran Wisbeck Refsum (later Kone OY) production of cranes on site.
From approx. 1980 - approx. 1985 produced Golar Metal AS helideck in aluminum and it took various mechanical operations targeting offshore construction derrick. During the mid - late in the 980s ran Norheim Larsen Industries mechanical activity of the let-down operations for about year.
From approx. 1988 - 2003 produced Lindstols Ship Yard & AS new vessels in aluminum, mainly catamarans.
Between 2003 and 2008, the Solsiden 1 AS run easier marina and circulation operations. Electrical Skagerrak AS had commercial premises in the area during the same period. The island has previously been cannon from the war. These were the pond around 1970 and it was in this regard that much of the area became a solid surface.

Risørholmen is a unique location with magnificent views both to the city , to the archipelago and to Skagerrak. Since 2006 until now Sjøsenteret Risør and Risør Fiskemottak AS are situated on the island. Sjøsenteret Risør (The Sea Centre) is a shipyard that contains a workshop and a selling point and Risør Fiskemottak AS includes a fish shop, summer cafe and en-gros market where fresh fish is brought in every day. The latter has been built in 2008 and is part of the Risørholmen development plan developed by Kritt Arkitekter and Østengen og Bergo Landskapsarkitekter which won the competition in 2008 organized by the municipality for Risør Holmen. Should the rest of the winning project be implemented, the shipyard would have to be torn down and built upon a new modelled island with underground parking.

2. The town's architecture

ill. 8 building by the harbour

ill. 9 Risør harbour during the Wooden Boat festival

ill. 10 house on Torvet street

ill. 11 Risør in wintertime

ill. 12 *The church of Holy Spirit* - wooden baroque church still standing since 1647

The white timber town by Skagerrak

The old town was characterized by large commercial houses which timber merchants built by themselves right by the docks while in the back row, small wooden houses between alleyways and steep staircases became the homes of sailors and merchants. But after the great fire of 1861 which completely destroyed almost the entire town and new buildings had to be build from scratch a general desire of showing prosperity and rebirth came from the people still living here. It seems that by choosing the white paint as a finishing for their wooden houses. It was never a question of a municipal regulation but rather a question of "good taste". Prior to the big fire of 1861 most of the houses were either unpainted of had a non-descriptive gray color. Even to this day, in some rear sides of houses or sheds one can spot either a previous layer of red color or ocher. After a strong recommendation from the Presidency, the Ministry exempted from the provisions of Building Act of 1845 about the walled enforcement in market towns. This required walkable spaces between the houses. Therefore the decision led to wide streets and quadrature buildings. The city's topography gave natural limitations for building plots. Local craft tradition and contemporary architectural styles influenced the town's appearance. The impetus came from abroad, mostly from Netherlands and the Empire style was reinterpreted using timber. Therefore, brick empire houses became timber empire houses. After theurban densification and expansion took place in the late 1800s and early 1900s, the architecture started being influenced by different styles: Swiss style, Art Nouveau or Functionalism. The houses are made of logs, gabled roof, the traditional notched corners and tall windows with three panes per frame. Wooden cornices and decorative details are recognisable as Empire style.

Tangengata 28, *Klock House* is one of the oldest houses in Risør, built in 1720 as a two story log house with a gallery in timber frame and its own oven. Many of the buildings are to this day very well preserved and representative for the town's history, tradition and character.
Risør has in recent years embraced the design and architecture specifically related to wood as a material.
The region has several local organizations that have expertise in the use of wood in large and complex interior projects. These include Bosvik AS and their furnishings of the new Opera in Oslo.

Should Risør preserve and continue their tradition of wood-based construction, and get new competence in the use of wood in today's construction projects, will undoubtedly become a great advantage in being part of a national environment.

Conservation plan

In recent decades there has been a growing awareness about the protection of older buildings. At the beginning of 70th century there was a comprehensive registration of wooden towns in the region. Risør took a prominent place in this registration. In 1970 Risør City Council decided to adopt a plan for the center aiming to secure the environmental qualities that the settlement represented. The plan has been unanimously approved after a long process which lasted 20 years. The conservation plan is comprehensive and detailed, so that the buildings characteristics, identity and historical details can be secured and returned. Therefore, the cooperation between private owners and public authorities in strongly encouranged in order to preserve the appearance of the old centre. However, the owners of houses which were built before 1900 are being offered free guidance on changes, rennovation or maintainance.

The criterias to decide whether a building is preservation-worthy or not are set taking into consideration buildings/ houses or building environments that have historical, antiquarian or other cultural value. Very often it is desirable that heritage building or building environments are given a legal protection. This has to be done either by protection through heritage law or by enclosing the area under the Planning and Building Act. In Risør center there are only three buildings which are legally protected (Risør church, Kjæret on Kragsgata and Vatikanet in Buvika). The other buildings are protected through the Planning and Building Act.

"All houses regardless conservation value needs maintenance. For the buildings that we traditionally regard as worthy of preservation, it is particularly important that maintenance is performed so often and in such a way that the original building components requiring replacement. For some houses results poor maintenance of the house must be demolished. It understood, however, that demolishion is the opposite of preserving, even if the original house is beeing replaced by a copy or close copy. The same can be said about the replacement of building components. Any measure which involves replacement helps reduce building conservation value. (...)When introducing new materials some of the knowledge that can be linked to old craft tradition can be disspated and new materials will always give building a somewhat different feel than the original. Insertion a copy or close copy is correct only when the decay has come so far that there is no alternative but to replace the old materials with new ones." [1]

-> *New construction and replacement buildings*
New construction is allowed when designed and placed in harmony with original buildings and environmental character scale and tradition. [1]
-> *Function/ Change of function*
The new function must not irritate or be a disadvantage for Risør original features. In keeping with this character, mixed-use should be permited where appropriate. [1]
-> *Conversion/ Extension/ Equipment*
Conversion can be done with reference to buildings' own character. Solutions need to be chosen in harmony with the traditional design. More preferable are the solutions that allow older or original appearances to be restored. [1]

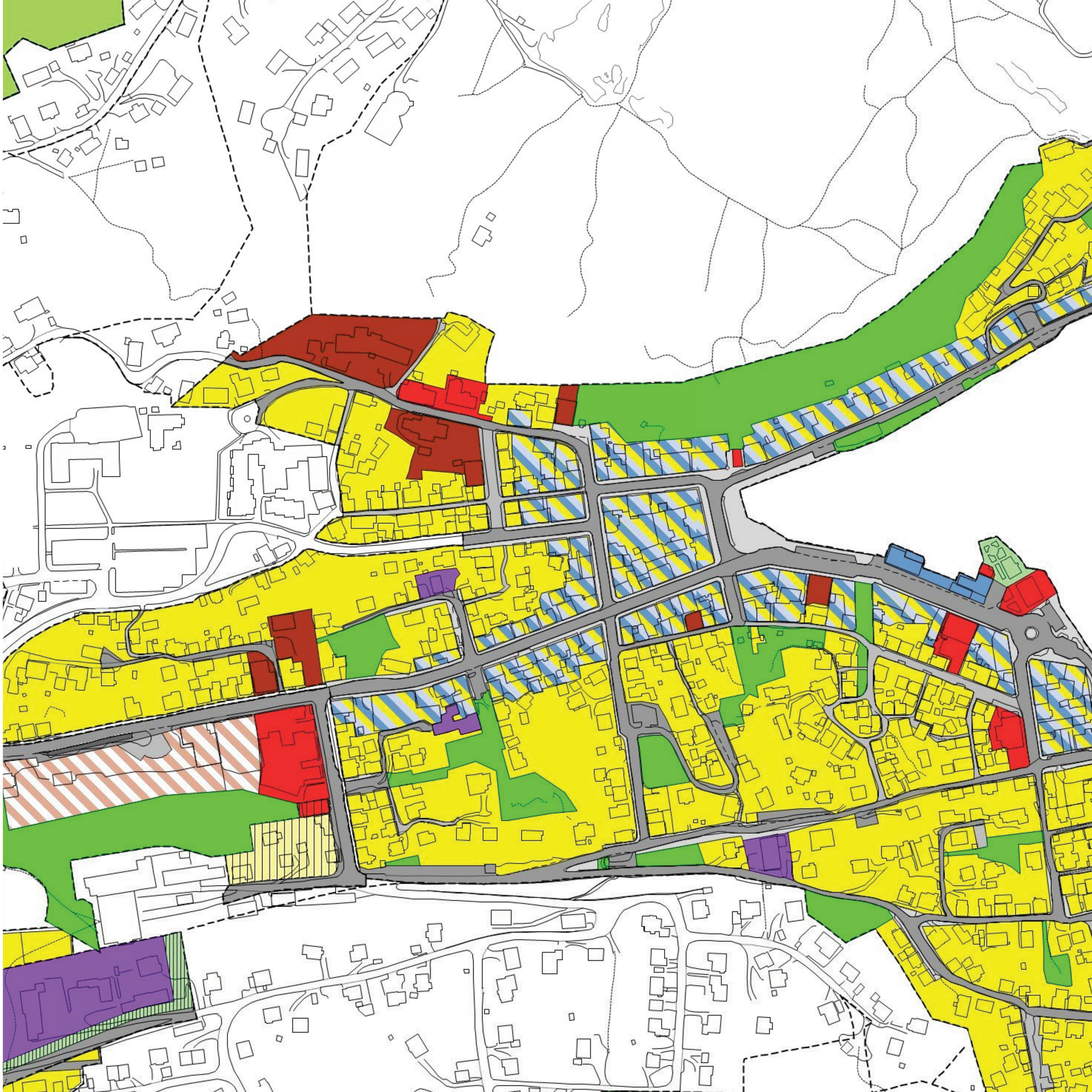
The goals of zoning and conservation plan

1. To preserve and develope the historical, antique, architectural, cultural and environmental representative values for Risør.
2. To provide a framework for both protection and development for the above mentioned values.
3. To prevent interference with the status quo that is inconsistent with cultural heritage.
4. To ensure that old Risør maintains and gradually develops its central functions for housing, business and jobs.
5. To maintain and restore the urban mixed-use environment and the balance within.
6. To maintain and partly ensure an increasing of utilization of the centre.
7. To improve the overall infrastructure in the centre.

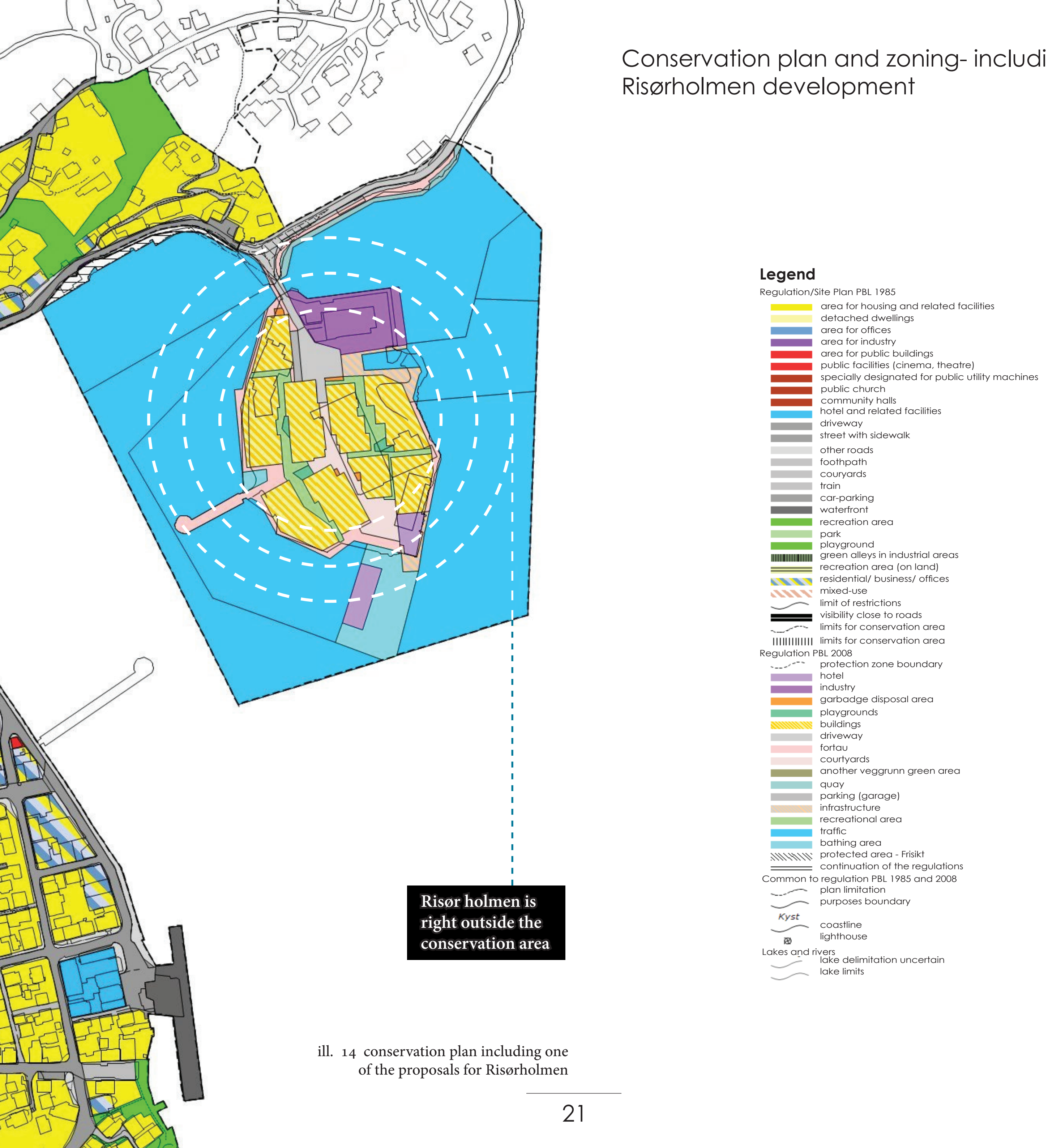
Overall zoning for the conservation plan

Housing	Park, walkpath, playground	Public buildings
Business, office, residential	Harbour	Public utility purposes

ill. 13 conservation plan



Conservation plan and zoning- including Risørholmen development



ill. 14 conservation plan including one of the proposals for Risørholmen

--- Trebiennalen 2008 --
--- Beyond Risør ---
--- Risør Chamber Music festival ---
--- Bluegrass festival ---
--- Villvin arts&crafts market ---
--- Wooden Boat Festival ---

Risør is a beautiful small town of 7000 inhabitants located in Southern Norway. It is predominantly built of wooden houses and situated at the outermost coastline towards the Skagerrak sea. This historical town was previously a seaport and is still marked by hundreds of years of merchant shipping; resulting in an unique mixture of Norwegian and European influences.
Risørs' location, the intimate atmosphere among the wooden houses and its' historical setting comprise the basis for developing new products and design for industry and the creative arts. These distinctive qualities are highlighted by some of the worlds leading musicians as being basic to the choice of Risør as the location of the yearly Risør Chamber Music Festival. Risør believes that these same unique properties give their small town an advantage in creative activities – hereunder Design to Improve Life.
In many ways, the small town of Risør is representative for both southern Norway and coastal Norway generally. Historically the town developed both technologies and designs to ship goods and people across the great oceans. Today, industries in Risør and the region of southern Norway produce among other things products used in advanced off-shore oil technology and specially designed wooden products which have been used in such well-known buildings as the Library in Alexandria, the Opera house in Oslo and the Cultural Center in Kristiansand. [2]

Trebiennalen 2008

estimated number of visitors 15,000

Trebiennalen is an initiative jointly between East and West Agder county councils, county of Aust-Agder and Vest Agder, agriculture department and Innovation Norway.
In 2006, the first Trebiennalen conducted in Vest-Agder. In 2008, Aust-Agder responsible for conducting this event and Risør was host to Trebiennalen 2008.
Both Agder counties has in recent years been involved in the use of wood as a material of interest related to cultural heritage, economic development and encouraging the use of wood in modern architecture..
Risør is selected as the host for Trebiennalen in 2008 because of its unique wooden buildings and exciting environments in wood. People from timber industry, wooden boat builders, local carpenters with high expertise in conservation efforts, architects, designers and artists working with wood.
Topical theme for Trebiennalen 2008 was "Coastal town development. Risør Wooden City - architecture and design ", the focus was on adaptation of new, larger building in an established wooden houses, as well as architecture and building. The goal is to focus on innovation, modern wood architecture, design, development and tradition based timber construction.

Beyond Risør
- where design meets business

BeyondRisør is a major event in design-Norway. The conference is held in Risør every other year and brings together designers, business, architects and representatives from other art fields to an intense two-days exhibition/seminar. The seminar is held in an old shipyard from earlier days in the middle of the heart of Risør. The participants gets inspired by international speakers representing all sides of a design-process.

beyondrisør

"We embrace designers in all disciplines, with a focus on life-enhancing design. The meetings are held every other year in Risør. The program includes professional seminars , lectures , stage design , exhibition and speed dating between designers and business. BeyondRisør will also be an important venue for socializing in combination with professional networking."

"BeyondRisør, established by the municipality of Risør and supported by the national government was started in 2005 as a Norwegian design event with national and international outreach. The design event has developed from being a specialist meeting place to become a national network where design and economy meet. The overall mission is to promote design and design thinking to solve future design challenges in every aspect of public and private life.

BeyondRisør runs in two year project cycles. Each cycle culminates in the BeyondRisør biennale design conference in Risør, which gathers designers, architects, artists and business people from the Scandinavian countries to exhibitions, lectures, workshops, education programs and speed-dates between designers and industry.

BeyondRisør has initiated and launched design solutions to health problems, public areas and climate challenges – of which several have been internationally awarded." [2]

The international focus Risør already has achieved as a Partner City to INDEX: Design to Improve Life ®, is a solid foundation for both Risør, the region and Norway in its entirety.

Risør Chamber Music festival

estimated number of visitors 20,000

"The Risør Chamber Music Festival is a non-profit foundation, the purpose of which is to arrange an annual chamber music festival at which both important classical music and more contemporary repertoires will be presented. Efforts will be made to find musicians - both Norwegian and foreign - of recognised high artistic standard or with proven, indisputable talent. The Chamber Music
Festival will be a national and international forum for chamber music and will also stimulate musical and cultural life in Risør and the region." [3]

Established in 1991, the Risør Chamber Music Festival takes place every last week of June.

The Festival is theme based and according to each theme, the program will reflect this in musical profile. Most concerts presents a mix between solo, chamber music and chamber orchestra based classical music repertoire in the range from early baroque to contemporary. A Norwegian composer is normally focused as guest composer, but the repertoire in general are mixed between Nordic and international classic composers. During the last years the Festival has made a profiled series with lighter classical concerts presented in an informal way and in new and different locations. This is a mix between indoor and outdoor concerts. The Festival also present some jazz concerts as part of the program.

The artists in the Festival are picked from a top range of international artists as well as we want to present high class Norwegian singers and musicians. The Norwegian Chamber Orchestra is the Festivals orchestra.

The artists in the Festival are picked from a top range of international artists as well as we want to present high class Norwegian singers and musicians. The Norwegian Chamber Orchestra is the Festivals orchestra. [4]

The Holy Spirit Church

Venues for Risør Chamber Music Festival

The festival uses the picturesque scenery of the city itself as the main stage. Thus, the venues vary from outdoor to indoor, the main concert hall being a wooden Baroque church from 1647 - "The church of the Holy spirit."

Kunstparken

Kunstparken is the Art Gallery in Risør. For the Festival, the Gallery also serves as concert hall, venue for lectures, as Music Pub and as a Restaurant [4].

Hødnebø

By the waterfront, Hødnebø serves as another concert hall. It is a former exhibition area which performs well for more informal concerts. It provides a beautiful overlook to the fjord with its islands while listening to the music.

Stangholmen

One of the outdoor venues is located on the light house Island of Stangholmen. Late night concerts make this a beautiful experience as the day light slowly turns into night during the concert [5].

ill. 15 The Church of Holy Spirit

ill. 16 hodnebo

ill. 17 kunstpark

ill. 18 stangholmen

The Risør Bluegrass Festilval

estimated number of visitors 20,000

The Risør Bluegrass Festival is Norways' only festival of its kind. Established in 2001 and it actually moved in 2012 to a new location in Gjerstad, the Prestfoss Mill, which still belongs to Risør area, but in the neighbouring community. After being held for 10 years in a beautiful 'horse ranch', located on the banks of a true wilderness lake. The new location is trying to maintain the specifics of the festivals former location by being held in an "old mill by a waterfall, which is now used as a state-of-the-art sound studio for many well known bands"[6].

ill. 19 location for the festival

ill. 20 scene of the festival

ill. 21 current location of Bluegrass Festival

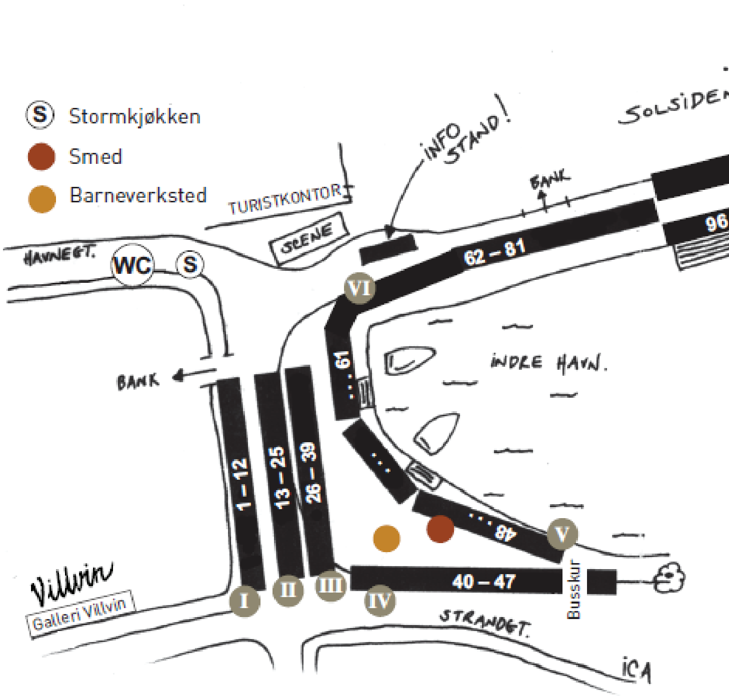
ill. 22 image from previous years of the festival

Villvin Arts&Crafts Market

estimated number of visitors
25,000 - 30,000

Villvin Craft Market has been established in 1979, in close connection with Gallery Villvin, and it represented an event for annual sales for craft artisans. It is being held every year in June and it contains "demonstrations of arts and crafts and activities, stalls, musical performances and theater in the middle of the busy streets" [7]."Gallery Villvin pioneered in professionalized craft sales in Norway, and inspired the founding of Gallery Format in Oslo – the gallery owned by the Norwegian Association for Arts and Craft."

Villfin's summer market enjoys high regard amongst craftspersons and the craft audience alike. Exhibitors are mainly Norwegian, with some contributions from Denmark and Sweden. To exhibit at the market, craftspersons must be members of the Norwegian Association for Arts and Crafts [8].



ill. 23 schematic distribution of the market exhibit points around the harbour of Risør [9].

ill 24. streets of Risør during Villvin Arts&Crafts

Wooden boat festival

estimated number of visitors 20,000

The busiest weekend in Risør is blamed on the Wooden Boat Festival which takes place every year in the beginning of August and brings together hundreds of old or new wooden boats, with or without engines.
Risør Wooden Boat Festival began as a fairly small fair for wooden boat enthusiasts back in 1984 and it has gradually evolved ever since into becoming a large, popular and extremly colorful festival.
"The atmospheric harbour is surrounded by a bustling exhibition of demonstrations from purveyors of maritime crafts. Kids are catered for in a designated area, and the young ones even get a chance to make their own wooden boat souvenirs. Look out for the street parades and the entertainment from a myriad of stages" [10].
"The bustling harbour is the centre of the action, with sea culture and traditional handicrafts very much in focus, but there are also street parades and entertainment all throughout Risør. A real festive atmosphere" [11].

"Cultural experiences all year around
Experience a variety of events and festivals in Risør from spring to summer, autumn and winter. Bring your family and friends to the beautiful timber city and participate in unique and exciting cultural experiences such as Brune Dager, Kulturnatt, Kammermusikkfest, Villvin Kunsthåndverkmarked, Bluegrassfestivalen, FyrJam, Trebåtfestivalen, Risør Festuke or Christmas in a white town" [12].

ill. 25 Woodenboat festival

ill. 26 organisational map

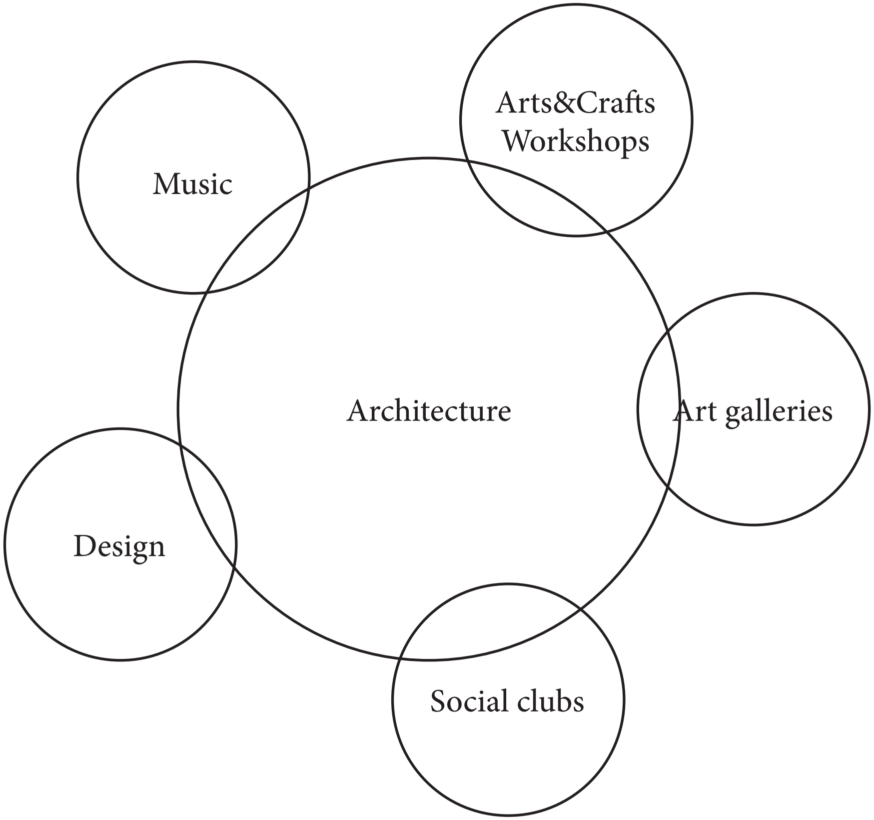
Conclusion

It is generally acknowledged that Risør is a pictoresque timber town with vibrant history and traditions, thus a perfect background scenery for seasonal festivals and cultural events which contribute to promoting the town on an international scale.In regards to the social life there are several assosciations that work throughout the year, giving the locals a chance to interact with each other also when the weather is not at its best. Most of them are behind the main festivals taking place: Villvin Galeri - supporting Villvin Arts&Crafts Market, the Sailors Assosciation - supporting the Wooden Boat Festival or The Risør Jazz Club supporting The Chamber Music Festival . There are, however, associations such as Brune Dager i Risør whoes goal is to organize activities and events off-season, when the atmosphere is very quiet and calm. Therefore, compared to the massive income of people during summer festivals when the town is extremly active, the residents of Risør feel the need to entertain their lives during less busy seasons as well. As part of nordic culture, they have a strong sense of community and social gatherings often organized. All in all, cultural and social life aren't particularly stable throughout the year while their venues vary as well from old shipyards or churches to the narrow streets around the downtown harbour, which, due to the big number of visitors, often become over-crowded. Therefore, by expanding the central street network and providing a new and more stable location in resonance with the well defined traditions a more stable cultural and social life all year round could be assured.

In addition, some of the cultural events taking place in Risør are in close connection with architecture, design and innovation and industry, Risør becoming a partner city in the danish organization *INDEX: Desgin to Improve Life* and host city for the 2012 *INDEX: Design Touring Exhibition.* Consequently, because of its status on the international design market, it is only natural that Risør would benefit even more from a landmark building, which integrates traditional values and modern aspirations. In INDEX:Design motto :"We Inspire, Educate and Engage in designing sustainable solutions to global challenges" [13].

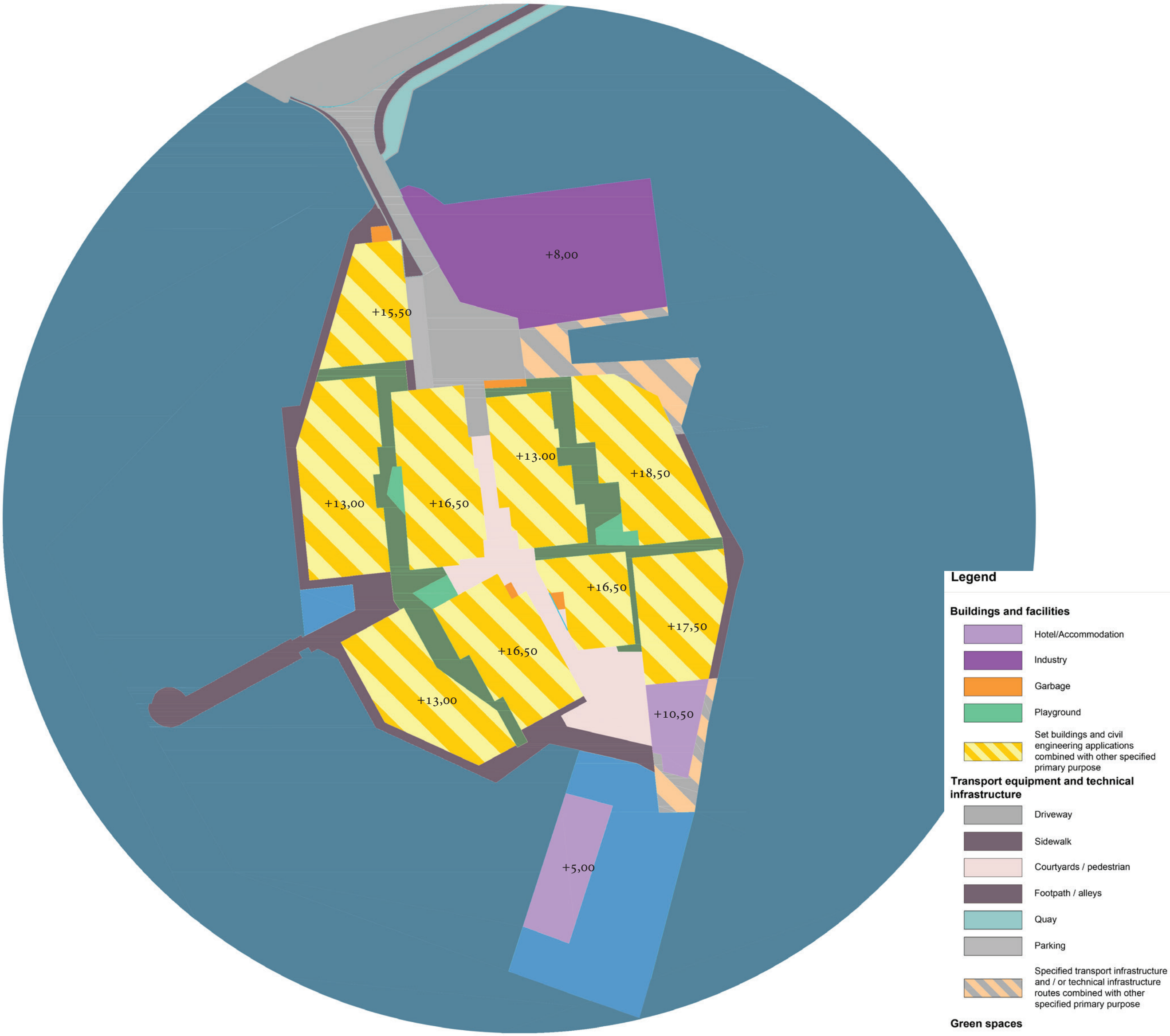
Created by Denmark in 2002, INDEX: Design to Improve Life® is in sync with the values and principles that made Danish design widely renowned in the last century, focusing on humanism, social understanding and democratic thinking. We promote the application of design and design processes to improve vital areas of people's lives worldwide, and to us, the best definition of design has been expressed by our esteemed jury member Professor John Heskett, who said:

"Design is the human capacity to shape and make our environments in ways that satisfy our needs and give meaning to our lives" [13].



ill. 27 conceptual diagram

Zonification map of Risørholmen project



ill. 28 plan for the new development

4. Architectural competition for Risørholmen
- ongoing projects -


ill. 29 project rendering

The winning project for the urban development competition for Risørholmen in 2008 aims to transform the island into a residential area summing up to 110 holiday apartments ranging from 65 to 130 sqm (22 buildings of varying height)with 2 floors of underground car parking, and shore boat parking.
According to the article posted on www.aftenposten.no it seems that the initial winners of the competition - Kritt Arkitekter - had a disagreement with Solsiden 1 so Petter Bogen Arkitekter came up with new drawings to the municipality. Critics say that the new plans look more radical that and the most obvious change is the average height of the buildings which went from 3 storeys to 4. Thus Risør will end up having its first barcode neighbourhood which may not be in total harmony with the its specific architecture and especially the conservation plan. It is actually an irony of faith that the island is situated right outside the conservation area, fact which allows architectural innovation by disregarding the traditional architecture which characterizes the surrounding area and thus it might actually ruin the concept and image of the whole harbour. The position of the island (right in front of the harbour) together with the agglomeration of low-rise buildings which is not in resonance with the contextual architecture might interfere with the concept behind the conservation plan for the city centre. Although painted in white, thus respecting the color promoted by the conservation plan, the rectangular buildings create a "barcode" island right at the entrance of the harbour , becoming a landmark because of their location. The necessity of a residential and summer house apartments area has been motivated through the fact that it adds growth and income to the small town of Risør. However, it is debatable if growth and income could be assured with such a development since most of the apartments are destined to be seasonally used, and maybe not even then for the entire season. It is true, however, that the main income for Risør at the moment is done through tourism but one strong reason behind this is Risør's appearance, location, and specific atmosphere which should be kept and promoted. Its cultural and social events are attracting up to 30,000 people for just one weekend when the streets of Risør become over-crowded. Furthermore, the fact that the project has been changed since the beginning and only a small part of it has been implemented so far (Fiskemontakket) shows that there are second thoughts about the feasability of the project. Simultanously, there is one other housing project currently developing 500 m south from the city centre, also by the seashore, which will provide more apartments in a 6 storey heigh building complex with clear views towards Skagerrak. The project, named Flisvika, seeamed more feasible thus it is at the moment under construction. According to the municipality's annual report similar projects are currently under development - such as Buvika (35-40 apartments) or Vestlandsstykket (19 villas) [14]. Consequently, Risørholmen development project seems not to be the most suitable project for the town centre.

ill. 30 map analysis

The porposal is narrowing down the view from the city centre towards Skagerrak and could also provoke more boat traffic at the entrance of the harbour which is over crowded during summer and especially during Wooden Boat Festivals when big ships can barely enter the harbour. Proportionally, the island seems to be expanding and dominating the area, almost closing up the harbour. It is un-avoidable not to become a focus point of the area because of its location and dimension. Thus the site might be suitable for a construction which better suggest the character of the city, in order to become the town's landmark.

Fiskemottak

ill. 31 Fiskemonttaket

However, there is already an errected building part of Risørholmen project . The building has 600 sqm,it was built in 2008 and it encloses several functions. Its orientation has been done accordingly - towards the sea the fish unloading dock while towards the road the cafe together with the fish shop and en-gros market. Regarding its construction, the building represents and assembly of timber frames. The facades and exterior finishings are white, in resonance with the rest of the city centre and the conservation plan. An exception from the latter would be the roof, which is flat and cofered by sedum.

"Demolition is the opposite of preserving" *[1]*

The fact that the current urban development for Risørholmen is still undergoing changes and it has been severly criticized, especially by the locals, it shows that the architectural solution suggested for this area is probably not the most suitable one. Not only that a historic place would be replaced, fact which goes against the conceptual belives of the small town of Risør but it also doesn't provide a proper architectural solution that fits within the context. Regardless the fact that the site is right outside the conservation area, the solution should be in harmony with the surroundings and follow the natural demands of an expanding central area. On the contrary, it provides a residential area with up to 16 m high flat roof buildings which could bring demographic growth but not necessarily urban evolution. Therefore, the project aims to change the functions of the area, by transforming it into a public space - an expansion of the centre around the harbour. By following the sense of place, a new masterplan will be developed aiming to create a continuation or an alternative to the cultural and social life of Risør. Furthermore, in the light of conservation and protection of historical and representative buildings the shipyard (Sjøsenteret) will be kept, together with Fiskemottak. However, the functions will slightly change, especially for the shipyard. The site will eventually accommodate a cultural and social centre which is destined for the whole town's community together with the estimated number of visitors during festivals, markets or events. and will be the focus point of this project. Although some functions will be used on a seasonal basis, some of the permanent galleries, exhibitions spaces, community halls will also be enclosed within the architectural programme, destined towards a more frequent usage.

ill. 32 interior of the shipyard

ill. 32 exterior of the shipyard

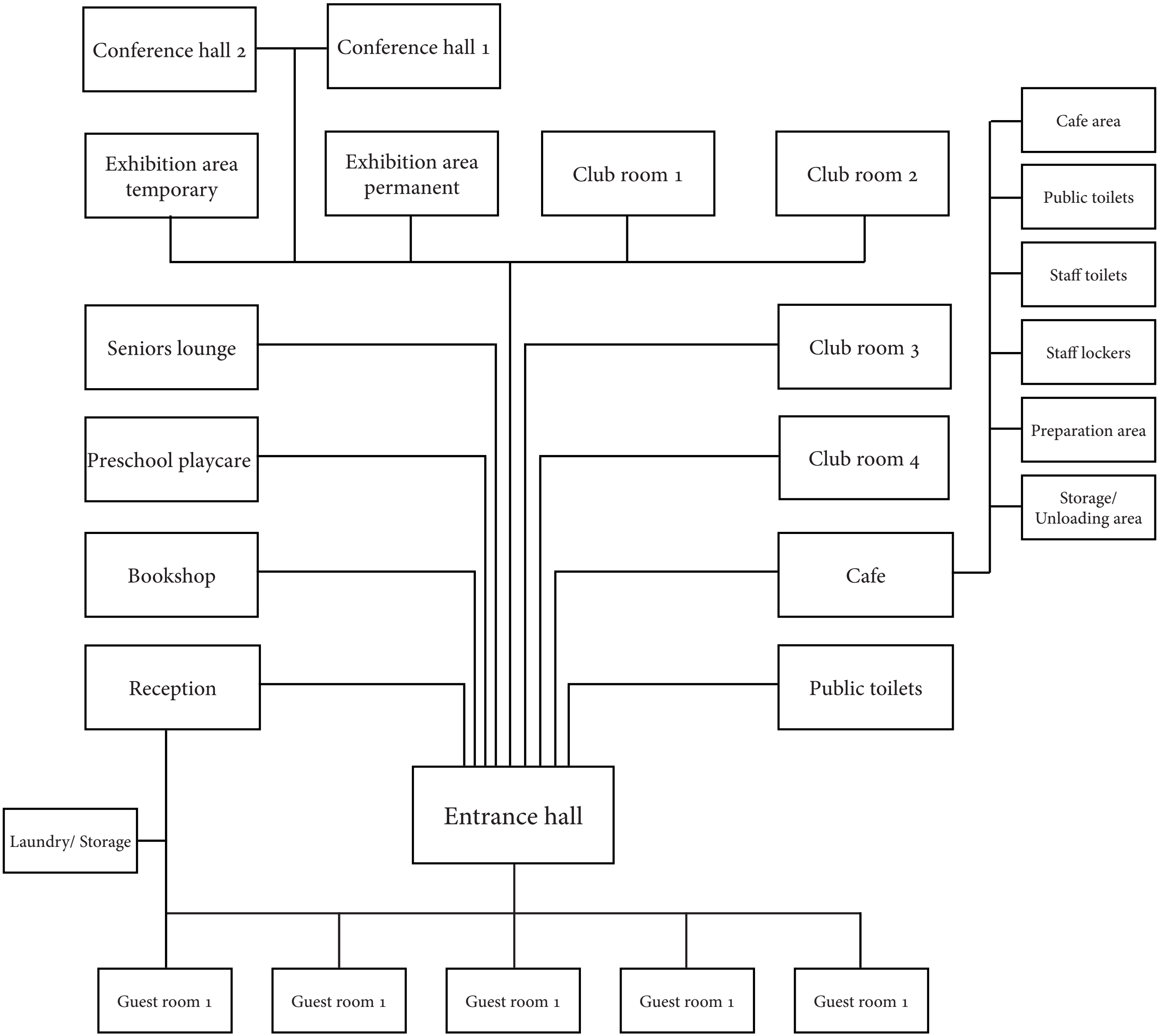
III. architectural programme

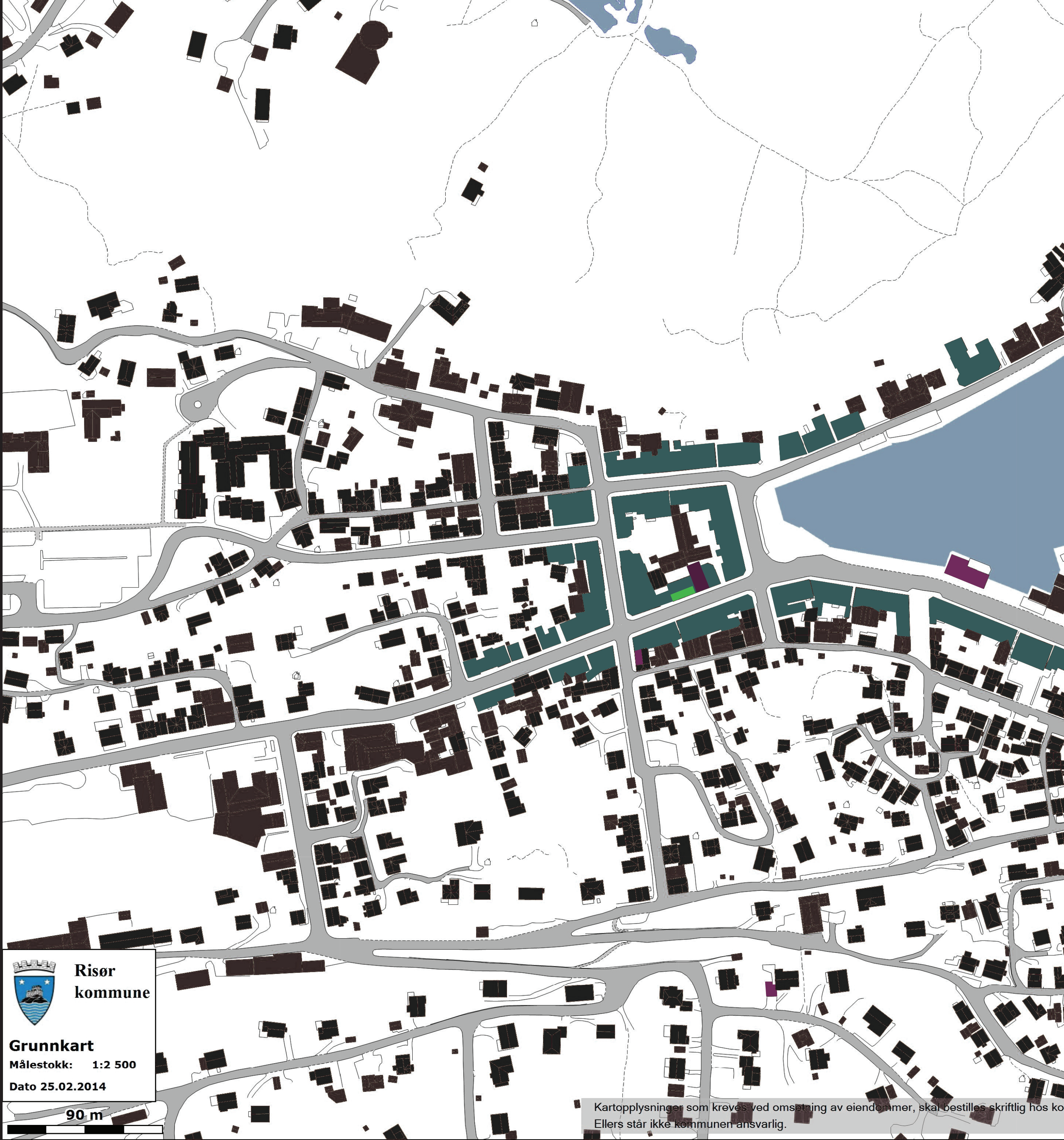
1. Room functions

Room functions	No.	Surface (sqm)
Entrance hall	1	120
Reception	1	10
Bookshop	1	100
Public toilets	2 (1 per gendre)	20 (10 each)
Cafe		
Storage/Unloading area	1	8
Cafe area	1	115
Preparation area	1	10
Staff lockers	2 (1 per gendre)	12 (6 each)
Staff toilets	1	6
Public toilets	2 (1 per gendre)	20 (10 each)
Conference hall	2	1400 (700 each)
Exhibition area - temporary	1	250
Exhibition area - permanent	1	200
Club room 1 - Risør Jazz Club	1	150
Club room 2 - Sailors Association	1	150
Club room 3 - Vilvin Galeri	1	150
Club room 4 - Beyond Risør	1	150
Seniors lounge	1	300
Preschool playcare centre with indoor playground	1	250
Guest rooms w/ ensuite bathroom	5	20
Laundry facilties/ Storage	1	10

Total surface = 3,501 sqm

2. Functional diagram ill. 34




Risør
kommune
Grunnkart
Målestokk: 1:2 500
Dato 25.02.2014
90 m
Kartopplysninger som kreves ved omsetning av eiendommer, skal bestilles skriftlig hos
Ellers står ikke kommunen ansvarlig.

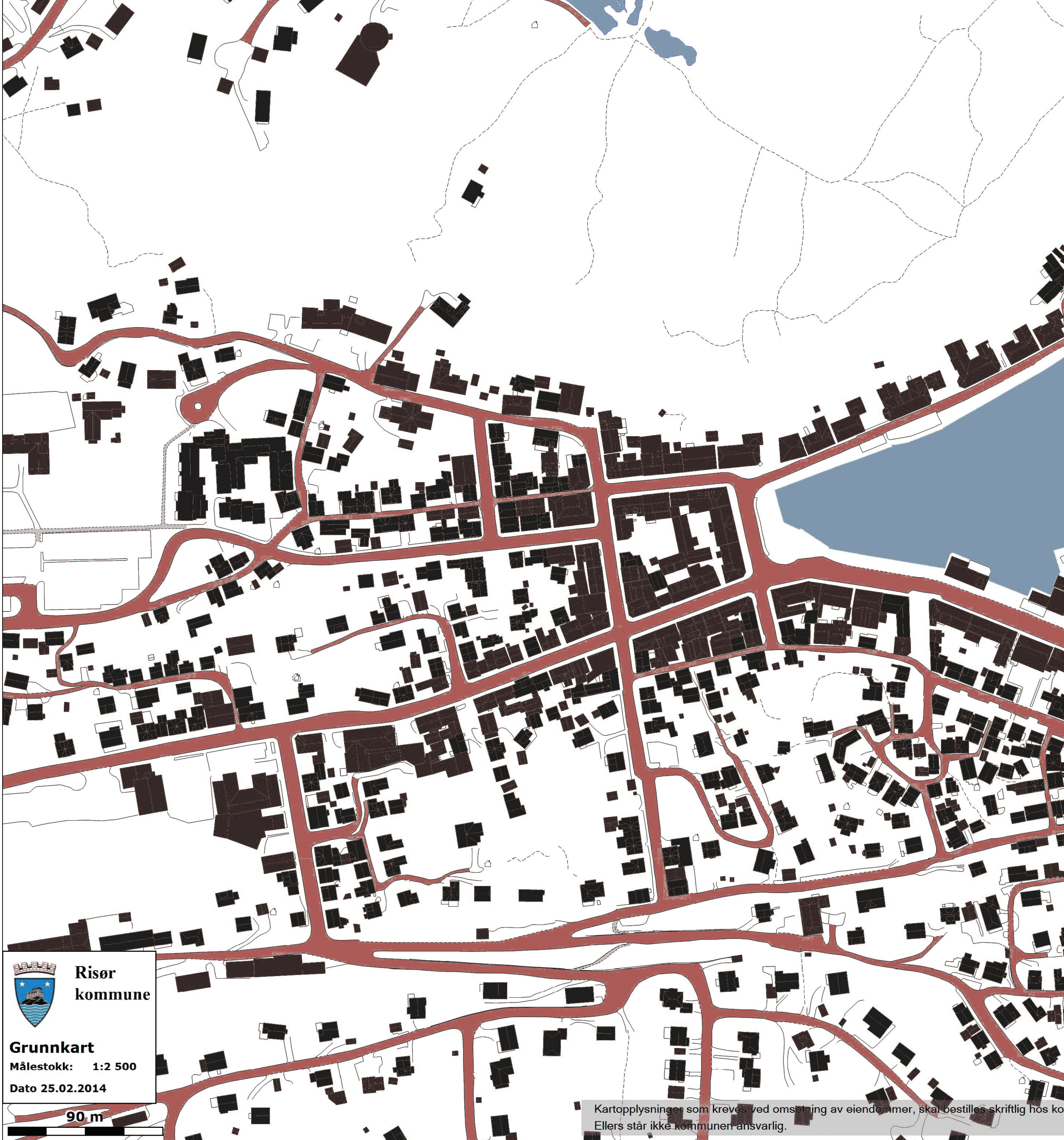
Facilities in Risør centre

ill. 35 facilities in Risør centre

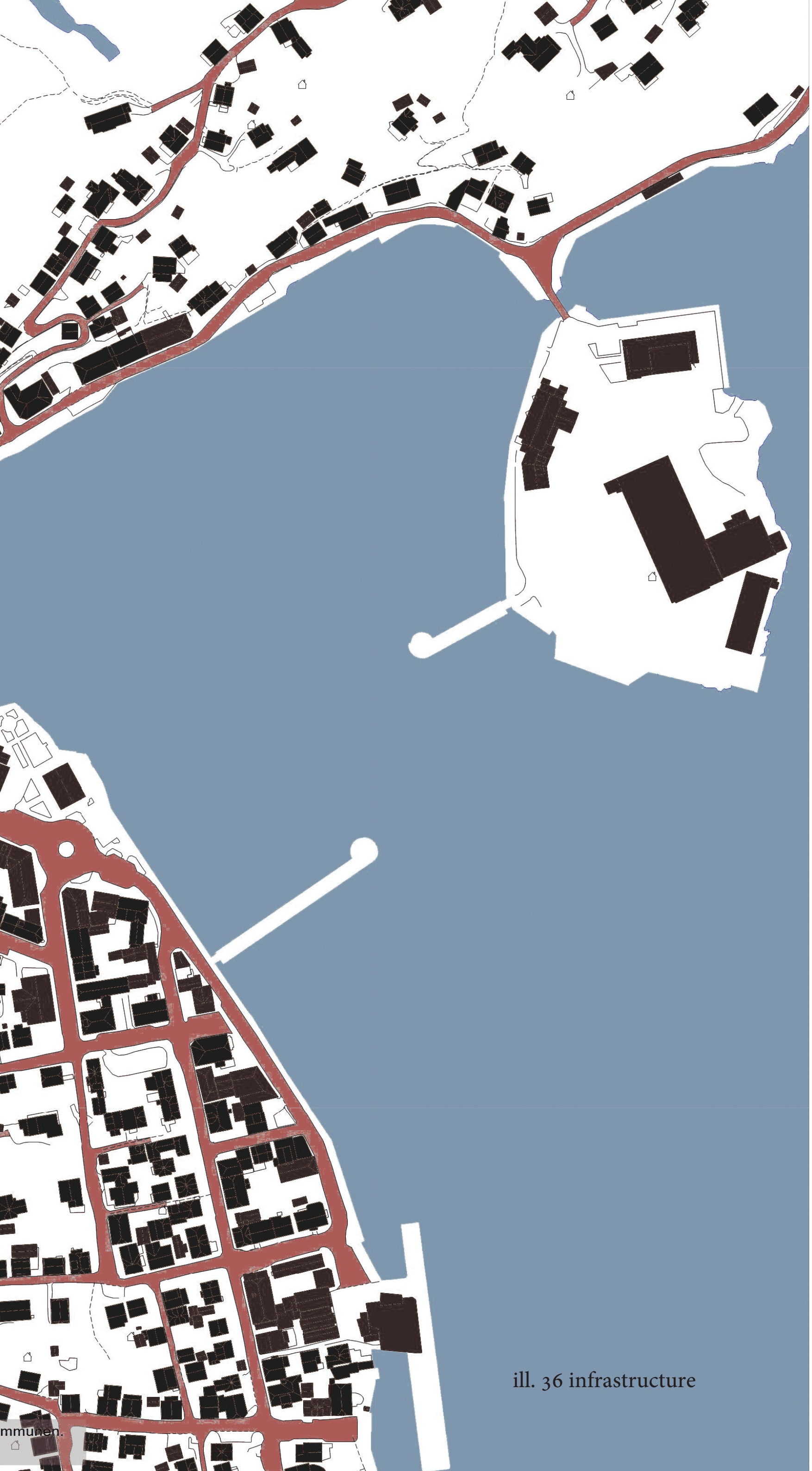
The neighborhood in Risør according to Prospekt Risørholmen

Goods and services	
Risør Post Office	0.4 km
Pharmacy 1 Risør	0.4 km
Arne Aas Eftf	0.4 km
Yx Risør	0.4 km
Risør liquor	0.5 km
Ica Risør	0.5 km
Risør Video Center	0.6 km
Ica Close Randvik	1.4 km
Statoil Service Risør	2.1 km
Pig Large Centre	26.5 km
Demographics (solsiden unit)	
married	34%
families with children	24%
have a college education	28%
have income above 300,000 nok	23 %
own their own home	53 %
own cabin	7%
have housing of over 120 sqm	48 %
of the homes are newer than 20 years	30 %
live in detached	49 %
Places of Interest :	
Citadel	0.5 km
Enghavet	0.5 km
Market Square	0.5 km
Tangen	0.5 km
Transportation :	
Kristiansand Kjeivik	111.5 km
Sports facilities :	
Tjenna activity area	0.9 km
Kjempestein marsh grass / artificial turf	1.5 km
Atletix Centre	1.7 km
Schools and kindergartens :	
Tjenna kindergarten (1-5 years)	1.1 km
Risør high school	1.4 km
Risør primary school (1-7 at .)	1.5 km
Risør high school (8-10 at .)	1.6 km
Frydenborg kindergarten (0-6 years)	2.0 km
Randvik kindergarten (1-5 years)	2.9 km
Tvedestrand high school	27.7 km

Boat shop
Vilvin Galeri
Mixed-use (commercial facilities at groundfloor)
Police Station
Mixed-use (commercial at groundfloor)
Mixed-use (commercial at groundfloor)
Residential buildings


Risør
kommune
Grunnkart
Målestokk: 1:2 500
Dato 25.02.2014
90 m
Kartopplysninger som kreves ved omsetning av eiendommer, skal bestilles skriftlig hos ko
Ellers står ikke kommunen ansvarlig.

Infrastructure



ill. 36 infrastructure

Topography. Ground conditions. Drainage

Holmen previously consisted of two smaller islands that have been connected by filling the space between them with ground in 1895. The terrain is mostly flat with a slight depression in the area which was filled. The main initial island has been carved down to the current level. Most of the areas are paved from the 1970's, with the exception of the north-east area where the industrial hall FIskmontakk is currently located. There is no specific drainage system designed in the area, this being mostly done over the ashpalt deck and into the sea or directly infiltrating the ground, where the asphalt is replaced by grass, gravel or stones.

Sea level rise and tide

Terrain level in that area is between 1.5 and 3 contour The closest monitoring stations for Sjokartverket is Helgeroa (Vestfold) and Tregde (Mandal). The highest water level observed in Helgeroa is 1.84 in terms 2/27/90. 20-year recurrence interval of 1.9 meters above mean sea Helgeroa. The highest water level observed at Tregde is 1.60 m measured 10/30/00. 20-year recurrence interval is 1.43 meters above mean water in Helgeroa.
"Estimates of future sea level rise in Norwegian coastal communities " by Bjerknes Centre on behalf of the DSB in 2050 estimated a sea level rise of 18 cm in Risør. The predictions are that sea level will rise in 2100 with 65 cm.
Storm tide of 1 meter may occur along large parts of the Norwegian coast. Tides can be especially high if, in addition, low pressure and strong onshore wind are occuring. A calculation made by Multi Consult in 2006 concluded that the water level at Larvik harbor can come up well over 2.0 meters over NN 1954 during a storm tide. A storm tide of 2 meters is considered to have a 100-year recurrence interval. According to the report on sea level rise is the year 2050, with possible storm tide of 1.47 m in Risør . The same report indicates a possible storm tide in 2100 to 1.99 m.
Lowest contour excess floor is therefore recommended set to minimum 2.5 m.
Consequences of flooding associated with sea level rise and ebb is considered harmless to people, the environment and a risk of socially important functions. By planning measures in terms of flooding and storm tides drawbacks could be avoided. When there is uncertainty regarding possible water level placing of sensitive technical equipment should be considered and increase the contour with more than 2.5m.

Geotechnical

The geotechnical report concludes that mountain increases to the north and east and that all new buildings are mostly laying their foundations on mountain rocks. Existing fill materials are not considered sufficiently secure foundation for quality buildings. Filling the soils in the lake requires extensive site investigations. It should be noted local unstable parties at 2 locations along existing shoreline that require further consideration and measures in future planning.

Requirements for the design and implementation for damage prevention

The following considerations must be given special attention during project planning:

-- Fire risk must be considered when planning and operation

-- Secure environment associated with high and rising sea levels. This is especially conserning digging below the ground

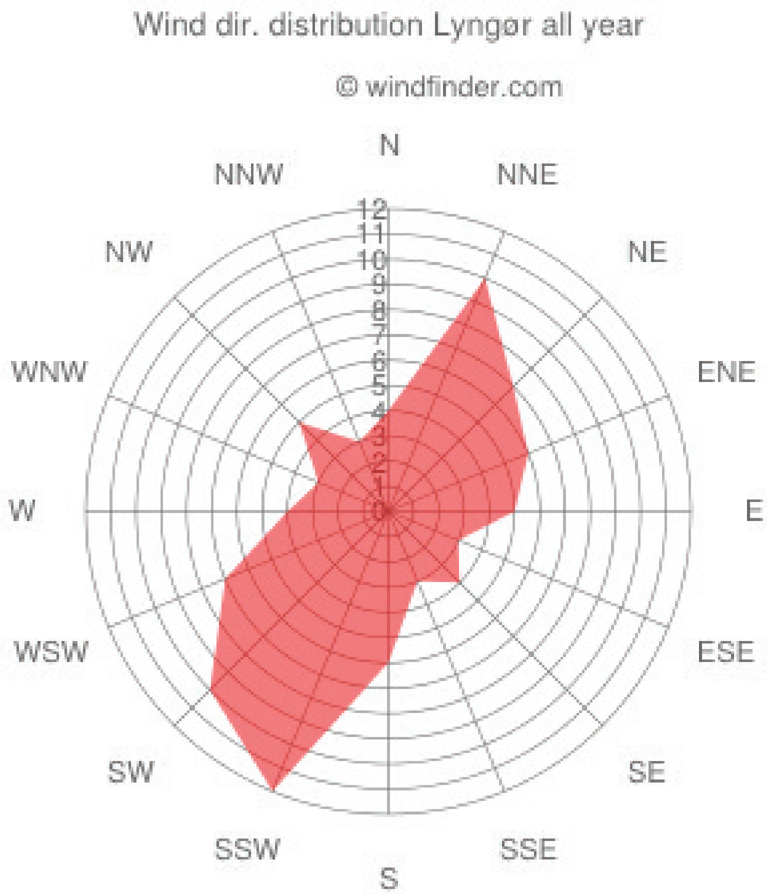
-- Safeguarding against violations of wiring (VA, electricity, telecom)

-- Proper handling of contaminated

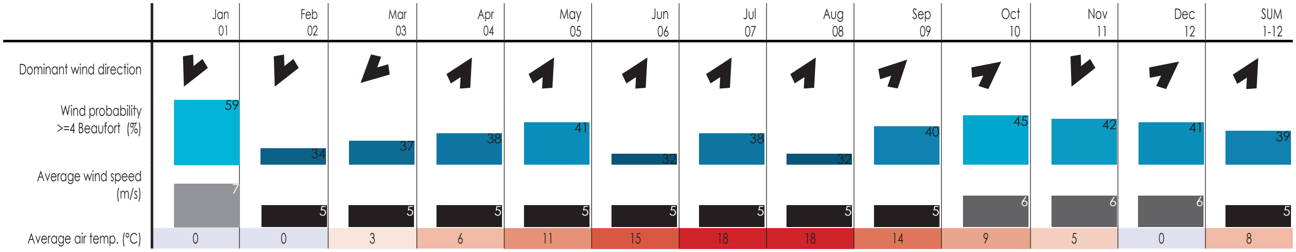
-- Secure the necessary foundation

-- Securing against terrain slipping

The wind data has been collected from www.windfinder.com by taking the nearets station to Risør - Lyngør



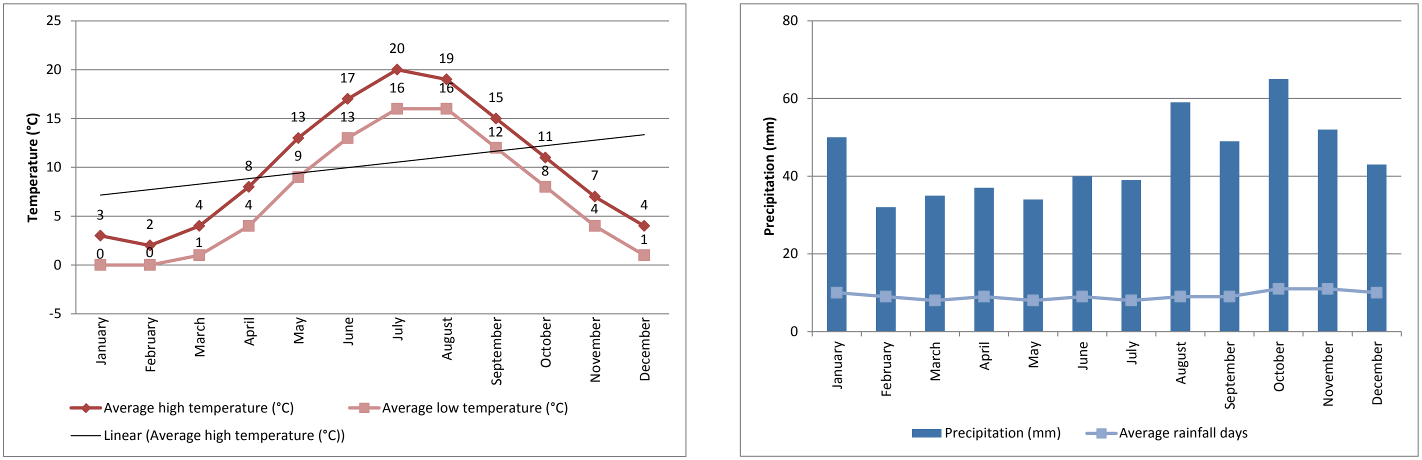
ill. 37 wind analysis



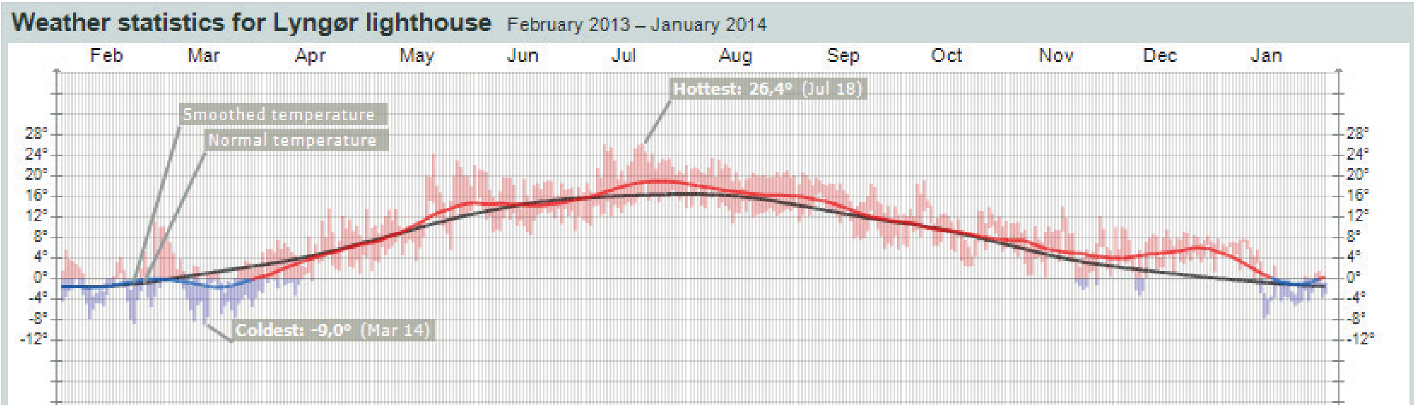
	Jan 01	Feb 02	Mar 03	Apr 04	May 05	Jun 06	Jul 07	Aug 08	Sep 09	Oct 10	Nov 11	Dec 12	SUM 1-12
Dominant wind direction													
Wind probability >=4 Beaufort (%)	59	34	37	38	41	32	38	32	40	45	42	41	39
Average wind speed (m/s)	7	5	5	5	5	5	5	5	5	6	6	6	5
Average air temp. (°C)	0	0	3	6	11	15	18	18	14	9	5	0	8

The weather data has been collected from www.weatheronline.com by taking the nearest station to Risør - Larvik

ill. 39 frozen fjord



ill. 37 temperature and precipitation analysis



The black line shows mean value (both precipitation and temperature). Some stations does not have mean values, and hence no black line.

The red/blue line shows average temperature during the day (24h) (equalized for 30 days). The line is red by pluss degrees, and blue by minus degrees.

The red/blue areas shows the temperature variations throughout the day (24h) with max- and min. temperature as endpoints. The area is red by pluss degrees, and blue by minus degrees.

The lightblue bars shows total precipitation this month. The black lines crossing is the normal (mean) value for precipitation. **The dark grey bars** behind the precipitation bars shows snowdepth measured day by day. (http://www.yr.no/)

theoretical approach

V. timber architecture

-- Forests and timber industry in Norway --

Timber is the only renewable building material and as stated by TTF - *Timber Trade Federation* - "according to Eurostat, in 2007 the the total area of forest land in the EU covered approximately 156 million hectares, which corresponds to 42% of the total area.(...) A large proportion of EU wood consumption is satisfied by domestic forests (...). Much of this production is concentrated in Germany, Scandinavian countries , France and Polland."

NFF - *Nordic Family Forestry* - states that around 38% of *Norway*'s surface is covered by forests summing up to a total of 12 million hectares, out of which 7 million hectares are productive forests. As tree species in Norway, the most important are ***spruce*** (47%), ***scots pine*** (33%) and ***birch*** (18%) [15].

The sawmilling industry in Norway consist of around 200 mills, spread all over the country. In order to be close to the raw material, the mills are mostly located in the rural areas and they have a major role in employment and local economy. The total number of employees in sawmilling industry is around 5000.

"The total annual production of sawnwood is approx. 2,3 mill. cum. and the total turnover amounts to 8 billion NOK (1 billion Euro). The main products are building materials for the construction industry. All building materials are graded according to Norwegian standards and a great proportion of materials for construction is machine stress graded. Furthermore a major part of the building materials is kiln dried. Wood panelling and flooring are available in spruce and pine in a great number of dimensions and styles. Other products are impregnated wood, gluelam, components for joinery, furniture and carcassing" [16].

The forests are growing slowly thanks to the climate and topography which secure sawnwood with particular good strength qualities.

Although in Risør, the timber industry doesn't sustain the town economically as it used to, it is still representative for the area. Norsk treindustri is one of the biggest suppliers of building elements for construction companies and carpentry businesses based in Kristiansand and Risør such as Agderbygg AS, Kaspar Strømme AS, Sivertsen Bygg AS or Bosik AS. The latter is a company based in Risør as well and specialised in interior timber projects.

Timber characteristics [17]:

Spruce is used for different purposes - from basic construction to wooden aircrafts or musical instruments, however it is recommended for indoor use only.
dry desnity - 400 kg/m3
open porosity - 72%
fibre saturation point 32.6%

Scots pine is generally used for pulp and sawn timber products, therefore in construction industry. Scots pine has a pale brown to red brown color.
dry density - 470 kg/m3
open porosity - 60%
fibre saturation point 0.25 kg/kg

Birch wood is pale and fine-grained. It is used for veneer while birch plywood is amongst the strongest plywoods, although it isn't reccommended for exterior use.
dry density - 571 kg/m3
open porosity - 63%
fibre saturation point 27%

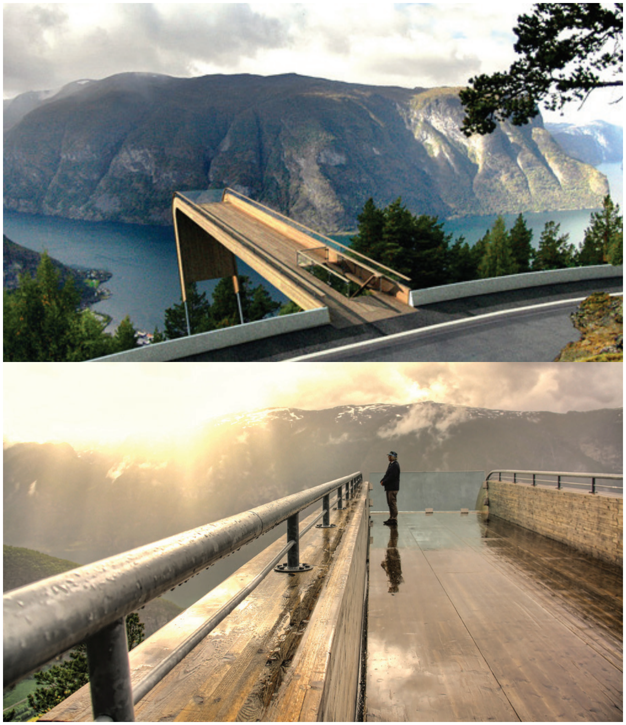
"Timber is recognised as one of the oldest building materials used by humans for their shelter, with its softness, warmth and versatility proving to be of almost universal importance in cultures across the world." [18]

As the only renewable material construction, timber outperforms many other materials due to its numerous characteristics: adaptiveness, malleability, possibility to be used widely both indoors and outdoors, in varying climate conditions and last but not least affordability.

As the project aims to fullfill the 2020 energy requirements which means to reach a total energy frame of 30.3 Kwh/m2/year an assesment of the materials' properties is required. However, aspects of sustainability are fullfiled only by chosing a local, unexpensive material, thus decreasing the costs for transportation, manufacturing, etc. In terms of material properties, timber
"*(...) is an excellent insulator in colder climates and can be used to create light, open structures, that encourage cross ventilation in hot climates. It is also structurally versatile, with a very high strength to lenght ratio. Pine, for example, can provide the same degree of strength as steel with a structure that is 16 times lighter, and as concrete with a structure 5 times ligther*". *[18]*
Timber is widely used in construction purposes, which until recently only regarded domestic areas. However, nowadays, large public buildings in dense urban areas are built in timber, due to new technologies and possible structures that allow large spans, thus making timber comparable to concrete or steel structures. For example, glu-lam beams which are made by bonding pieces of timber together in such a way that they posses uniform properties in both tension and compression make possible previously unattainable spans.

Norwegian timber architecture comes with a double meaning. It could either refer to norwegian vernacular architecture - which made use of timber since it was the most locally available resource and followed traditional building techniques (hand crafted log houses with notched corners) but it also indicate a contemporary direction in architecture occuring in Norway and not only. Generally, *"the architecture of Norway has evolved in response to changing economic conditions, technological advances, demographic fluctuations and cultural shifts. While outside architectural influences are apparent in much of Norwegian architecture, they have often been adapted to meet Norwegian climatic conditions, including: harsh winters, high winds and, in coastal areas, salt spray." [19].*
But no matter the factors that influenced norwegian architecture, the use of timber seemed to remain the only constant factor. A widely recognized fact as being part of their culture is that norwegians worship their impressive landscapes. In a "nature before architecture" sort of way, their houses are scattered around, following topography and avoiding major human interventions within the landscape. In addition, due to its high availability throughout the country and renewability character, timber seems the most suitable construction material for the purpose of integrating the natural landscape withing ones home. Furthermore, *"As a material, wood makes a direct appeal to humankind. As one historical style has yielded place to another it has remained the preffered material. Wood has a living soul; it has, one might say an inherent configuration of its own" [20]*. Living with nature or rather building for nature and not against it seems to be the guiding principle behind norwegian architecture and culture, two aspects that should be interrelated in any designing situation.

The contemporary use of timber predominately aims to suggest the conceptual approach of the design (as seen in the following examples), most probably because, structurally speaking, the technological advances or other materials already allow for large, impressive structures. However, timber is still a material that allows for enourmous potentialities implicit in its joinery which could furthermore lead to developing new and outstanding structures and therefore appointing them with the tectonic character. Tectonics is yet another strong focus of this project and will be defined in the following chapter.



ill. 40

The Aurland lookaout - Aurland

The lookout by Saunders Wilhelmsen takes the form of a dividing board, complementing the surrounding steep mountains, however, minimal and clean in geometry and execution. Load bearing galvanized steel are covered with environmental pressure-treated pine. The walkway is a platform constructed from massive planks of timber. Almost the whole structure is cladded in timber, the reason behind this being conceptual, aesthetical and empirical. Through its expression, architecture gives "the feeling of leaving the moutainside and walking out into the air where the timber clad platform terminates only in a titled sheet of frameless glass , while the ground plane and balustrades continue on in a plunge towards Aurland Fjord" [21].

ill. 42

Kilden Performing Arts Centre - Kristiansand

A conceptual approach with the use of timber is illustrated in The Performing Arts Centre “KILDEN” from Kristiansand designed by ALA Architects. A huge cantilivered roof cladded in local oak creates a strong relation of drama and tension between the building and the canal, somehow deviding reality from fantasy. Timber is both used on the interior and exterior and surely a strong focus is placed on local materials and workforce. Furthermore, the curved surface cladded in timber creates a story-like foyer, giving birth to an impressive appearance, as if the future experiences are to be witnessed within a living entity [22].

V. tectonic architecture

Tekton [gr. *tekton*] = a common term used for artisan/craftsman, in particular a carpenter or wood-worker or builder [23]

Definition

It is interesting to observe the reason for which the definition of tekton makes an exclusive reference to carpenters or wood-workers, without including, for example, metal workers. Although nowadays, tectonic architecture defined through the famous vitruvian triad *utilitas* (function, utility), *firmitas* (form, solidity, materiality) and *venustas* (beauty, delight, desire, aesthetics) and the equilibrium within, could refer to any *material* and the way it is assembled into an *aesthetic* and *useful* structure, the original definition of the word tectonic refers exclusively to timber as the material. Metal workers couldn't be called tektons because of the simple fact that they are not working directly with the raw material; this is at first liquified, almost melted and only afterwards handled and operated. The greek origin, ultimately, derives from the sanskrit *taksan* which means axe or broad ax, which consequently refers to timber as material. Researching on the etimology of the word, Frampton, in his *Studies in Tectonic cultures* adheres to the generic definition given by Adolf Heinrich Borbein in 1982: "Tectonics becomes the art of joinings" [24]. The word *art* refers here to the ability and skillfulness of assemblying and interlocking building parts or even objects that are, individually, works of art, "to the degree that usefulness has been achieved. Only to this extent does tectonic also involved judgement over art production" [24]. The fine line between art and science, between master builder and demiurge has always been debated within architecture. Even Frampton avoids such classifications, stating that architecture is nor art or science but a artisanal crafting, handcrafting, a direct body engagement with materiality [25].
Gottfried Semper in his 1851 *Four Elements of Architecture* also refers to tectonics when classifying the building crafts into two fundamental procedures: "the *tectonics* of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the *stereotomics* of earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heaviweight elements" [24]. Therefore a tectonic/stereotomic distinction has been made which correspondently refers to timber lighweight framework and heavyweight masonry.
Conclusively, without denying a possible tectonic character to any other material, original definitions and theoretical studies seem to support timber as the primordial material that could, through the art of joinery possesed by the *maker*, endow an edifice with a tectonic feature. Although with numerous ways of jointing, timber has a finite challenging character (length, thickness), but appropriate jointing could lead to a variety of purposes. It is thus the finite elements that are individual within themselves but they articulate the whole once they are assembled together. The pieces are defined within the whole and in relation to its scale and viceversa. This is where the articulations between the pieces become of significant importance corresponding, analogic speaking, to a verb in a sentence. Taken for example german language, the verb is placed at the end of the sentence. Altough in some cases, one can guess the verb due to the context, the suspense waiting for the addend of the sentence only makes the story better.

Details

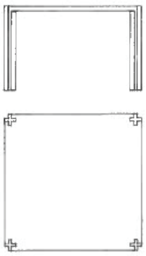
"Details are much more than subordinate elements; they can be regarded as the minimal units of signification in the architectural production of meanings." [26]. Furthermore, the maxim ascribed to Mies van der Rohe "*God lies in the details*" suggests not only that details contain the beauty and essence of the architectural meaning, but also that they, just as God, could be exhibit themselves in endless ways.

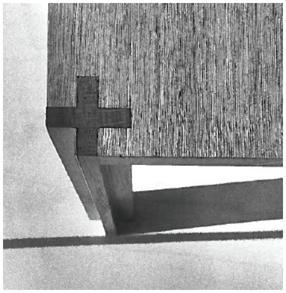
ill. 42

Blaser presents in his book *Joint Connection* a serie of different type of joints, stating that the idea behind its book is the aesthetics of simple objects that reveal their construction. Although he mostly refers to furniture in his theoretical exemplified study, the same concept applies to the architectural scale. The only difference between designing a house and a chair has to be the difference in scale, while their complexity is only defined by the level of detailing. Therefore, a chair can be more complex than a building. For that matter, Blasers' exemplifications and interpretations of timber joinery can surpass the furniture scale and simultanously reverberate over the architectural scale. Blaser also considers that the visibility of the joints is adding to the architectural intention, helping to integrate architecture and furniture into a total artistic expression, which should be the ultimate goal of *good* architecture. The structural honesty expressed through the exposure of joints contribute as an authentic gesture of craftsmanship, architectural expression but most of all gives identity to the process of production and perception. Carlo Scarpa also placed an emphasis on the joint in his book *The adoration of the joint,* where he considers the joint as a sort of tectonic gesture which brings the whole in its place. However, unlike Blaser, Scarpa refers to as a joint whatever represents an articulation, whether this is done between two pieces of material or it is merely a linking element between two different spaces. He is concerened with the joint as beeing the spot from where matter emerges and contours the architectural expression.

Following the concepts of the two theoreticians and the synthethis made on the definition of tectonics, the project, which has timber as the main material, will present a focus on ellaborating different types of jointing, articulating materials or spaces, that would add to the overall tectonic feature.

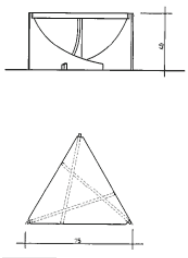
Werner Blaser

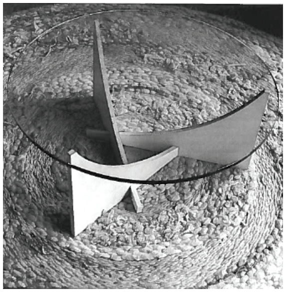




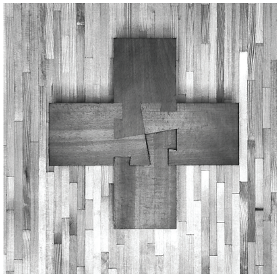
Leg of cruciform section

Finger joint with commponents of rectangular section

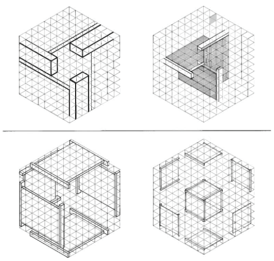


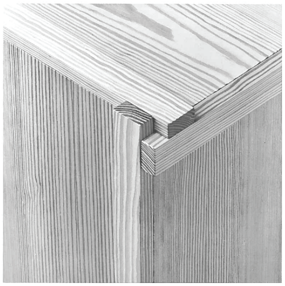


Interlocking system



Leg of cruciform section



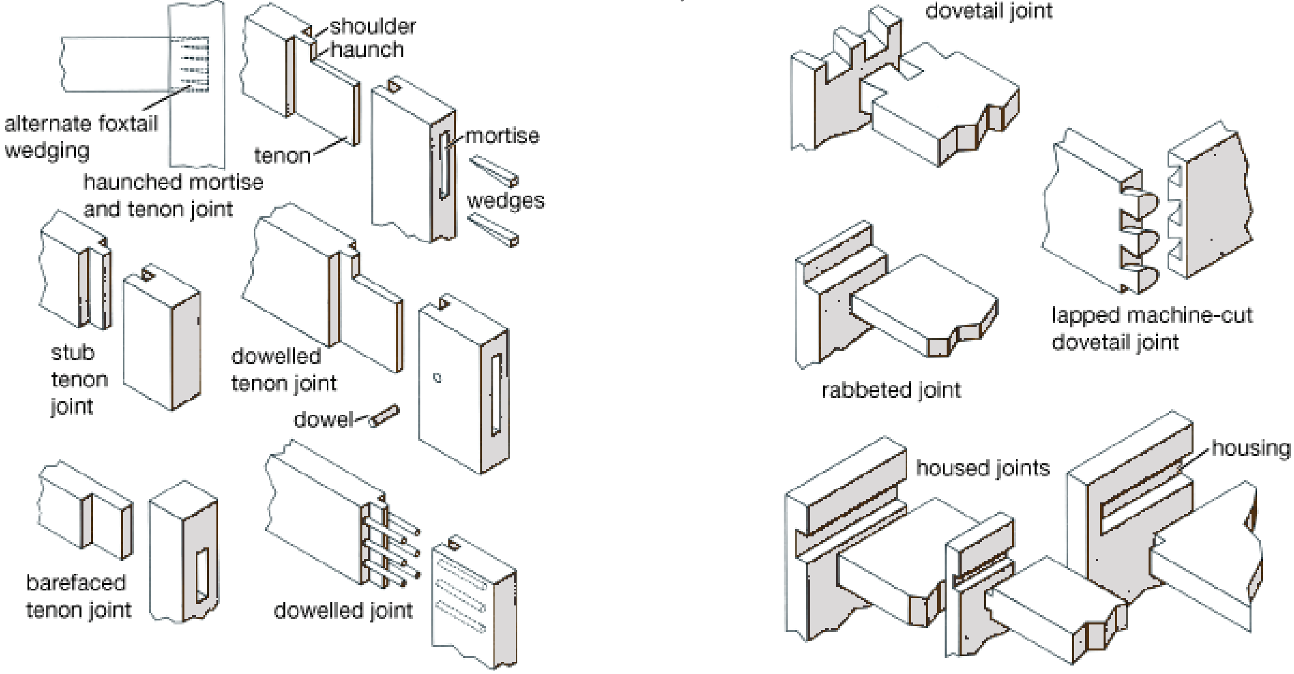


Plane with rail; fitting together of planes

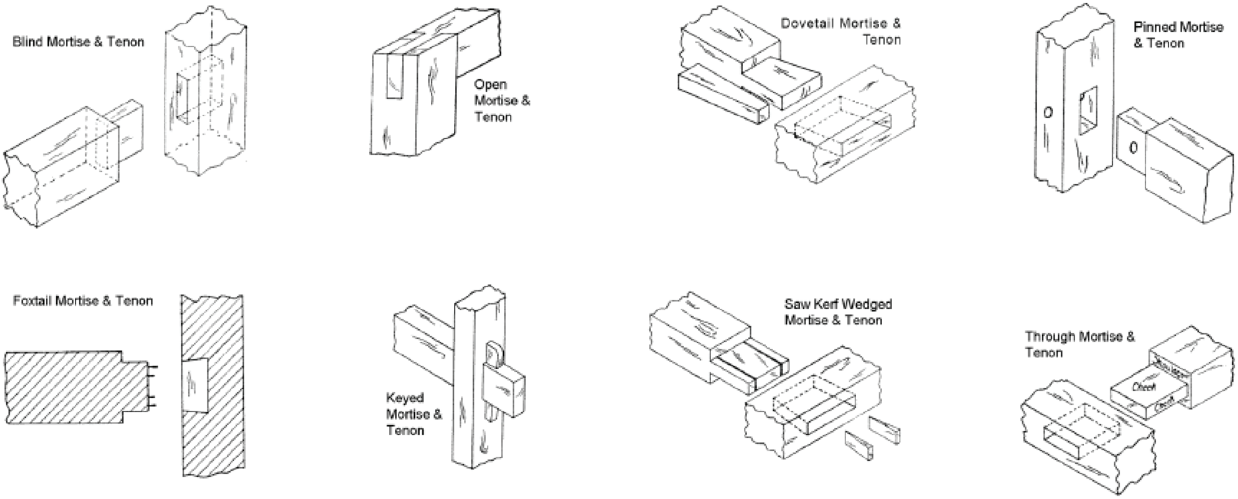
Dovetailed frames

ill. 43

Basic timber joints



ill. 44



V. nordic architecture

-- Sense of place/ Genius loci --

ill. 45

One feature which defines nordic architecture on a more phenomenological level is the idea behind the term sense of place, otherwise known as genius loci. Over the past centuries, the meaning of genius loci has changed. Originating from the classical Roman religion and being synonim to the protective spirit of a place, the term genius loci has evolved and applied in different art domains. However, in literature it often depicted a new aesthetic appreciation of landscapes that were exclusively garden or rural landscapes. As it evolved, the term could be currently applied to any landscape or any place, including urban ones.
One of the most complex studies over the concept of genius loci in architecture has been done by the norwegian architect and phenomenologist Christian Norberg-Schulz in his book called *Genius loci: towards a phenomenology of architecture. Norberg*-Schulz discusses the genius loci as a notion which defines the *"*sense people have of a place, understood as the sum of all physical as well as symbolic values in nature and the human environment" [27]. Schulz's theories are in strong connection with nature, as he considers that places and objects take meaning only in relation to nature, which represents the basis for people's interpretations. Therefore, essential in describing a genius loci, 2 of the thematic levels in Schulz theory refer to natural conditions - the topographical features of the earth's surface and the cosmological and temporal influences that refers to changes of light and vegetation throughout the year. In addition to these, the buildings which are reffered to as the physical form together with the symbolic meaning of a settlement define the society's cultural interpretation of place. The settlement (refered to as the dwelling) is the catalyzer which establishes the meaningful relation between the natural environment and people. And it is merely the meaning of things that gives identity. Otherwise put, it is architecture through which the attributes of the existing space are amplified or densified, thus making visible the genius loci. As Schulz concludes, the genius loci is *"place in nature that we have to interpret when we are changing our built environment"* [28].
In order to exemplify his theory in a more concrete manner Norberg-Schulz uses concepts as skogbotnen (the forest ground), himmelen (the sky), and synsranda (the optical array or panoptical view) as the generic elements used to describe *places.* These elements constantly and uniquely interact thus creating a vertical qualitative axis (up-down, ground-sky) which contributes to the empirical aspect of the space - what we walk on (earth), what is above us (sky) and what is around us (the surroundings). The surroundings can be seen as the limit of our field of view, a visual but also conceptual boundary. Following Heideggers' theories, which Norberg-Schulz uses as a basis in his study (idea of space, of dwelling, etc.) the surrounding environment represents the boundary which enables the existence of genius loci. ("A boundary is that at which something begins its existence").

Not coincidentally, Norberg-Schulz uses the example of a norwegian forest to better illustrate his theory. With wide topographic variations, the optical array is represented by trees that offer short glimpses to the sky. The topography seldomly changes dramatically, as norwegian landscape is extremly various, while light becomes a luxury during winter and an abundance during summer. When it comes to the traditional norwegian settlement, since Norway has no urban tradition Norberg-Schulz depicts "a cave of trees" (the log hut) placed in an open space that contrasts with the dense forests behind, alongside a river or behind a hill. It is within norwegian culture to incorporate strong warm colors in their interior that remind them of the short summers (red, yellow, blue, green) often next to flower motifs. And since daylight is a luxury on an annual basis, the preferred orientation of the windows is towards south or south-west in order to receive the mid-day and afternoon sun when the weather allows for it.

On a more contemporary and realistic note, *"place character, place structure, and place order are shaped through social, economic, and political processes."* However, *"these spatial properties have an impact on human feelings, attitudes, and actions. According to Norberg-Schulz, a phenomenological approach to place involves an understanding of local and cultural context"* [29].

Norwegian architecture is therefore strongly centered around its landscape, sense of identity and place, around its cultural values and nonetheless, around its light. The final design proposal aims to reach an equilibrium between traditional theoretical approaches, contemporary social and cultural demands and economical requirements.

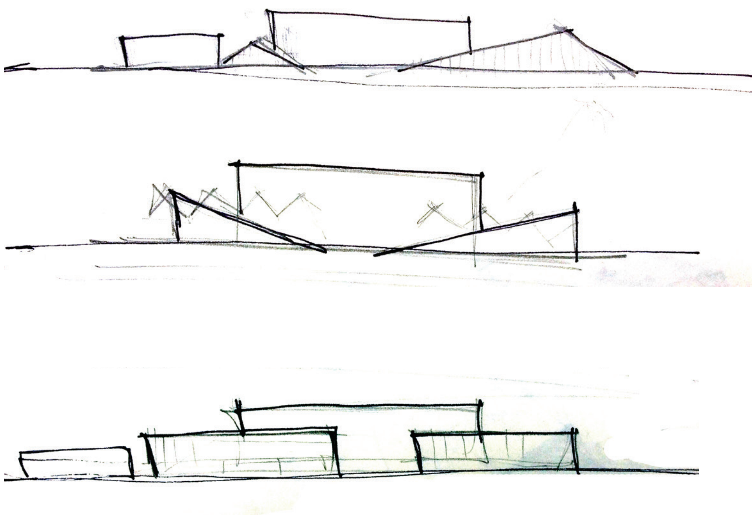
ill. 46

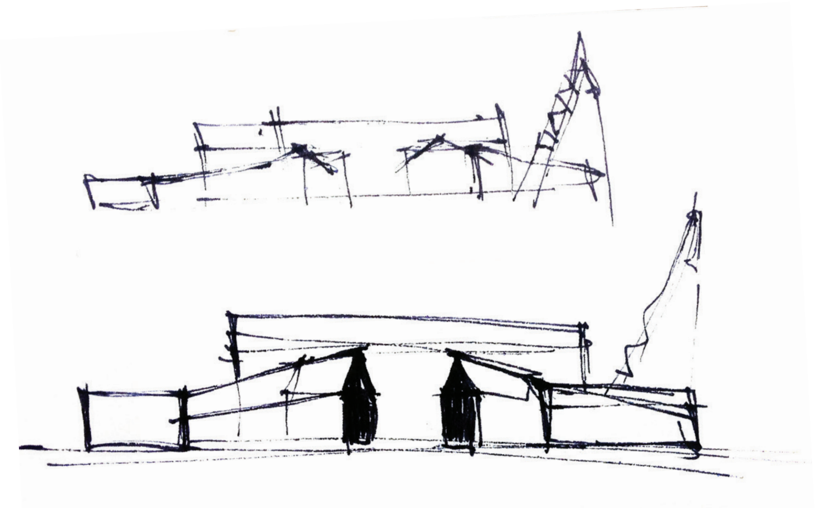
Contemporary themes in norwegian architecture [30]:

Growing public and private affluence	Buildings have a wider range of purpose, and are expected to meet increasingly complex demands. For example Opera House in Oslo designed by Snøhetta illustrates the desire to create a vibrant cultural centre.
Aesthetics as a factor of well-being	From the early austere principle that form should strictly follow function, there is a growing sensibility that aesthetics affect the physical and emotional health of those who use a building or structure. Norwegian laws concerning occupational health have for several decades emphasized access to daylight and fresh air, and it may also be that harsh climatic conditions create an added imperative for uplifting aesthetics.
Environmental concerns	In addition to concerns about air and water pollution, Norwegian architectural design has also emphasized integration with the natural landscape. More recently, architects have also worked with engineers to make the most out of scarce resources, e.g., energy, water, etc.
Demographic diversity.	Norwegian demographics have undergone significant changes the last few decades, resulting in new religious buildings
Norwegian building traditions	While it may be too much to speak of a renaissance in traditional Norwegian architecture, more and more urban planning is affected by the need to preserve or restore these traditions. Examples include plans to renew the center of Oppdal and recent work at the Oslo neighborhood of Grünerløkka.

[redacted]

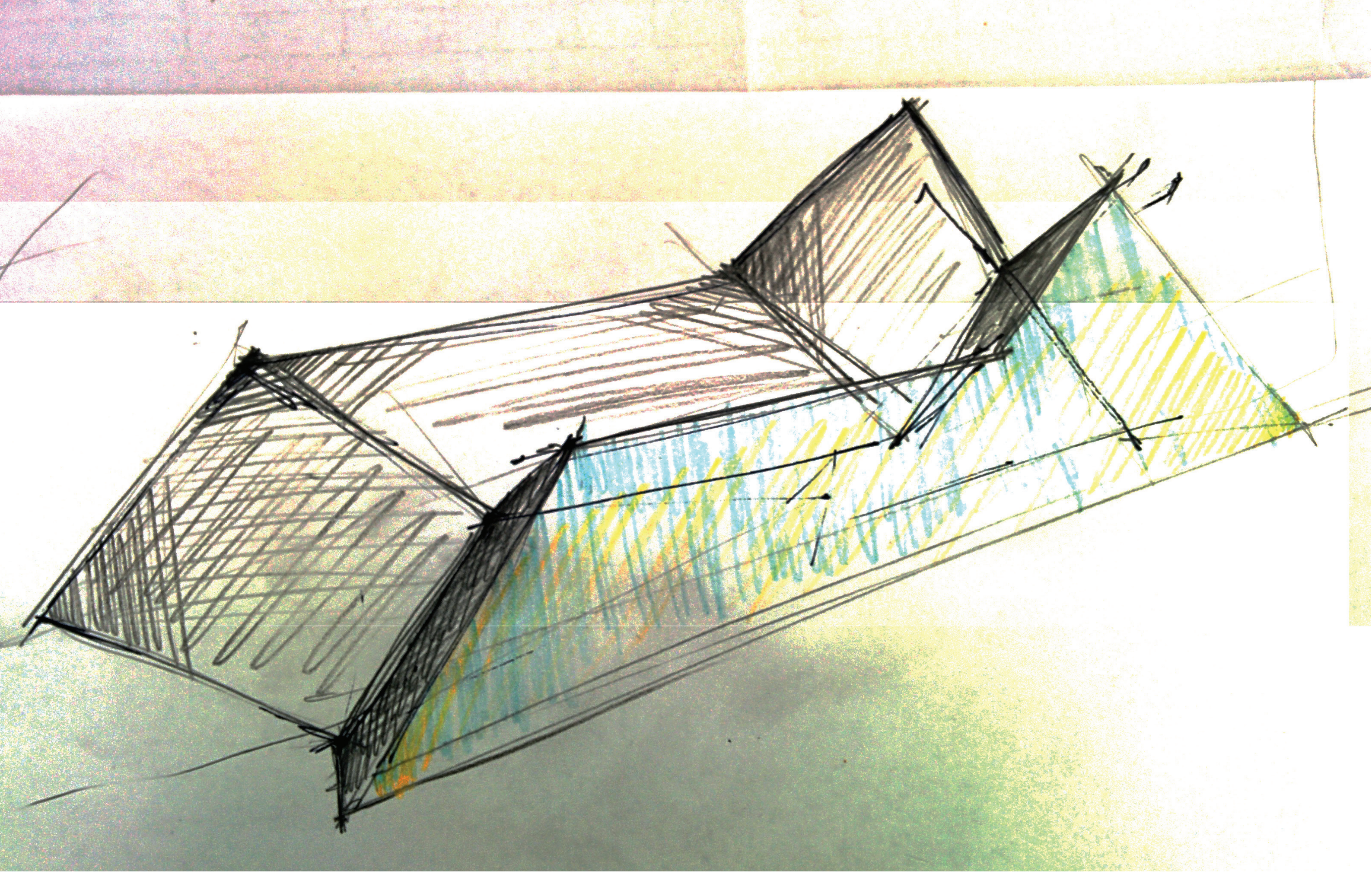
VI. design process

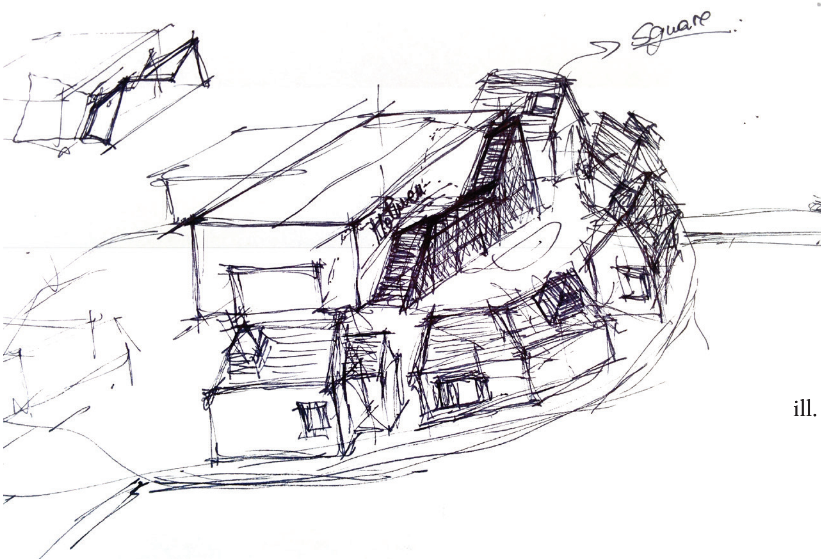




ill. 47

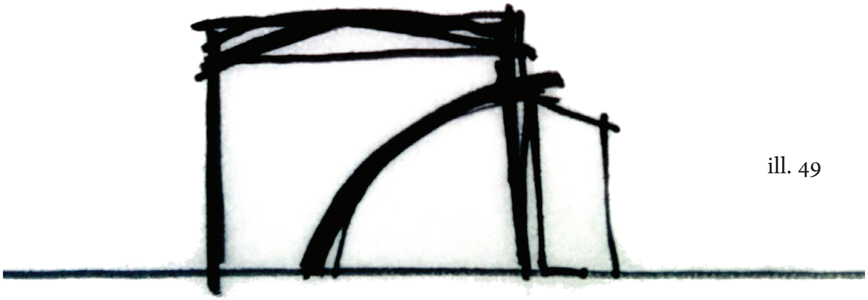
The point of departure for the design process focused on a formal expression which could connect the cultural center to the surrounding architectural context but also relate it to the existing construction on the site (the shipyard). However, demolition of the surrounding buildings is required, whilst Fiskemontakket and the shipyard are the only remaining buildings from the existing site constructions. The shipyard as a reminder of traditions, history and lastely, but not least, culture and the Fiskemontakket as a statment of a more 'un-orthodox' architecture which might begin its existance in the old city of Risør.
The architectural program previously outlined envisions one singular building which compacts all the facilities and functions and sums up to aprox 3500 sqm. This however, given a height level of one floor, in order not to obstruct views towards the shipyard and the fjord, would end up having the biggest footprint compared to the city centre which is characterized with small and dense houses. Moreover, since one of the initial goals of the project was to re-design an island and transform it into a continuation or an alternative of the city centre, a very first design parameter has been established - visual connections from the city centre towards the island had to be ensured. In terms of formal expression of the buildings, simplist approaches have been tried out, such as formal references to double-pitched norwegian houses which simultanously refer to the primordial huts and the triangular structure.
Thus, the initial designs regarding the masterplan and the placement of the buildings went from one massive 3500 sqm building to several smaller divided elements which alltogether are part of the one unity (fig. - diagram).





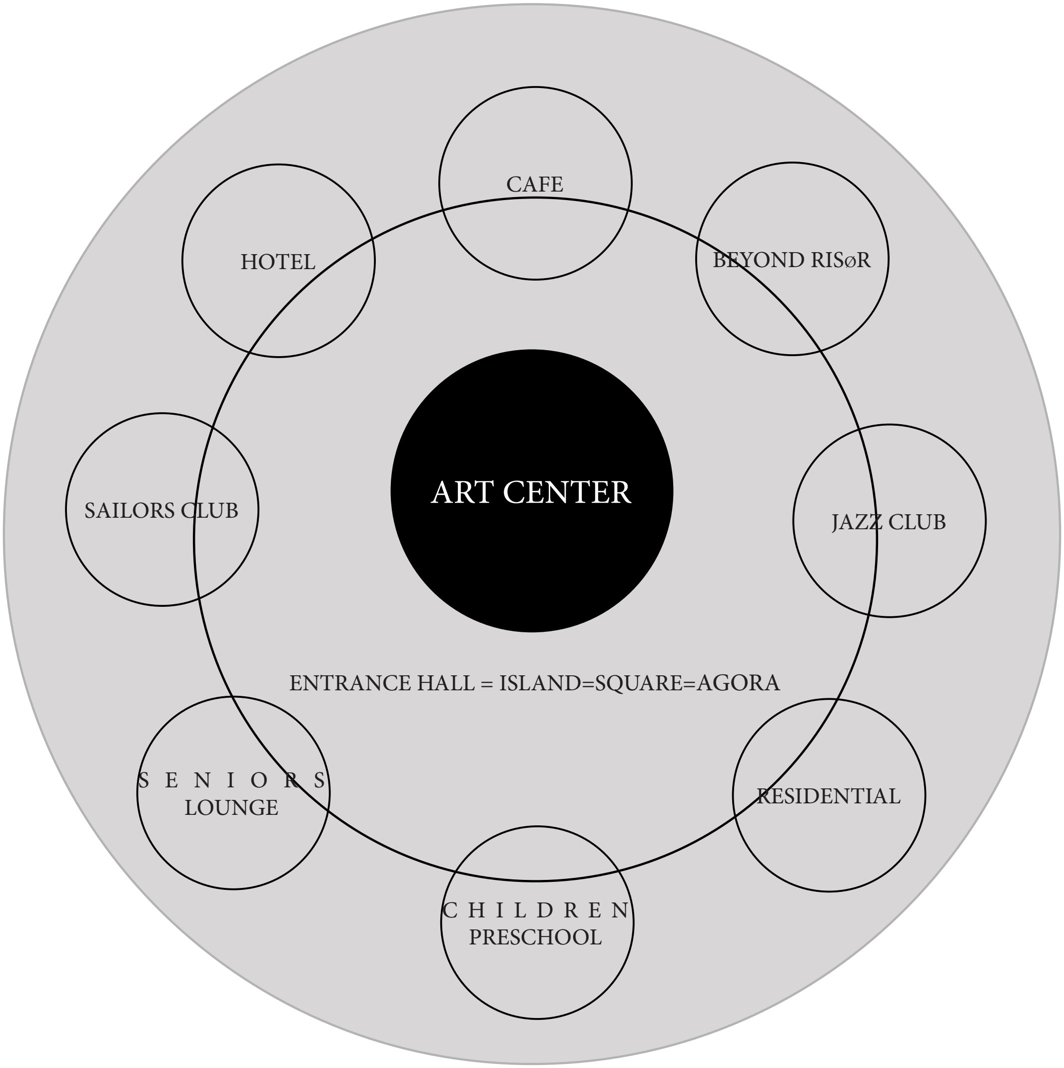
ill. 48

community within community.



ill. 49

The island always had a character of itself. Its vast history took it from being the fortress of the city to a symbol of traditions and industry. Simultaneously, the city of Risør and especially its centre has always been characterised with a strong sense of community. In order to keep the islands' 'different' character and respect the values of the city, the intetion reaches for establishing a new community within an existing one.



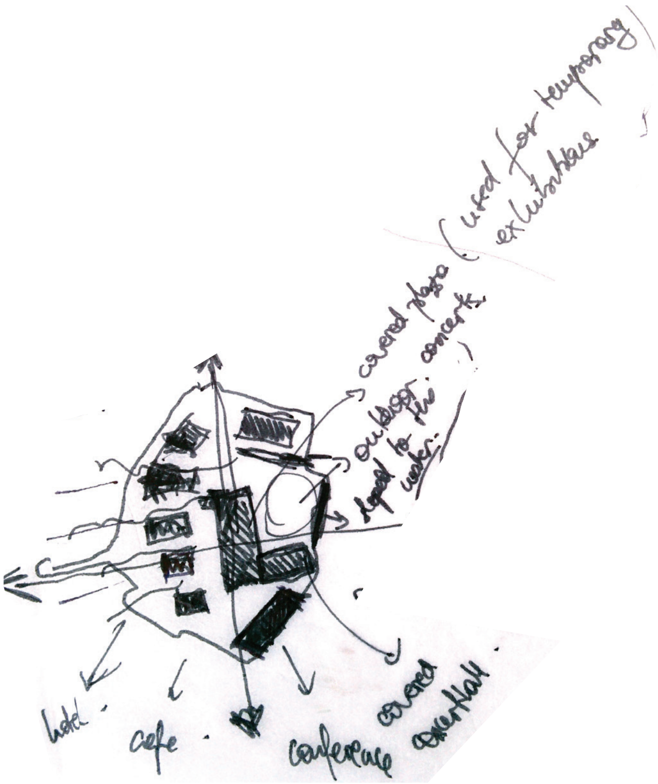
ill. 50

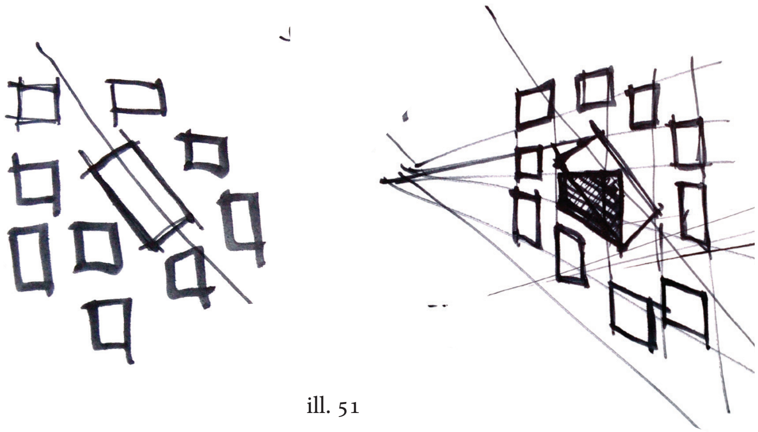
PROGRAM DIAGRAM AFTER INITIAL DESIGN CONSIDERATIONS

public space as a space of everybody not a space of nobody.

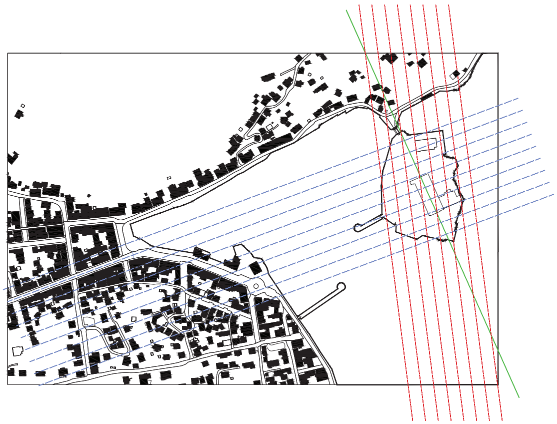
The public space has been always defined as a space for gathering and social interaction. If adequately designed, it is able to support and enhance public life, thus community life. A square, the greek agora - is defined as a gathering place, as an assembly. This architectural element, however usual and habitual, supports the articulation and connection of urban spaces, and furthermore of individuals.
Although taking into consideration climatic conditions in the given site, during winter Risør becomes a ghost town and the temporal restrictions for using a public space could be massive given these considerations. However, because of these natural imposed limitations, the public spaces are explored to maximum, should the weather conditions allow it.

The sketching process portrays different attemps to organize and display the elements of the island, with a strong focus in creating visual connections and outdoor spaces which could attrack people and be used as squares/gathering points and become a continuation of the centre and spaces for manifestations of cultural events. Possible main axis have been identified as guiding ones for organizing the island, such as the orientation of the shipyard or the orientation of Fiskemontakket. Lines of sight from different focus points in the city centre have been drawn in the attempt to find the best arrangement in order to secure a strong visual connection to the island.

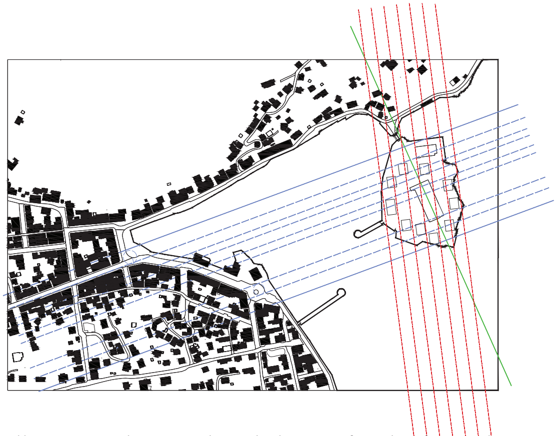




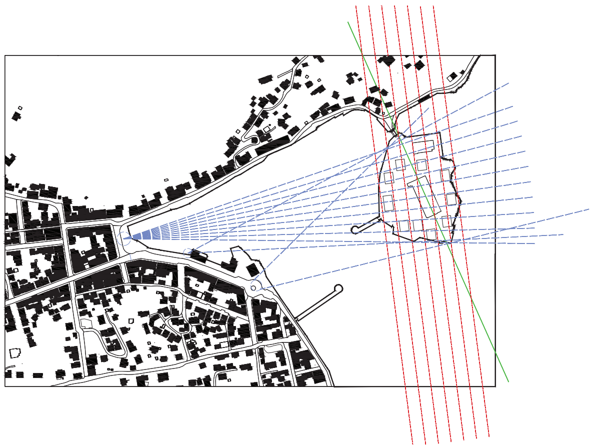
ill. 51



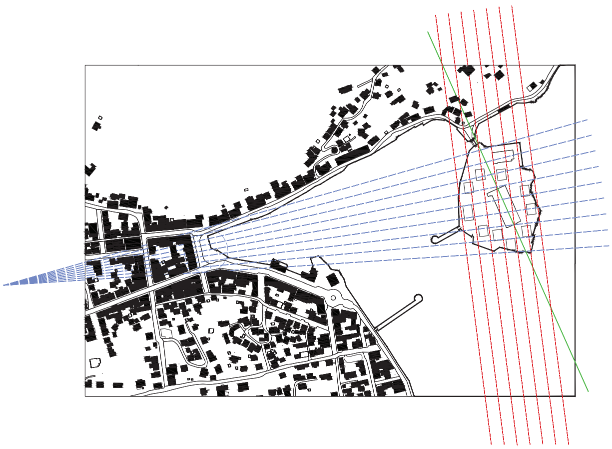
ill52.1. Grid created with dense lines of sight from the main street arranged paralel - difficulty in finding a reference point



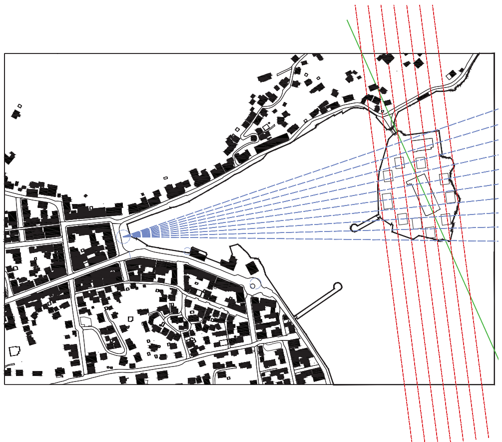
ill52.2. Grid created with lines of sight from the main street arranged paralel, focused on important spots - difficulty in finding a reference point



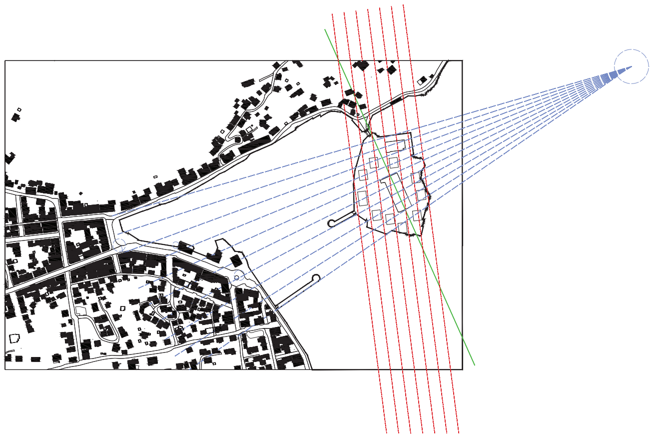
ill52.5. Grid created with lines of sight that have one main starting point and a few more from important sight spots - confusion, difficulty in reading the space



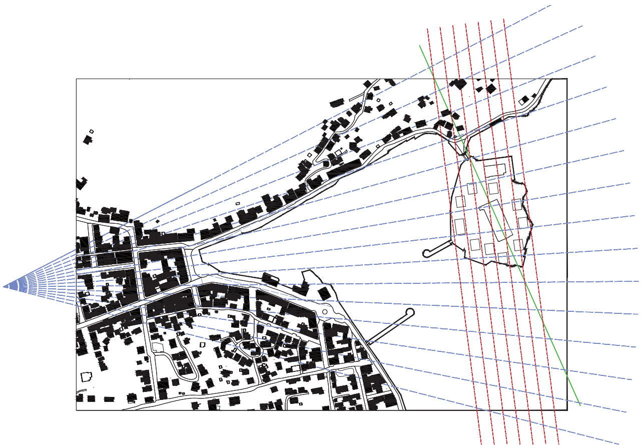
ill52.6. Grid created with lines of sight that have one main starting point in the distance and allows for different sights from the centre area - more spots for reading the space



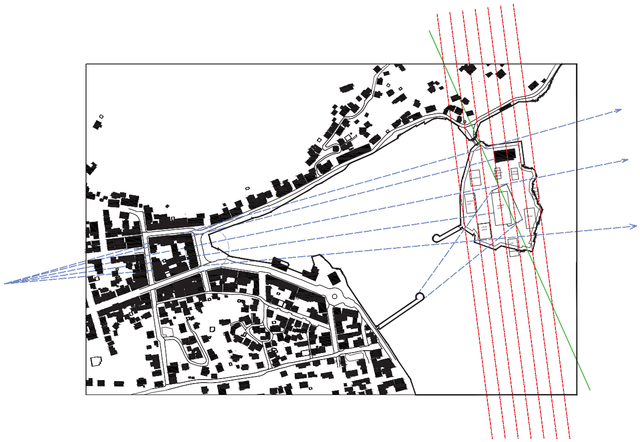
ill52.3. Grid created lines of sight that have one single starting point - good visibility from one point only



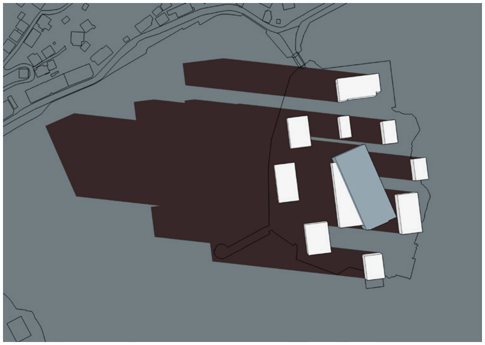
ill52.4. Grid created lines of sight that have one single ending point in the far distance - difficulty in finding a reference point

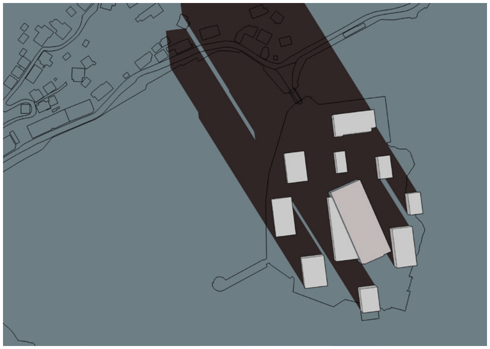


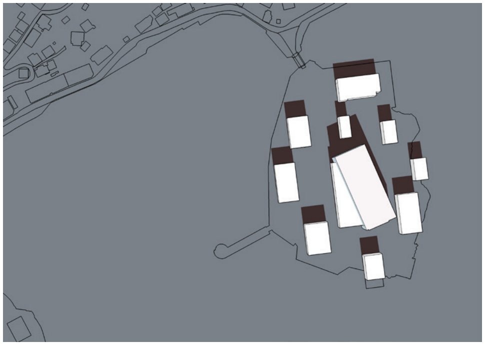
ill52.7. A wider array of the previous case - more spots for reading the space, however the sight lines don't all reach the island.

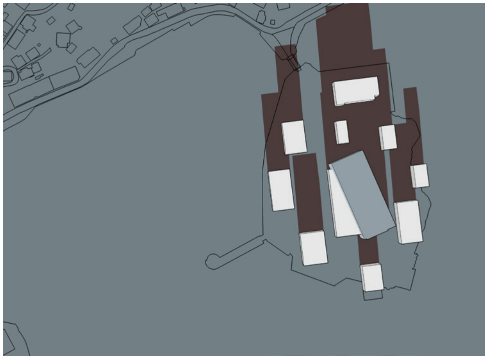


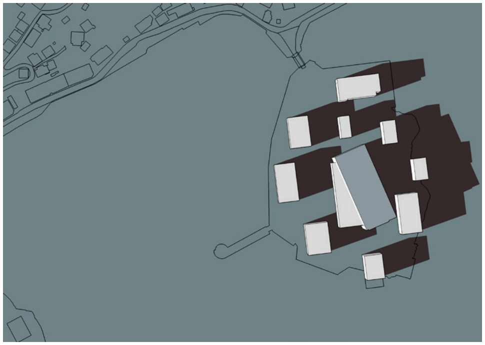
ill52.8. Final grid with lines of sight that allow perceptions from more points in the city centre. Some can go through and some can visualize the limits of buildings which helps with the perception of space

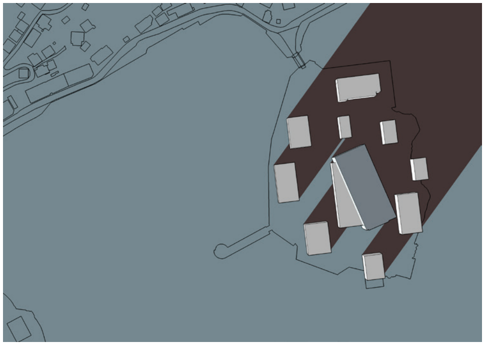

ill53.1 20 march 0700h

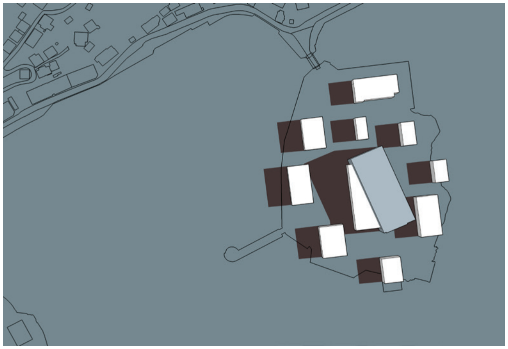

ill53.4 21 dec 1000h


ill53.2 20 march 1200h

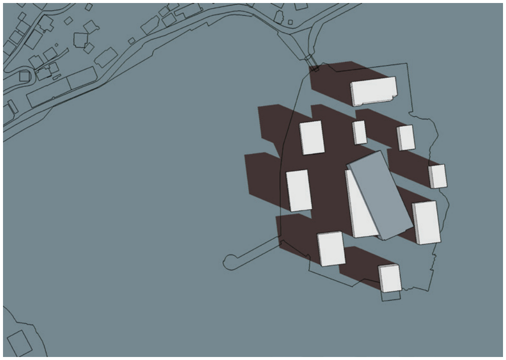

ill53.5 20 march 1200h


ill53.3 20 march 1500h


ill53.6 20 march 1500h



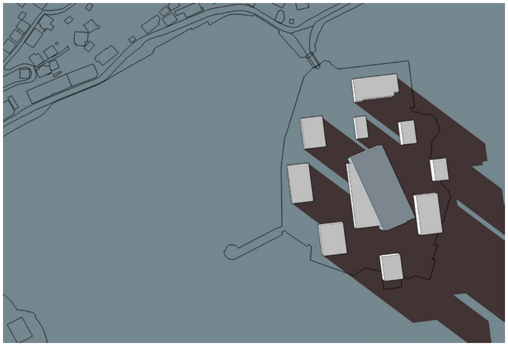
ill53.7 21 june 0800h



ill53.10 23 sept 0800h

ill53.8 21 june 1200h

ill53.11 23 sept 1200h

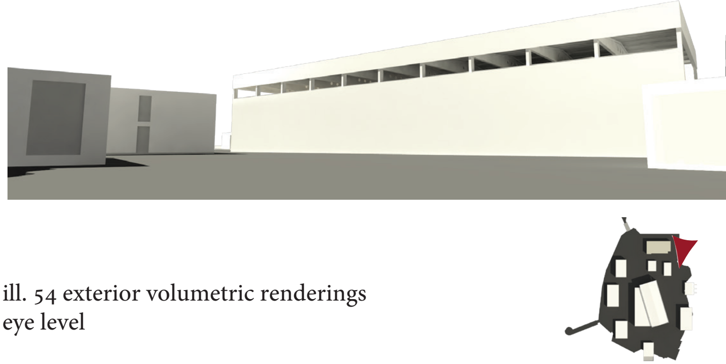


ill53.9 21 june 2030h

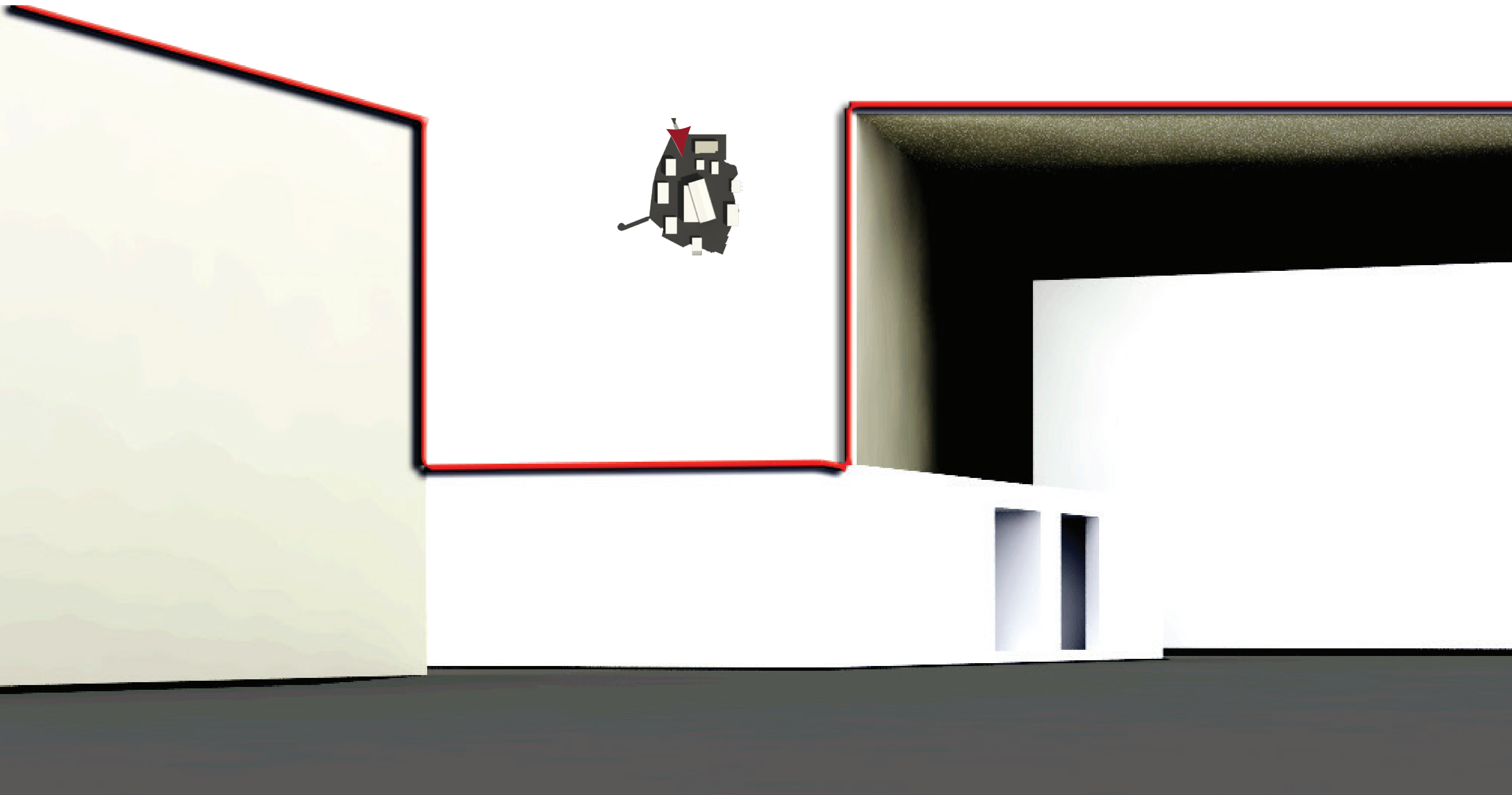
ill53.12 23 sept 1800h

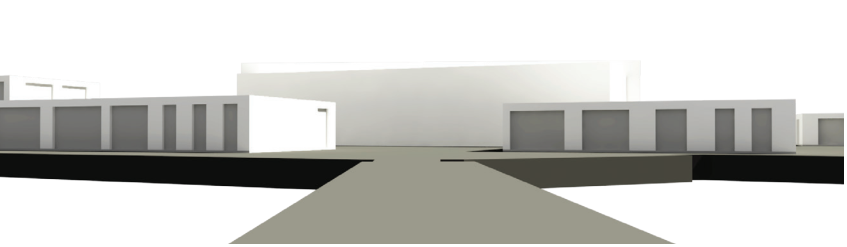
DIRECTIONS OF SIGHT

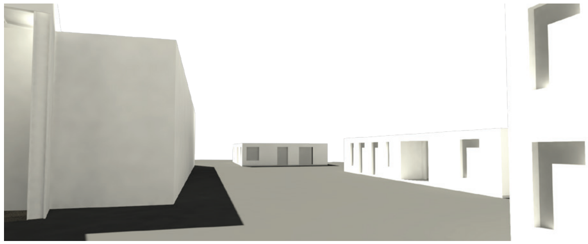
Since the island has been approach as one entity, a closer study has been done in order to visualize the 3 dimensional space on the island, from important points as one approaches it. The studies have been done in order to observe the dynamics of spaces between the volumetry of the buildings and their potential in becoming used as public spaces. The way they open up and their different character are important for defining possible different activities which might take place but also for directioning individuals into exploring further the island. No matter how easy to read it would be from the city centre, the feeling and views inside the island change and thus create the new community.

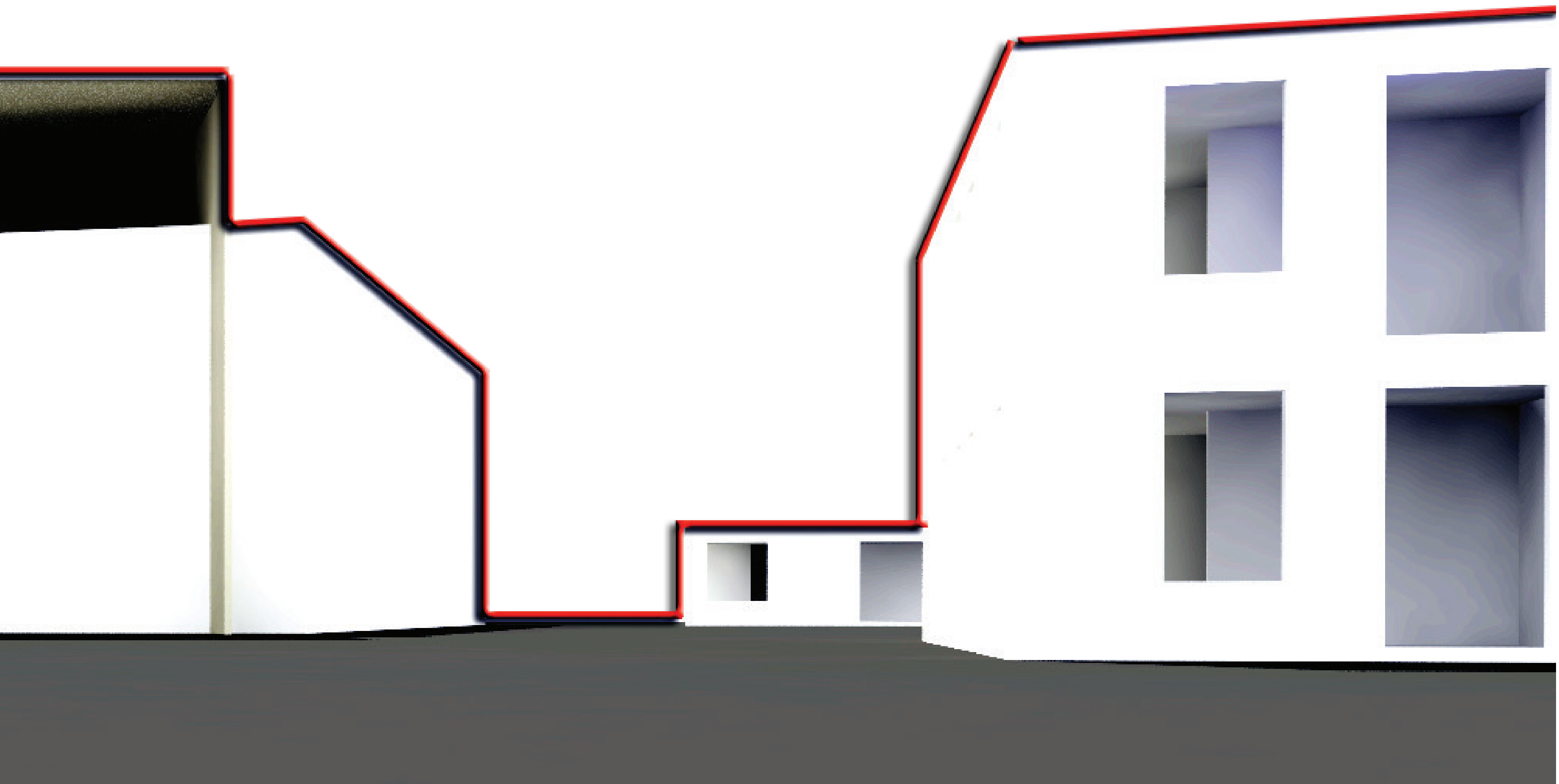


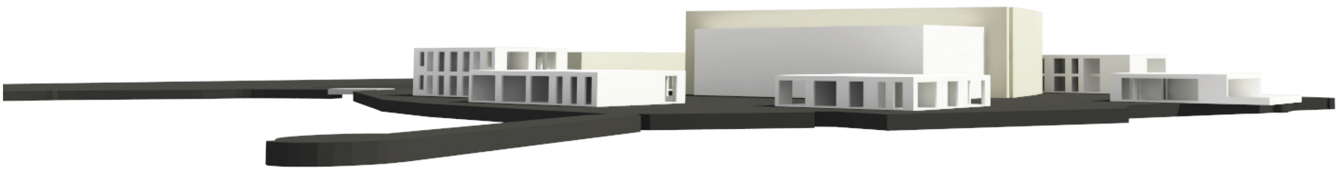
ill. 54 exterior volumetric renderings eye level



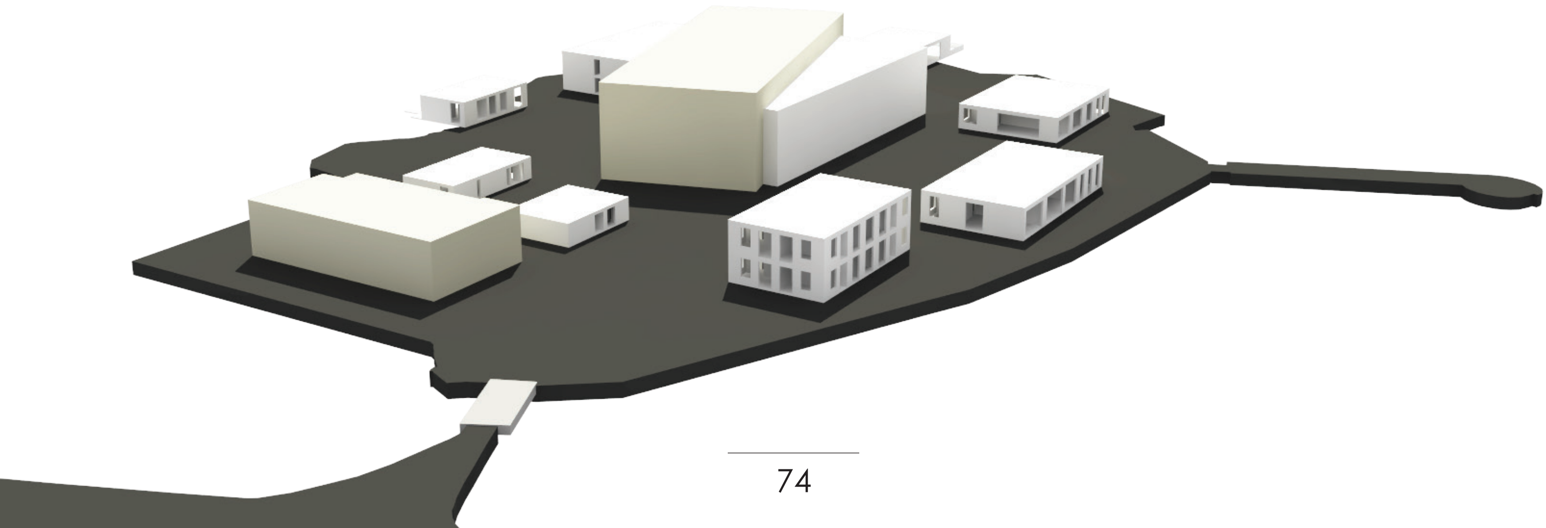




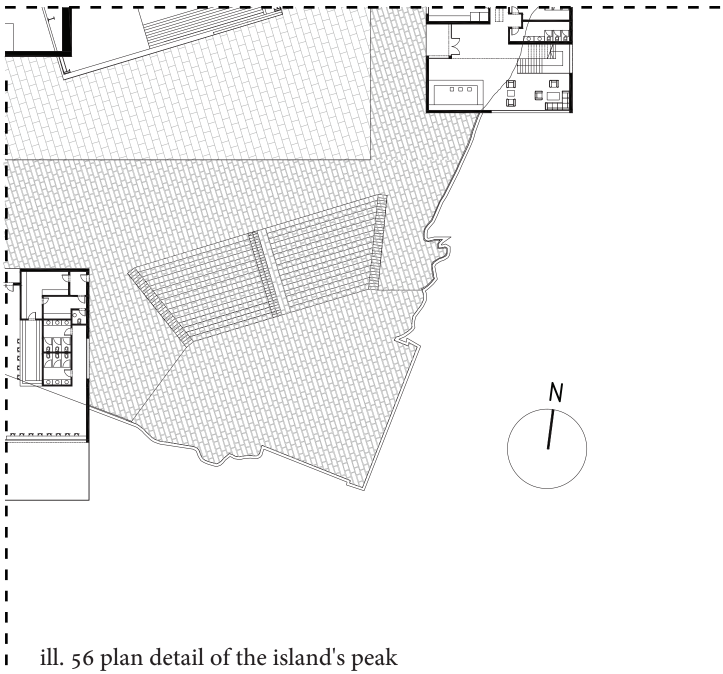




ill. 55 exterior volumetric renderings
eyelevel and birdseye view



SLOPE



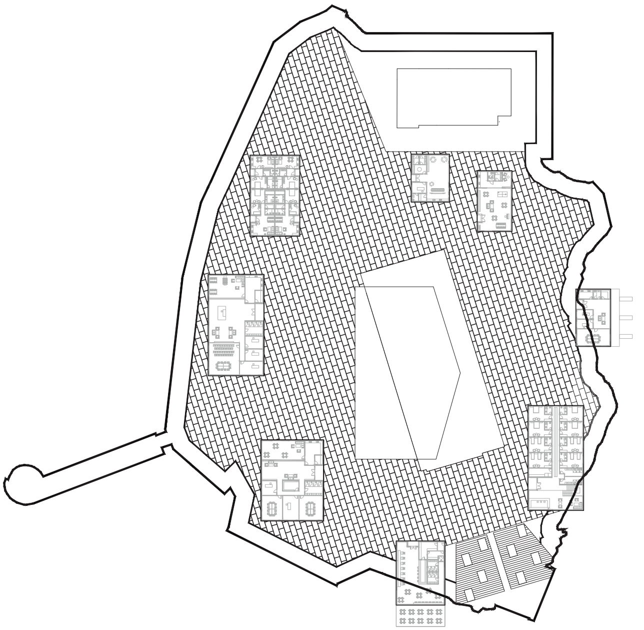
ill. 56 plan detail of the island's peak

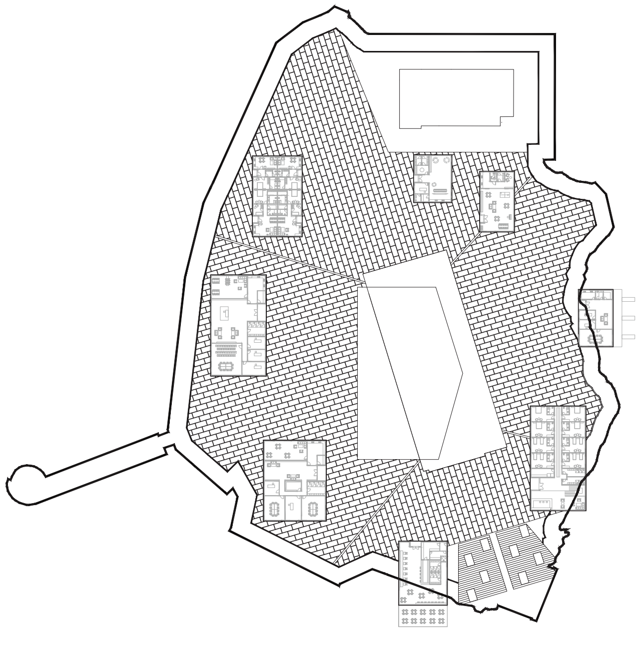
The sun study revealed some spaces with great potential for different times of the day. The functions have been placed taking into account light conditions, thus the cafe has been placed at the end of the island, together with a floating island where it can be direct sunlight throughout the whole day. Thogether with the view towards the fjord it gives the location positive attributes for attracting people, customers of visitors. However, beside the cafe, at the very peak of the island, another good location could be offered in terms of sunlight and view. Moreover, one of the outdoor spaces to be provided through the new design has to be destined to held outdoor concerts or movie projections. Consequently, the peak of the island becomes a small amphitheatre, which could be used with different purposes. A sightseeing point, and concert, speech, movie projection, etc.
However, this requires an elevation from the existing level of the island, thus needing to re-model the terrain which becomes sloped as one approaches the amphitheater, and then goes down again with 50 cm above sea level. Given the climatic studies, however, the "stage" of the amphitheatre might ocassionally be under the water because of the sea level rise or tide, which changes the chacter of the space

ill. 57 island section

The pavement stone blocks are orientated in the same directin as the shipyard, and the main axis of the island given by it.

The pavement devides the island into 4 spaces, orientated accordingly - this creates a hierarchy and delimitation between the spaces.

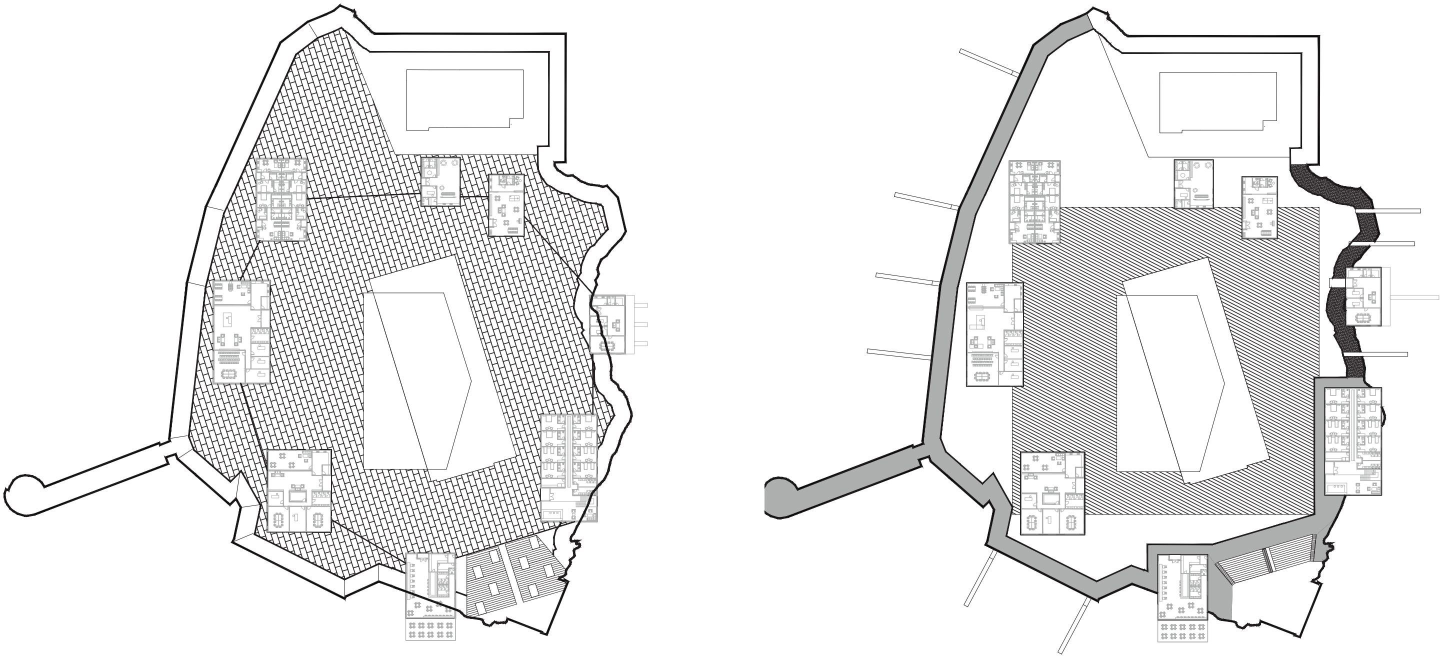




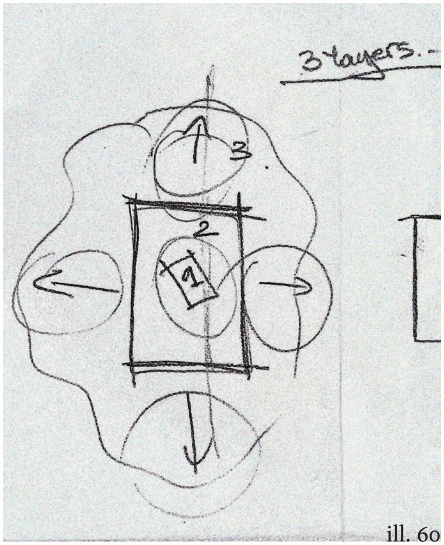
ill. 58 site plans - pavement studies

A delimitation at the pavement level surrounding around the main construction on the site which, it creates once again delimitation and hierarchy.

A delimitation in the same orientation as the new buildings on the site but belonging to the main building - connects the main building with the other ones and creates various spaces outside of it. The variety, in the final masterplan will be ensured by the 3 dimensional space, the pavement however, being the same all around outside the delimitation.

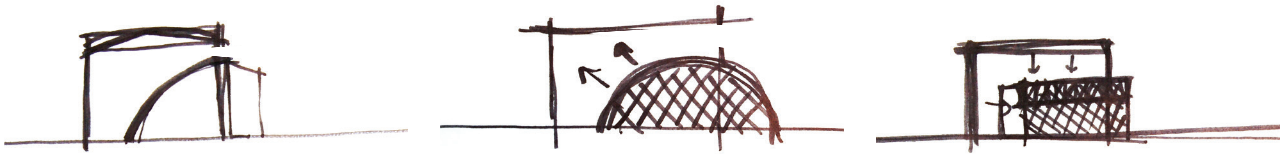


ill. 59 site plans - pavement studies



ill. 60

As previously portrayed in the new architectural diagram, the existance of 3 different spaces (layers) can be observed - outdoor, indoor and inbetween. The interaction between these 3 spaces have important results within their own definition. The inbetween the buildings becomes the outdoor and vice-versa. The existing shipyard has an indoor which related to the cultural center becomes an outdoor but at the same time an inbetween the cultural center and the square. The potential and the beauty of these converting spaces is that in the end they are only defined by human activities, thus creating an architecture subordonated to human needs. The different character of the spaces are difined simultaneously by the horizontal plane and the vertical one

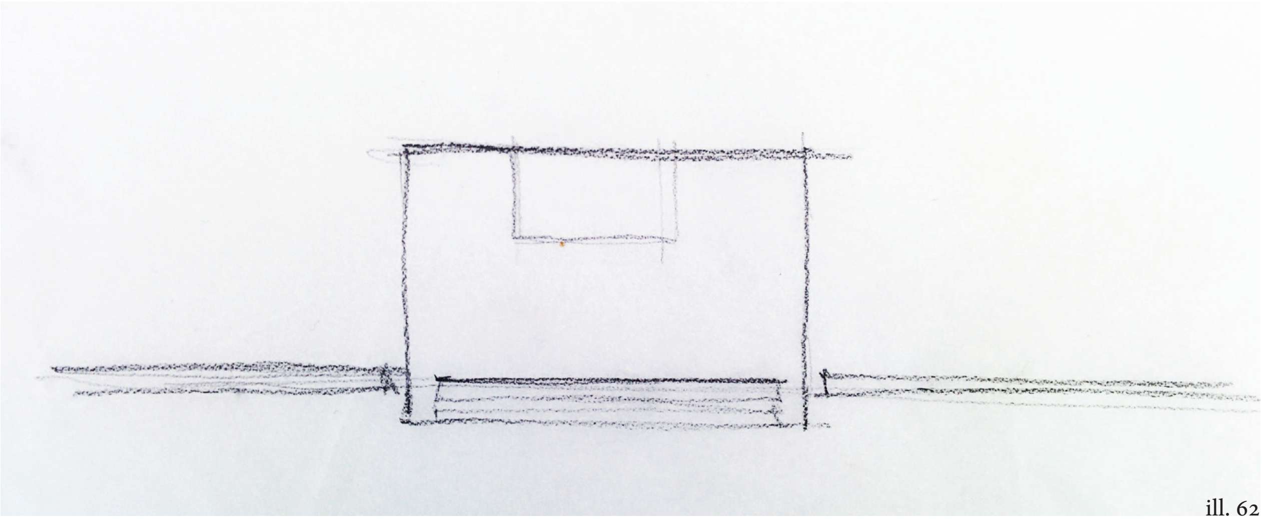


ill. 61 - shape relationships

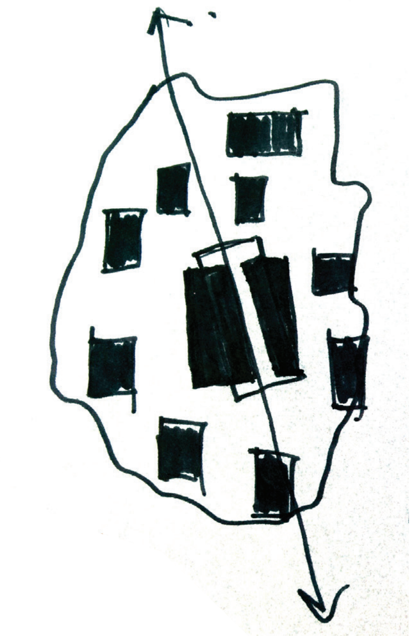
CONTEXT .NEW - OLD. PRESENT - PAST.GENIUS LOCI

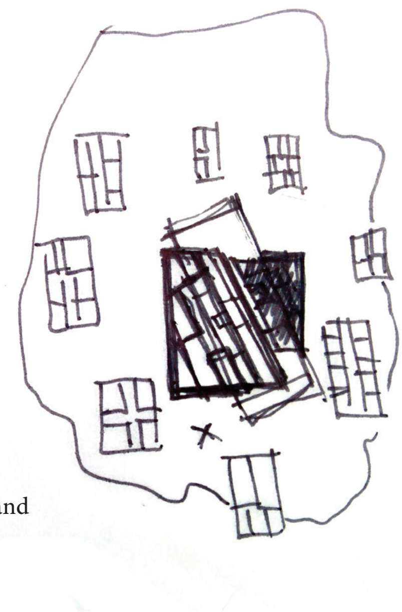
The idea of insertion of one new community within an existing one is taken further in the approach towards the new main building on the island and the existing one (the shipyard.) The preservation of the shipyard not only allows for a statment of traditions and history but also helps in taking further the design concept in the same direction. A community within community is created, a space within a space, a building within a building. Thus, the shipyard becomes the skin within which the new building starts to exist. On a more heideggerian note, the shipyard becomes the boundary at which something begins its existance. Moreover, by creating a strong physical connection through a symbolic one the idea of sense of place begins its existance as well, taking into consideration Norberg-Schulz' desfinition. Besides the classical old-new contrast and respectful intervention on an existing building, the idea of keeping and interacting with the shipyard creates the possibility for multiple ways of interacting with the spaces within and around it. It has a continuation and a reverberation effect on the whole island-square, it becomes an active remembrance. Concretely, the level of the shipyard is to be kept the same as a symbolic gesture of its belonging and as a detail that supports the testimony of the shipyard. The surrounding square and new community comes as an undisturbing addition to the existing element.

After considering different volumes for the new building to intersect the shipyard, a subordonation of formal expression has been taken into consideration, by choosing a rectangular volume for the new construction. This supports at the same time the idea of creating a new context, in the same way as the existing context has been created - small timber houses, very similar in shape and identical in color. In the same way as the convservation plan is set to keep the unity, integrity and character of the city centre, a coherent unity of its own can be kept on the island by using the shipyard as guideline for architectural development, however maintaining an interest point through the new-old contrast created. The present shall be new, with no copies or replicas of the past, whereas the past is portrayed as an evidence that it created the present.
Furthermore, the new context and the buildings within it are kept at a lower height all together compared to the shipyard which will remain being the biggest construction in the city centre. However, hollow, the shipyard has a strong character also given by its material which is unusual for the city centre - metal. In terms of strength, metal (steel) is stronger than timber and able to create impressive span, therefore, it is only natural that its structure keeps standing. It is the one determining the main axis of the island and thus the directioning of the pavement of the platform around it, which consequently is conceived in order to belong to the shipyard. The explanation of the approach, however, it can be simplified by merely stating that the shipyard remains the main actor of the past which sets the scene of the present.



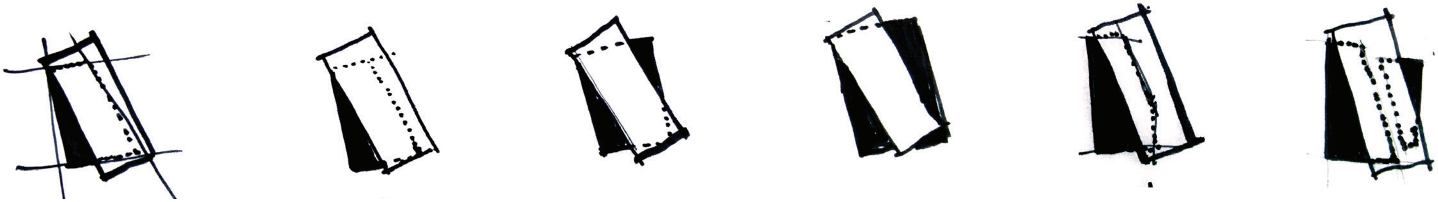
ill. 62



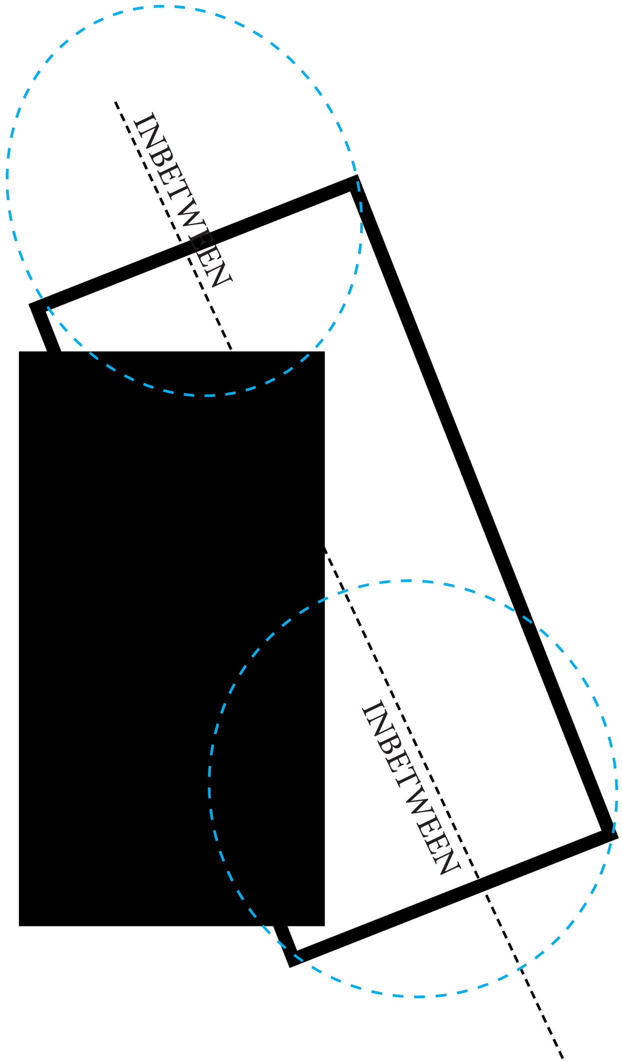


ill. 63 possible relation between the new building and the site

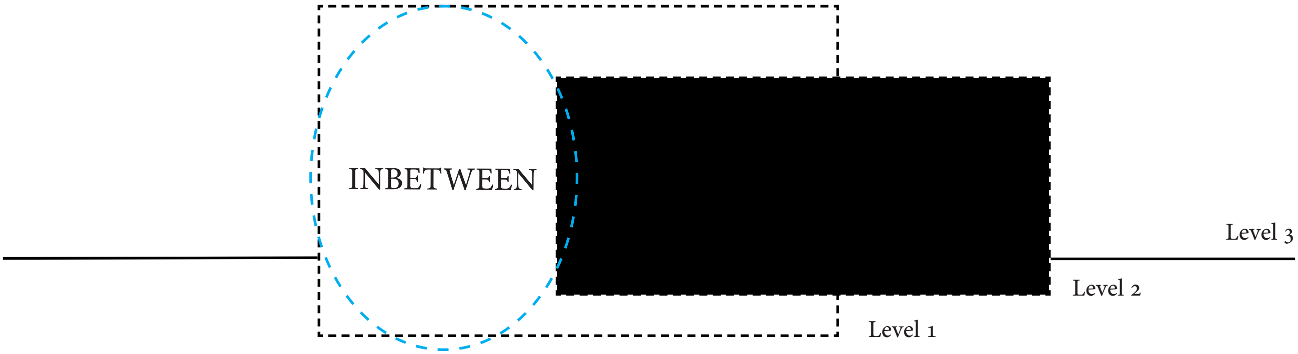
Different options for formally translating the importance of the shipyard in connection to the new building. The shipyard is the one that has the different orientation compared to the new buildings and also creates the main axis of the island. The way the shipyard can dictate the placement and arrangement of the new building can be shown in several ways (the orientation of the interior walls or of the external ones could follow the orientation of the shipyard).However, the final result came after a simplification and reaching out for, yet again, a rectangular simple plan, with its own spatial configuration that enables experiences related to the already stated approach.



ill. 64 different layouts for the new building

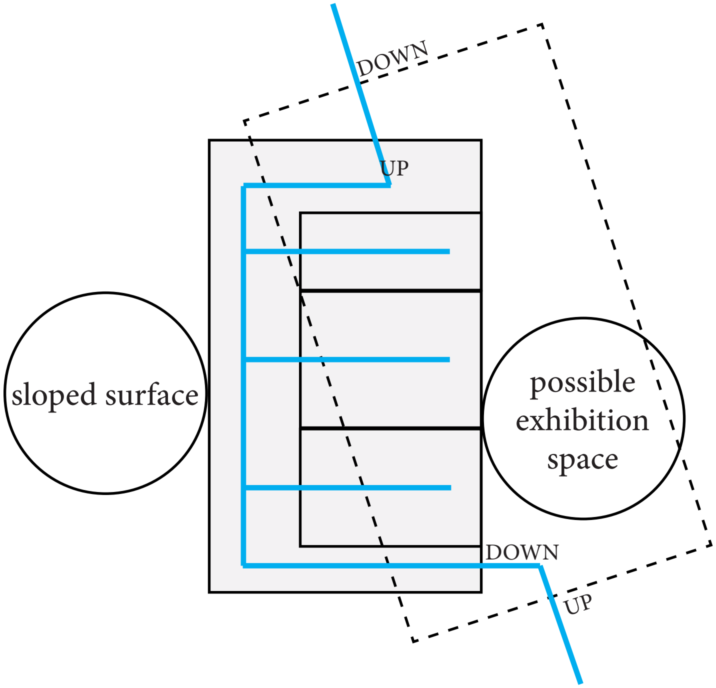


ill. 65



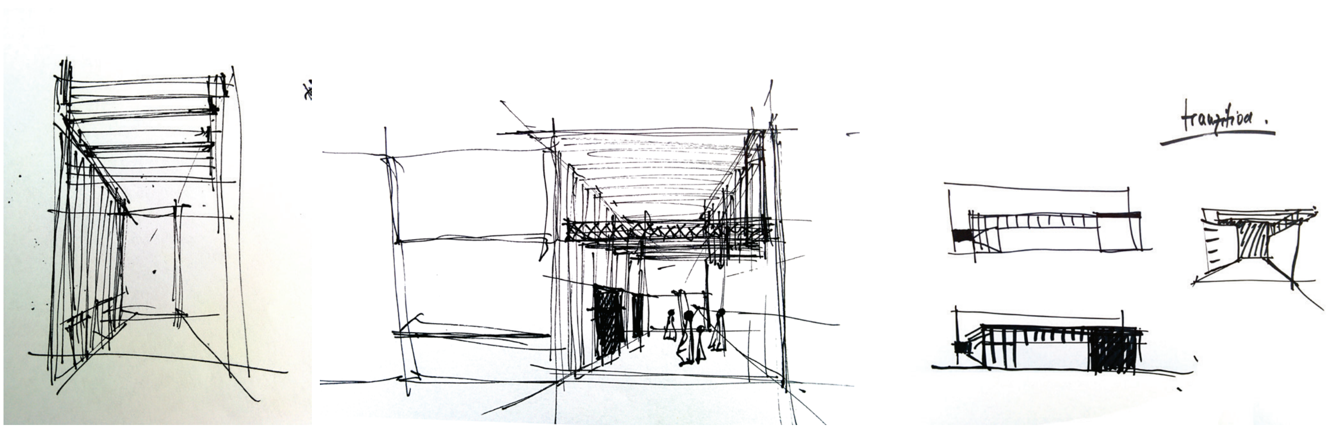
ill. 66

Regarding the level of placement for the new building, this represents the second intermediate level between the existing one (of the shipyard) and the level of the new surrounding and sloped platform.



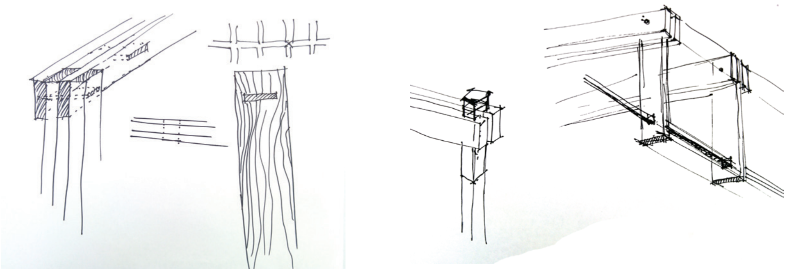
ill. 67

Since the division of the architectural program has been done in the beginning of the design process, thus resulting into several more buildings, the main one, which intersects the shipyard results in hosting only and exhibition hall and the concert hall. The internal distribution of spaces has been done in order to experience the different spaces created *inbetween*. The intentional gesture of placing the entrance in a way that people have to first experience the shipyard then enter indoor is triggering the interior circuit. People/ Visitors have to turn around in order to enter the foyer which gives a visual connection to the outdoors (the square around and the city centre). The difference between the sloped surface in the square and the lower level of the building raises a better spatial awarness. Furthermore and then they would have to turn around once more in order to re-enter the designated spaces so that finally, the exit could be done once again through the other end of the shipyard. However, several exits can be assured, thus creating the possibility of using the actual shipyard as a possible exhibition space.

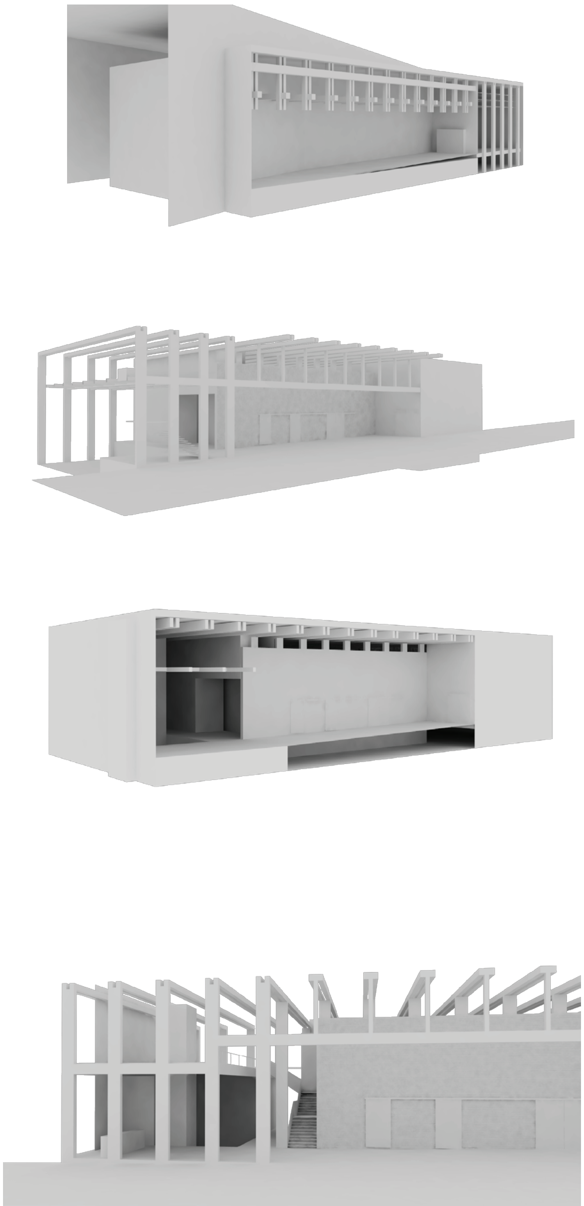


ill. 68 interior in connection to exterior

In terms of structure, different options have been explored.The volumetry allows for simple timber frame, however a seek for a structure that could enrich the spatial qualities and according to the main approach has been done. A special attention has been paid to the foyer and the connection with the outside space. It has been clear from the beginning however that the main building will be also divided several areas - the entrance, foyer and the concert hall as being the equivalent of the enclosed, opened and enclosed space once again. Initial ideas gravitated around using different structures in order to generate the character of each space, however, from a technical point of view, it would have been complicated the solution, which seemed to be against the whole approach of the project. Different jointing options have been studied, however constantly studied on rectangular structures. The visibility of the structure from the inside as well as from the outside was an important aspect which not only references to tectonics but also supports a dialogue between the existing and visible metal structure of the shipyard and the new timber structure.

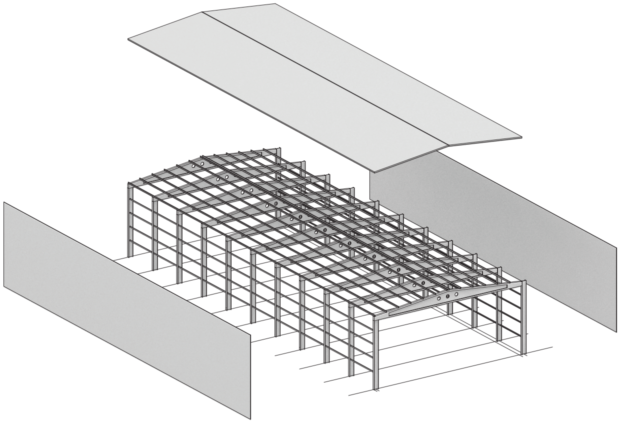


ill. 69 joint sketches

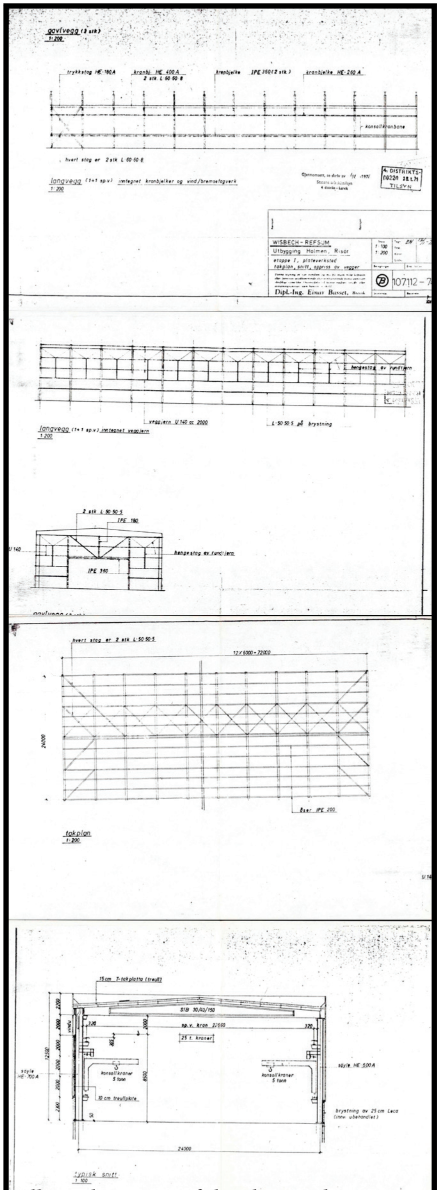


ill. 70 3D studies of different structures

EXISTING STRUCTURE



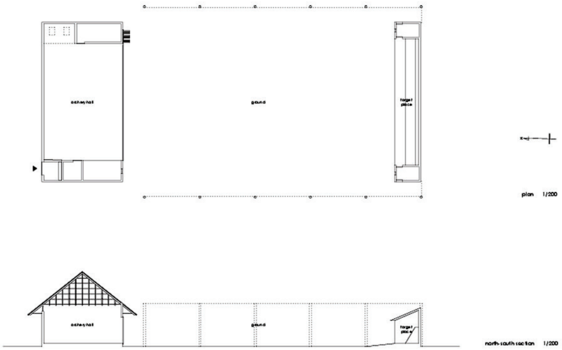
ill. 71 structure of the shipyard



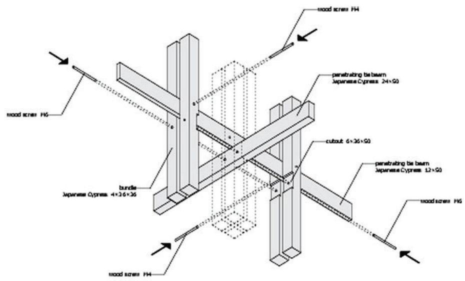
ill. 72 drawings of the shipyard structure

The existing structure has been modelled in order to better understand the limitations and restrictions of the new intervention. The new building would penetrate the shipyard, however there are two cases - in which the metal structure keeps standing, perforating the new bulding or the one in which replacements of the steel columns had to be considered withing the new structure.

CASE STUDY



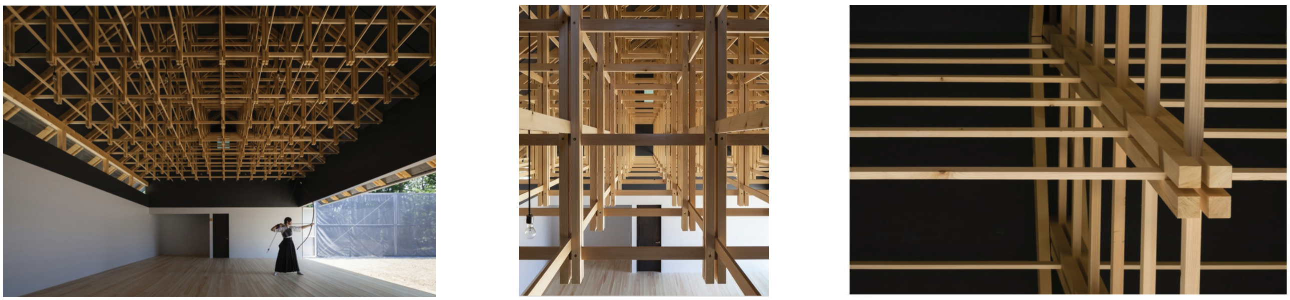
ill. 73



ARCHERY HALL - FT ARCHITECTS - TOKYO, JAPAN

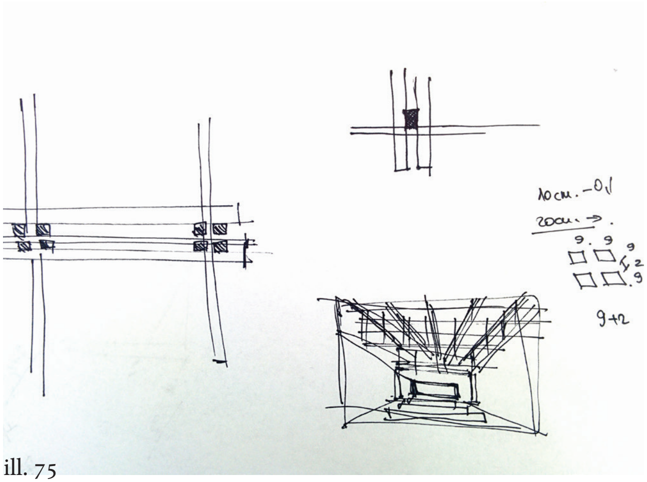
One representative structure which became a study case for its tectonic feature and its *furnitecture quality* is the one used by the japanese studio FT Architects (Katsuya Fukushima, Hiroko Tominaga) in the Archery Hall&Boxing Club in Tokyo. Two buildings, however not intersecting, with different character given by their structure which at the same time becomes their ceiling. The Archery Hall is of a particular interest because of its seemingless light structure.

" Through collaborative exploration with timber experts, researchers, manufacturers and suppliers, we derived timber construction systems that are not commonly associated with structural or architectural usage. Small timber sections, normally reserved for furniture making, were chosen for the archery hall.(...) Delicate lattice frame composed of slender ties beams and posts (...) have been constructed employing a simple, low-tech method of bolt-and-nut assembly. (...) The powerful presence of the timber structure emphasises the stark transparency of the void below. The whole is only achieved by the juxtaposition of these two contrasting and complementing qualities. Departing from the same starting point, the two buildings have arrived at a shared architectural theme via two different structural and spatial solutions [31].



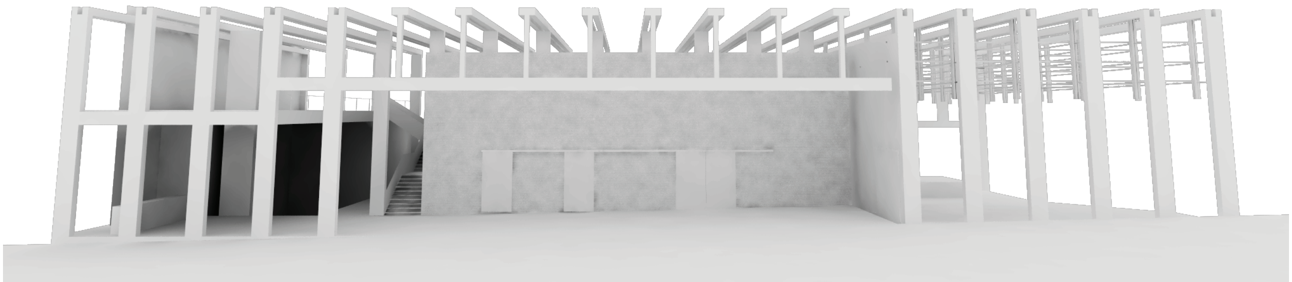
ill. 74

STRUCTURE



ill. 75

In the same idea of creating an architectural dialogue between the two different spatial and structural solutions, however different in material (metal and timber) the exemplified structure has been adopted in this case because of its tectonic and simbolic qualities. Although slender and thin as individual elements, set together in an assembly they create a unity, a mechanism that holds everything together, just as the several buildings on the island create a new community. In this way they become, on a more theoretical level, as Frascari mentioned, "minimal units of signification in the architectural production of meanings" [26]. Adopting the structure has however its limitations and challanges because of the differences between the study case - which shows a lattice system for a span of 7.2 m with a triangular frame and the rectangular cultural centre which, in order to ensure the required surface for the main functions, might have a span of aprox. 23 m. The structure and the static system has been investigated in Autodesk Robot Structural Analysis. A more detailed analysis of several options can be found in Appendix 1. At first,the structure being adopted only for the concert hall, the question of reaching a unity within the same building and with different structures arrised.



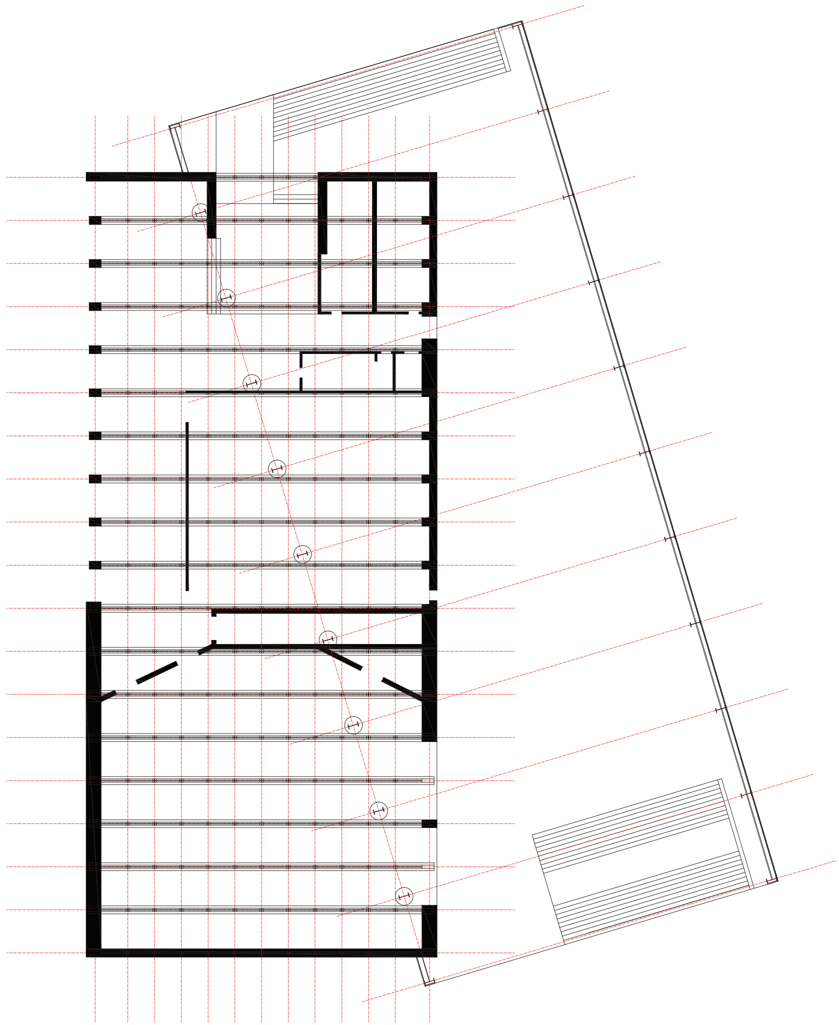
ill. 76 experimentation of different structures in the same volume

CASE STUDY

THE NORDIC PAVILION - SVERRE FEHN - VENICE, ITALY

ill. 77

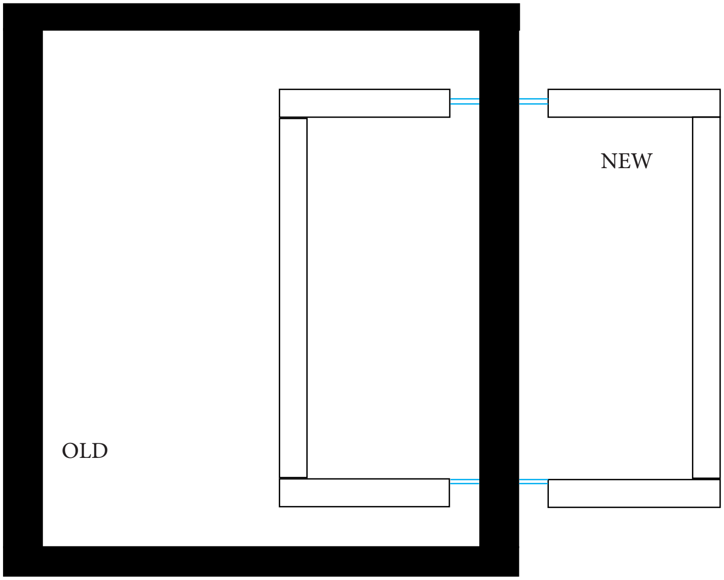
However old as a building (1962), the nordic pavilion designed by Sverre Fehn, although different in materiality is similar in approach to the archery hall, because of its structural ceiling which ensures a strong architectural quality. More concrete " the roof consists of concrete beams one metre high in two direction: each beam is 6 cm thick and together they form a 2-metre high brise soleil. Transparent roof elements are suspended between the uppermost beams.(...) The three plane trees inside the 446-squaremetre unsupported space are almost the only vertical elements. The trees intensify, as do the large walls of glass, the impression of being both inside and outside at the same time." The roof becomes yet again *furnitecture* and enhances the qualities of the space below. On a symbolic level, a reference to the idea of dwelling in the heideggerian conception is being made, the architectural limitations referencing to the earth and the sky. Since, as Heidegger mentions "upon the earth and under the sky we humans dwell"[32]. The two main, primoridal limitations being set, the only one remaining is nature which rises up yet again from the ground into the sky.
Being an architectural illustration of the phylozofic concept of dwelling, which has strong roots in the norwegian/scandinavian context, the pavilion becomes a relevant study case for the project.
Strong in its character, the structure (the ceiling) can be seen as a singular element in the whole building, fact which is enhancing its unity. In a simbolic way, the existing structure of the shipyard is penetrating the new building, continuos pillars going through. In the same respectful manner for the existing environment Fehn keeps the existing trees on the site as active elements in his architecture.



ill. 78 structural plan

As mentioned earlier the metalic structure of the shipyard is let to go through the cultural centre. According to their position a rectangular grid is generated for the new timber structure.

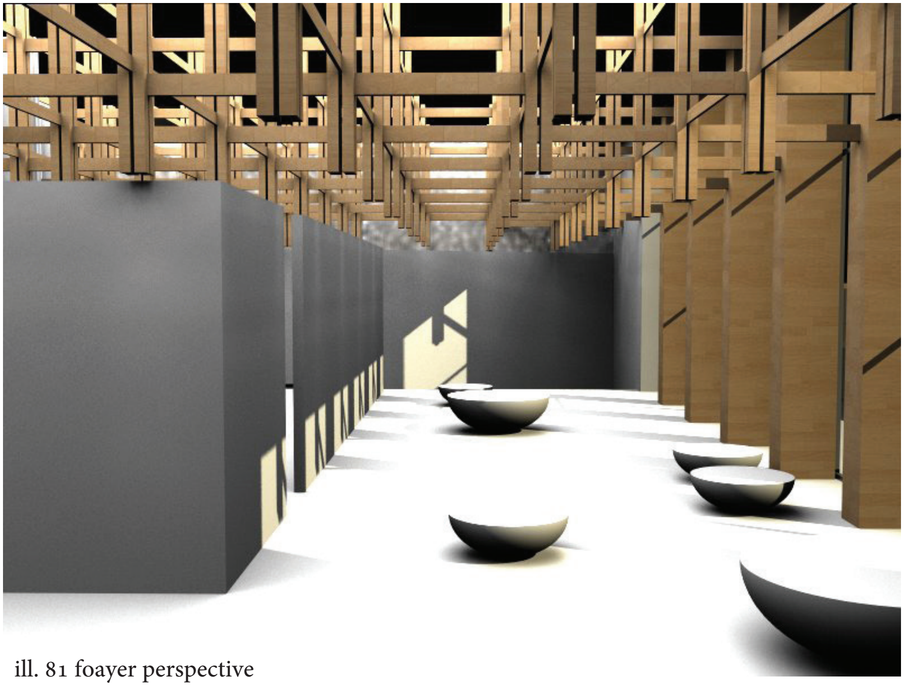
JOINT BETWEEN OLD AND NEW



ill. 79

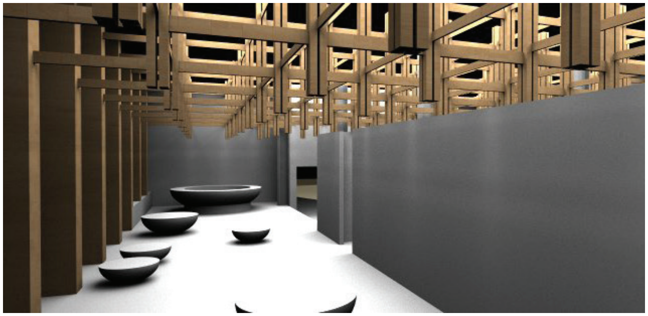
ill. 80 Baumschulenweg Crematory

In order to emphasize on the continuity of the steel pillars throughout the cultural centre, the connection between these two is done through a transparent material which allows for better understanding of the architectural intention. The same idea is explored in the Baumschulenweg Crematory by Shultes Frank Architeckten where the columns seem to continue into an unknown dimension, symbolizing the journey of human life.

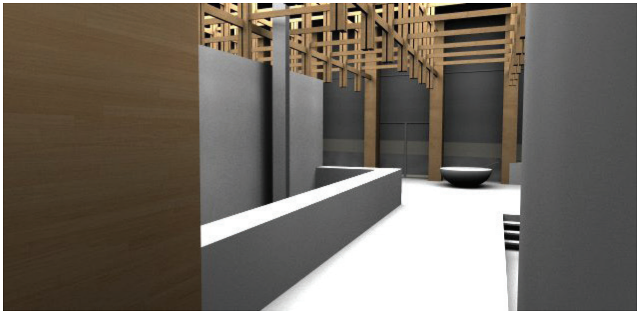


ill. 81 foayer perspective

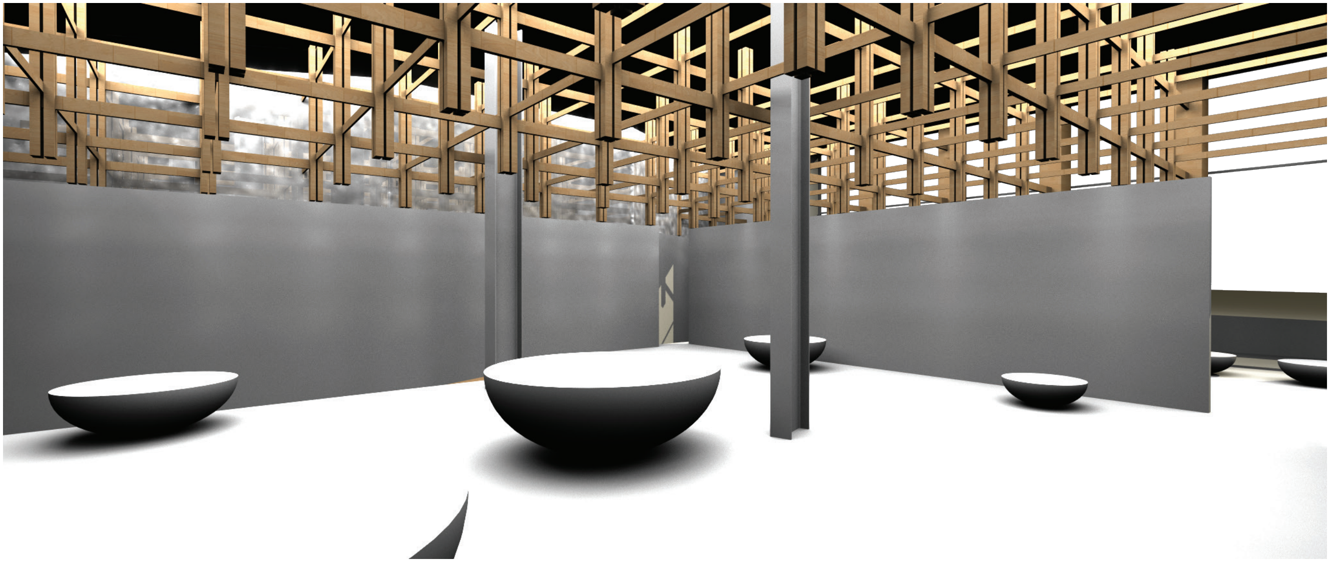
The interior has been conceived as an open plan, by placing the partition walls in disagreement with the structural grid. Thus each level has their own strong character - the ceiling, the space, and the floor, each acting individually but all together forming a unity. In terms of materiality, each level is characterized through their own structural material - exposed timber structure and concrete floor with plaster partition walls



ill. 82 foayer perspective



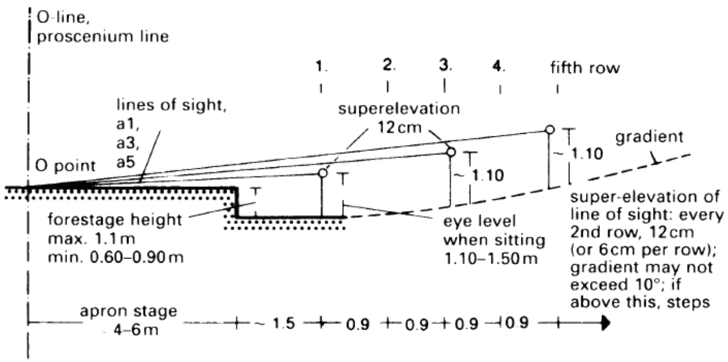
ill. 83 garderobe and reception area



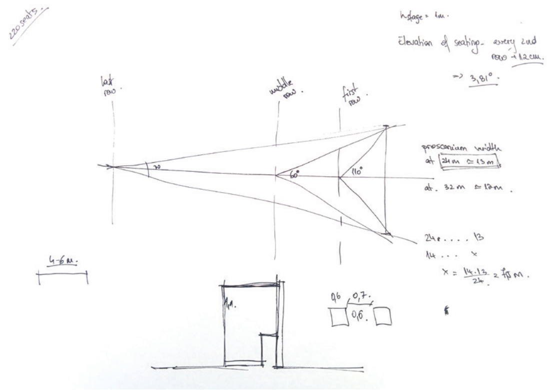
ill. 84 exhibition area

The same architectural language has been used for the concert hall, however with the following differentiations and interpretations.

- the choices of the materials as well as the geometry of the space have been done following the acoustics analysis detailed in Appendix 2
- the disposal of the seats and slope of the floor have been done taking into considerations the guidelines from *Architects' Data* by Ernst and Peter Neufert, so that every seat has an elevation of 11 cm and the rows of chairs are not allowed to have more than 15 seats until the next aisle.
- unlike most of the concert halls, this particular one has a window towards the interior of the shipyard. Assuming that concerts or conferences are scheduled in the second part of the day direct sunlight would not be an issue first of all because the window is perfectly shaded by the shipyard and descond of all bcause of the sun direction. In a symbolic and signalizing way, the shipyard can be closed at the end next to the concert hall, should the light be an inconvenience.



ill. 85 elevation of seating



ill. 86 auditorium width

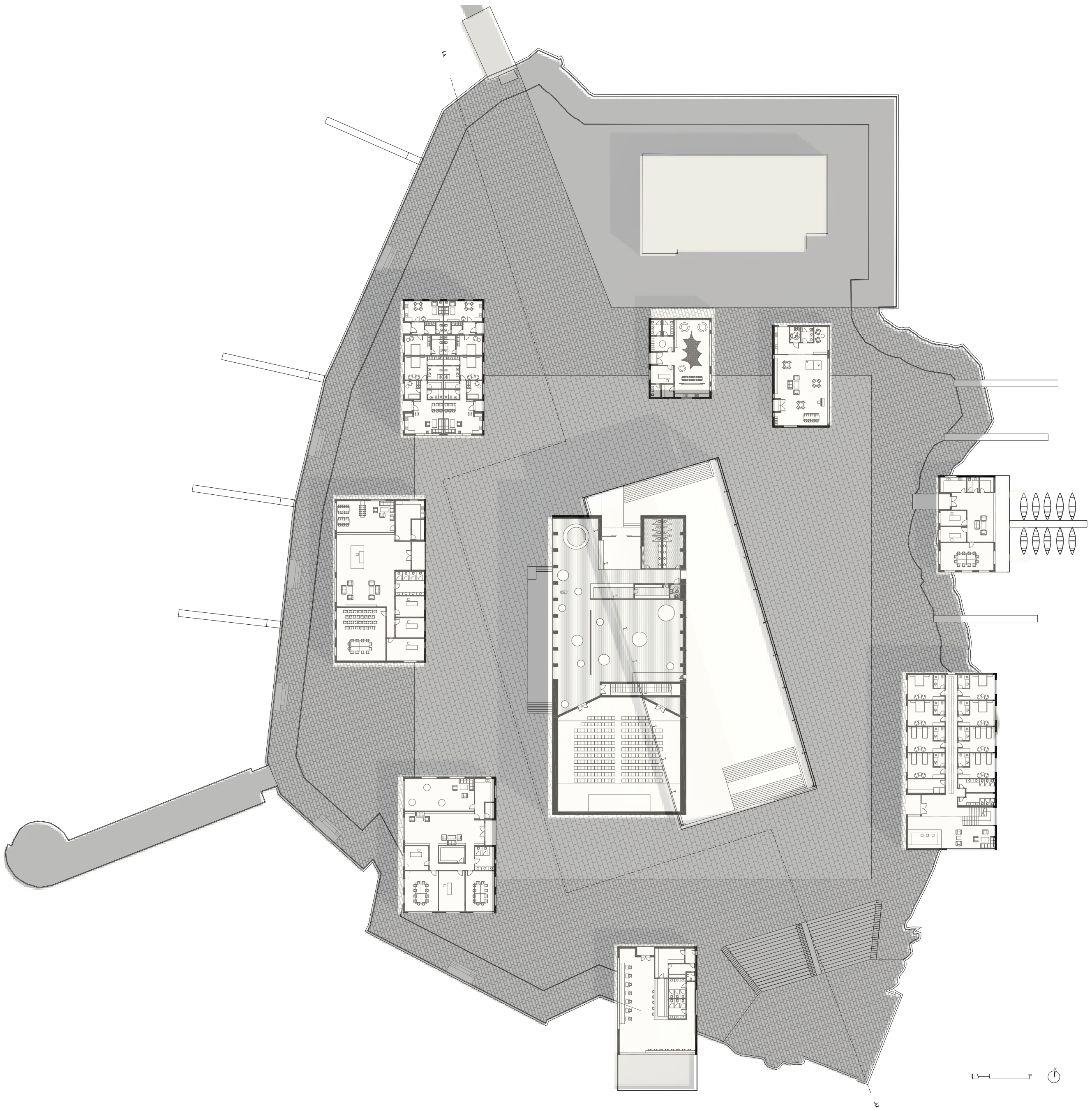
The project in intself has been a challenge in terms of size, complexity and limitations. As the attempt was to create a unity where the same concept or similar had to be found in the approach of each element of it, a constant logic connection between them had to be ensured. Regarding the technical detailing, the focus of the project was set in analyzing the chosen structure and through the integrated design methodology outline a proposal with strong tectonic qualities which as well fulfills acoustic and sustainable regulations (considerations of sustainability have been detailed in Appendix 3).

Reflecting backwards towards the analysis part of the project, an issue which might need more investigation might refer to site conditions and especially sea level. The main buildings' basement would go down with 2 m below level and thus has to be secured against water infiltration and water damage. However unusual for Norwegian landscape, the flat roof design might seem unpractial during the precipitation seasons. There are several technical solutions that can help that - the minimum slope for drainage is secured and several drain points are located along the roog, with pipes that go through the wall and into the ground. In case of snow, one could argue on its benefits as a good insulator in a time when its best needed. With a resistance to heat flow of 0.18 it participates in insulating the roof whose thickness is actually minimized due to height limitations.

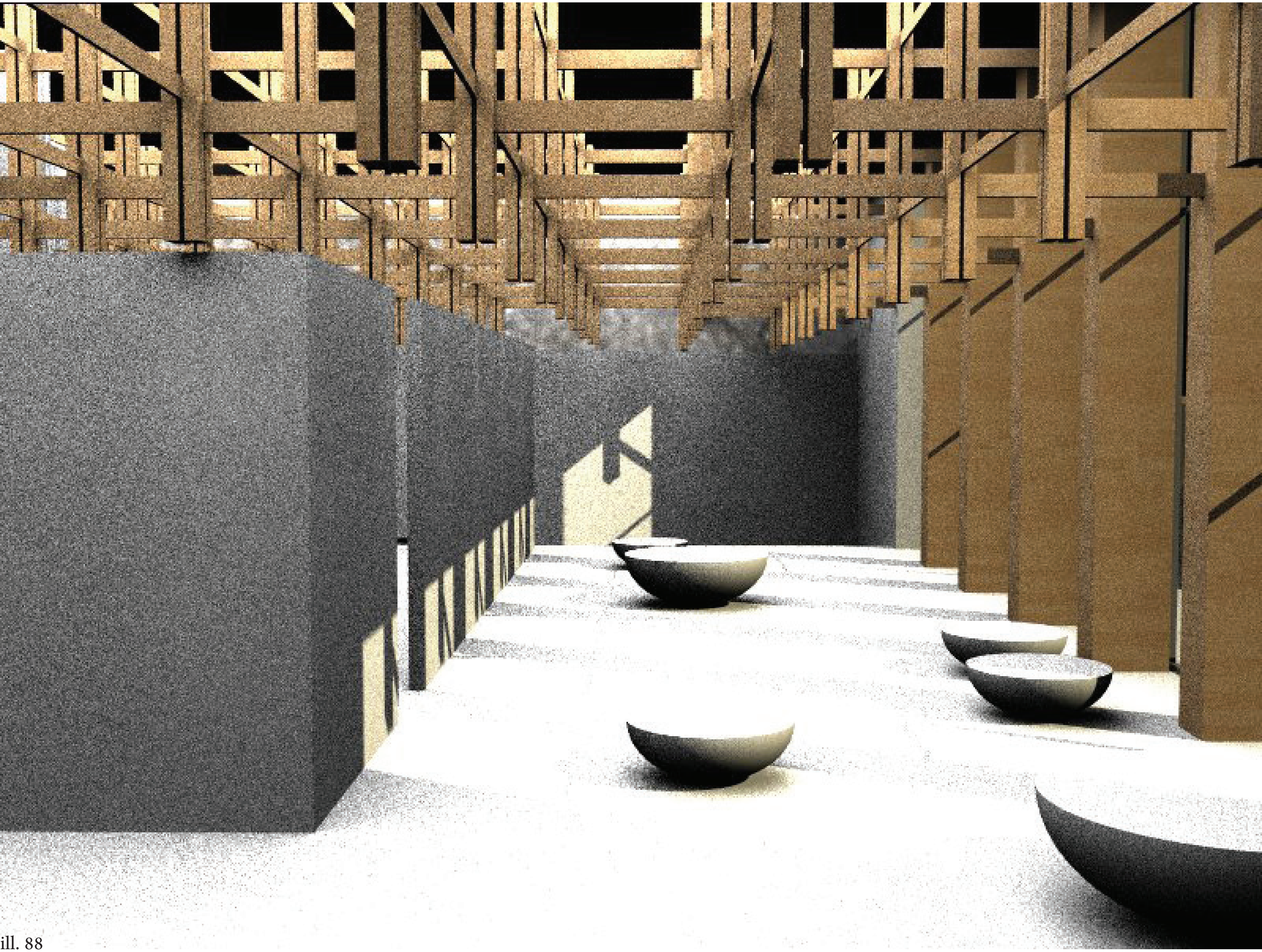
Design-wise, further detailing of joints would have probably been accurate should the time allow for it, in order to support stronger tectonic characters (for example the joint between the steel cables - mentioned in Appendix 1 - and the timber structure). The insertion of steel cables in the structure it is a solution which has been adopted due to its certainty for holding while the initial goal was to study more indepth the structure and conclude more accurately whether it could hold by being transfered from a pitched roof, as seen in the study case at page 89, to a flat roof.

In terms of respecting the conservation plan which has taken my attention in the initial stage of the project one could state that the following have been done - horizontal timber cladding has been kept for the exterior or the buildings on the site, however not for the cultural centre, - conversion has been done with reference to buildings' character, "demolition is the opposite of preserving" [1] - and no replicas were created. As the mayor himself Per Kristian Lunden mentioned during my data collection trip in Risør - by creating copies and replicas the character of the town is not geniuinely keep intact.

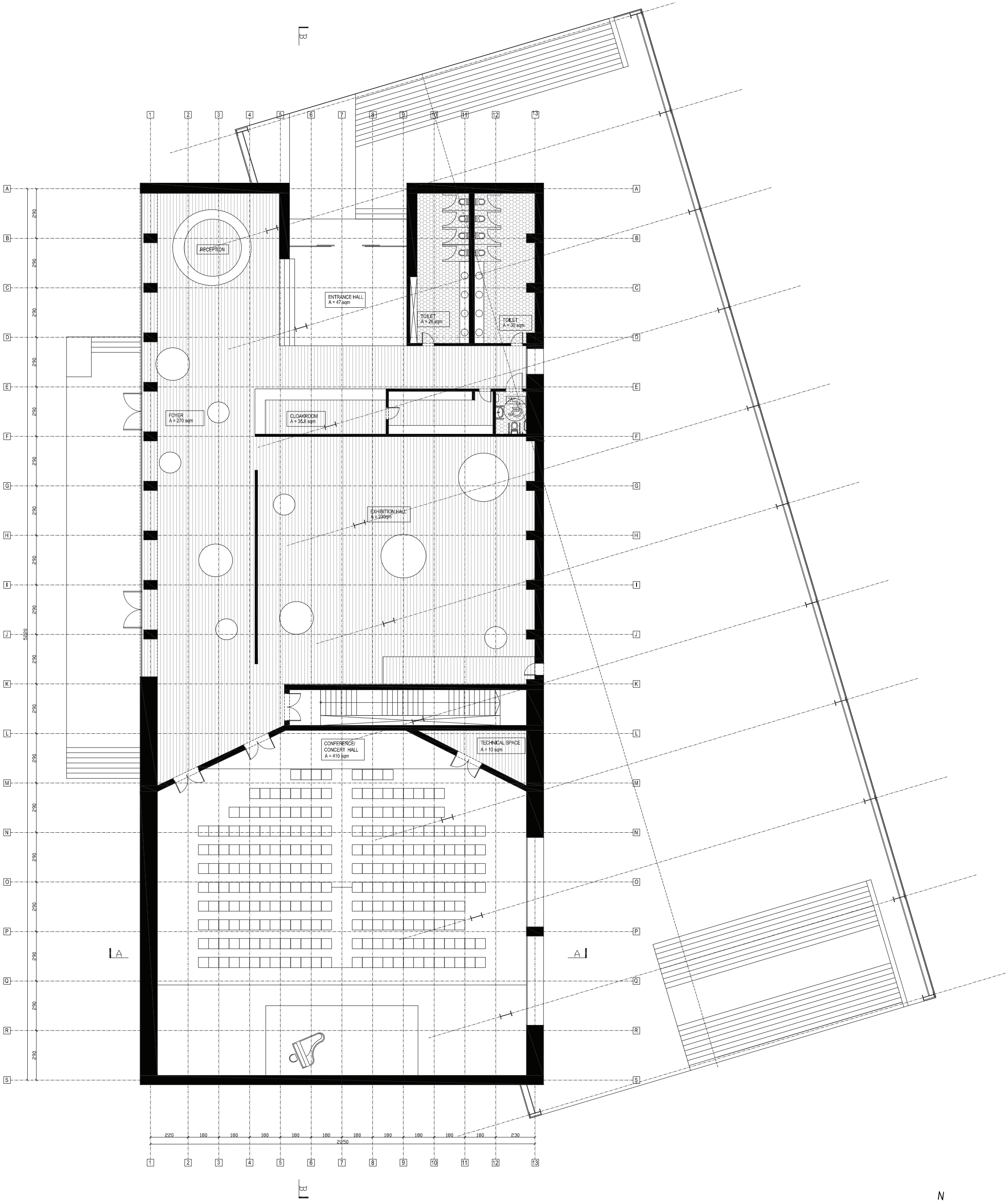
Lastely, it is my strong belief that, although a public and a cultural space, the new proposal would perhaps not bring imediate income and growth to the town but it would surely provide a landmark for it which has strong roots in the town's traditions.



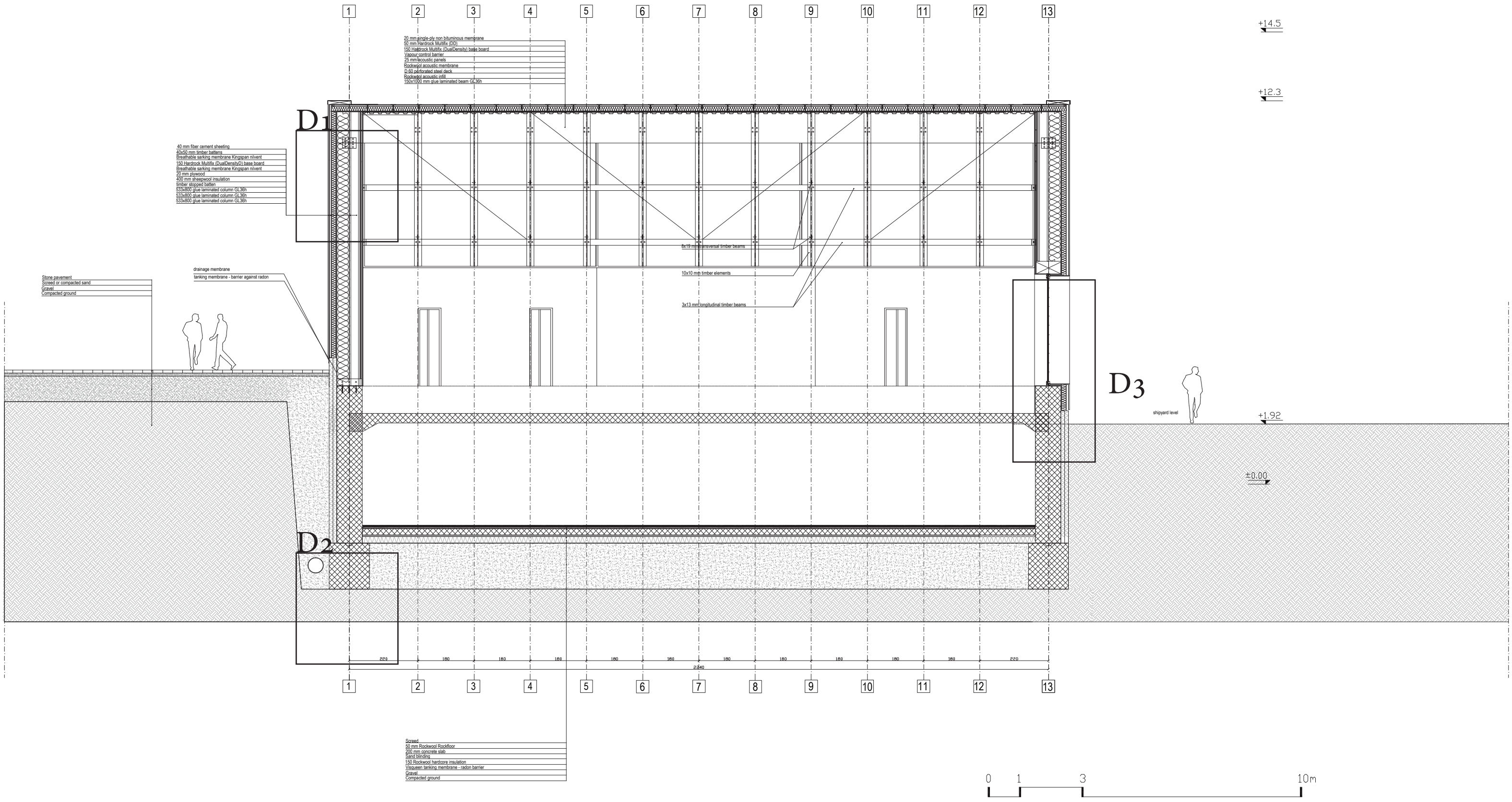
ill. 87 siteplan



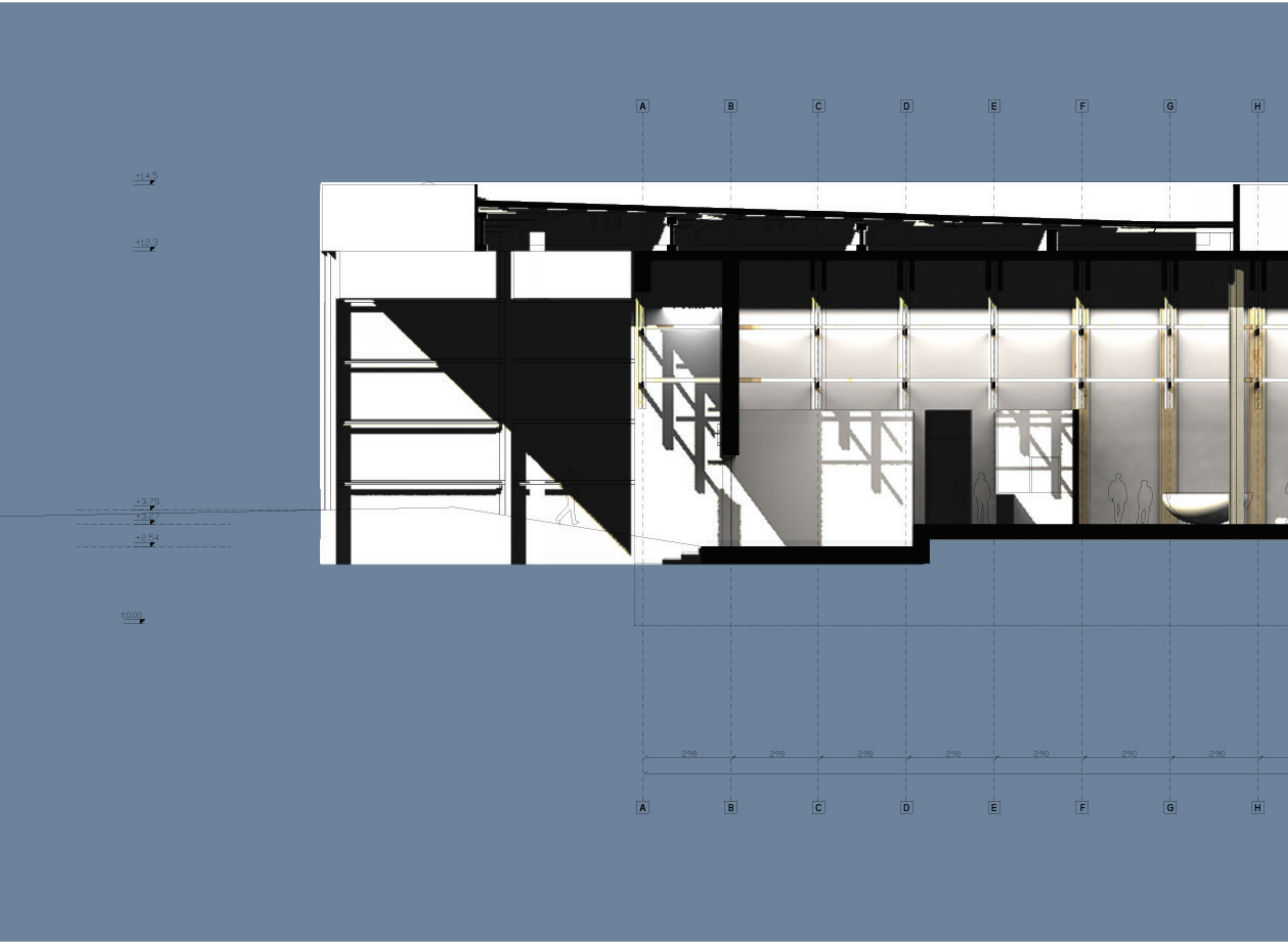
ill. 88


RECEPTION
ENTRANCE HALL
A = 47 sqm
TOILET
A = 26 sqm
TOILET
A = 30 sqm
FOYER
A = 270 sqm
CLOAKROOM
A = 35.6 sqm
EXHIBITION HALL
A = 230qm
CONFERENCE/
CONCERT HALL
A = 410 sqm
TECHNICAL SPACE
A = 10 sqm

ill. 89 plan



ill. 90 section AA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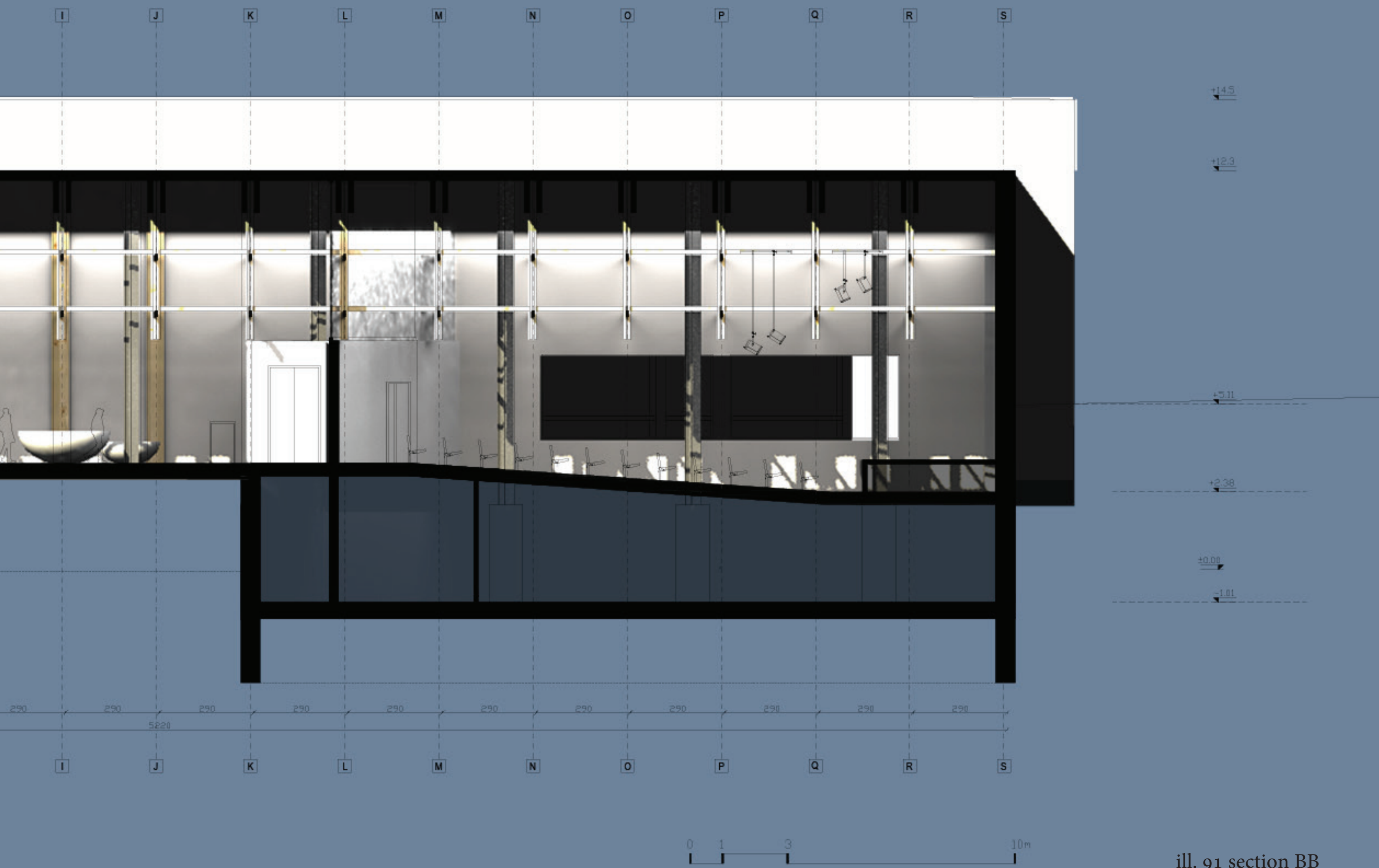
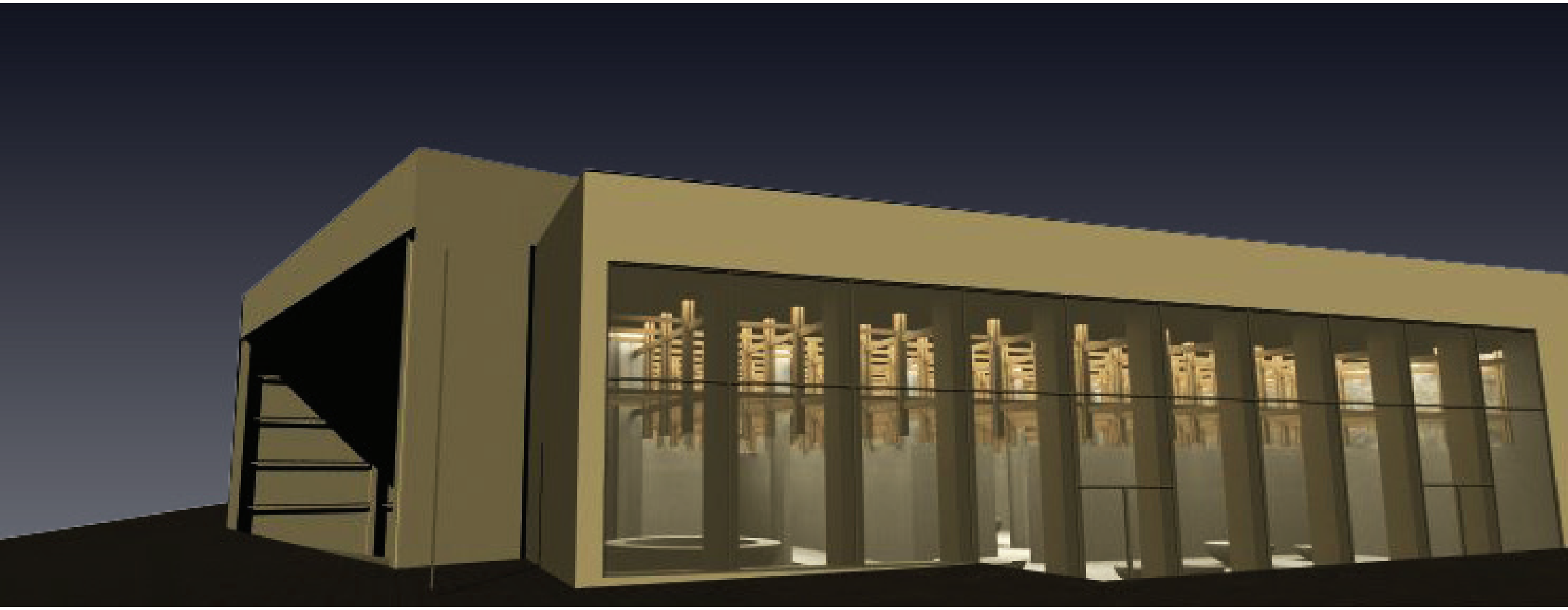
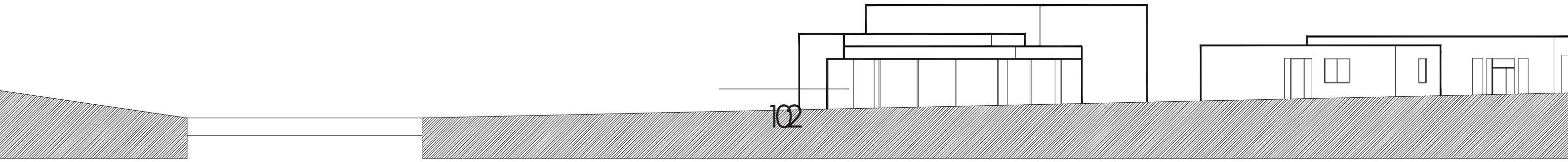
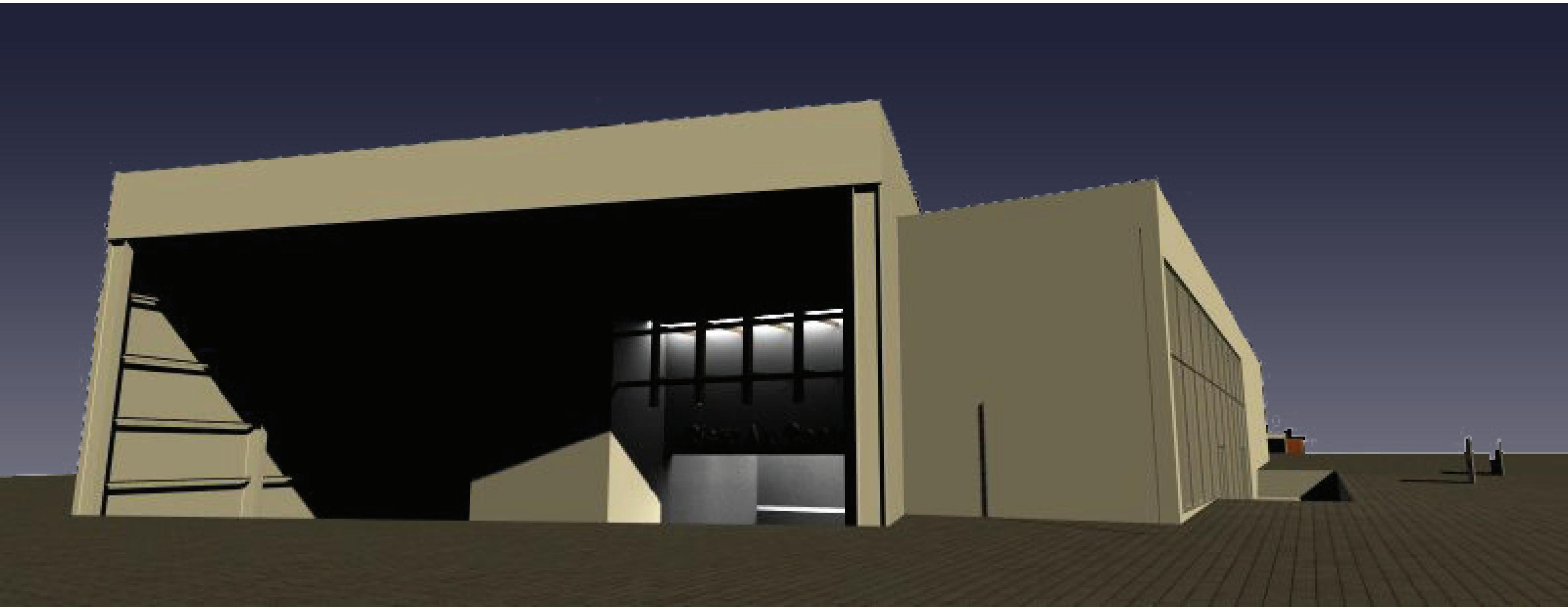


ill. 91 section BB



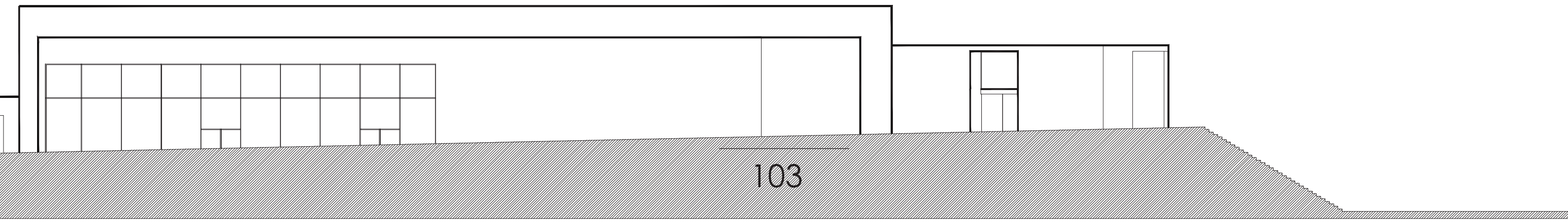
ill. 92.1 exterior renderings

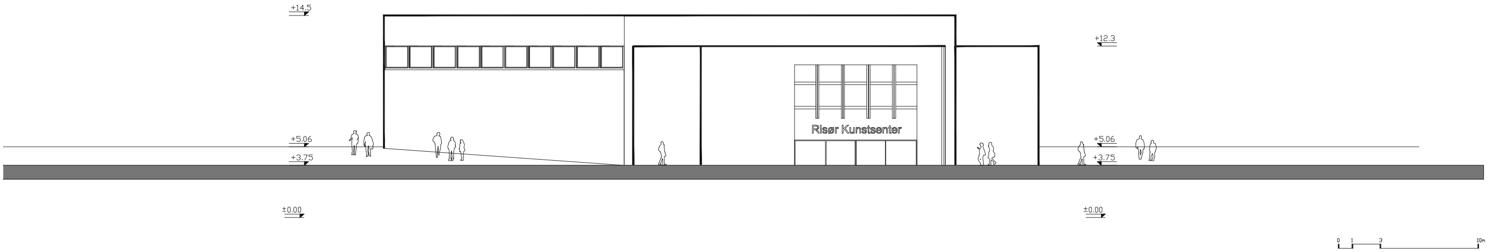




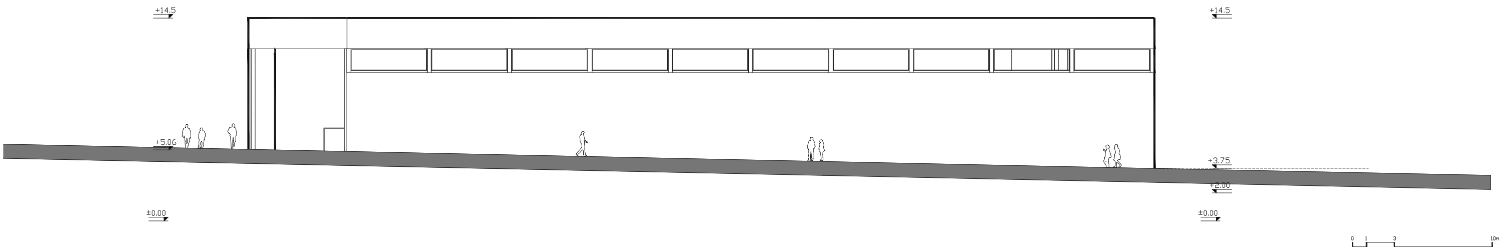
ill. 92.2 exterior renderings

ill. 92 site section

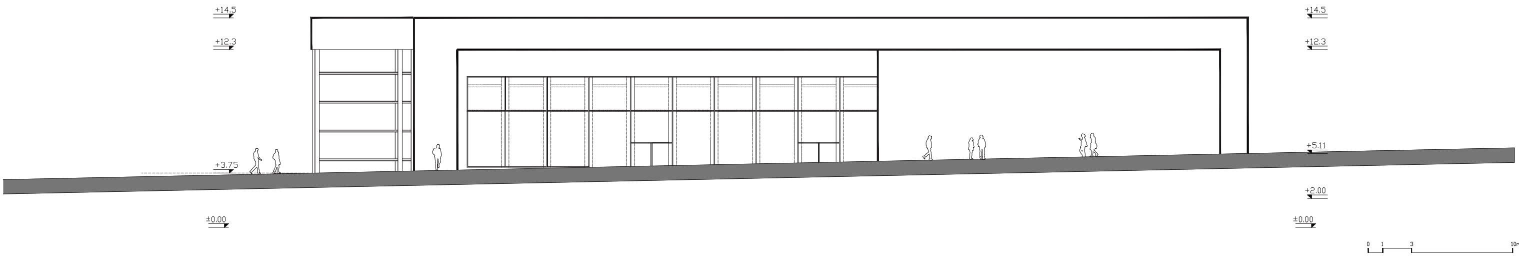




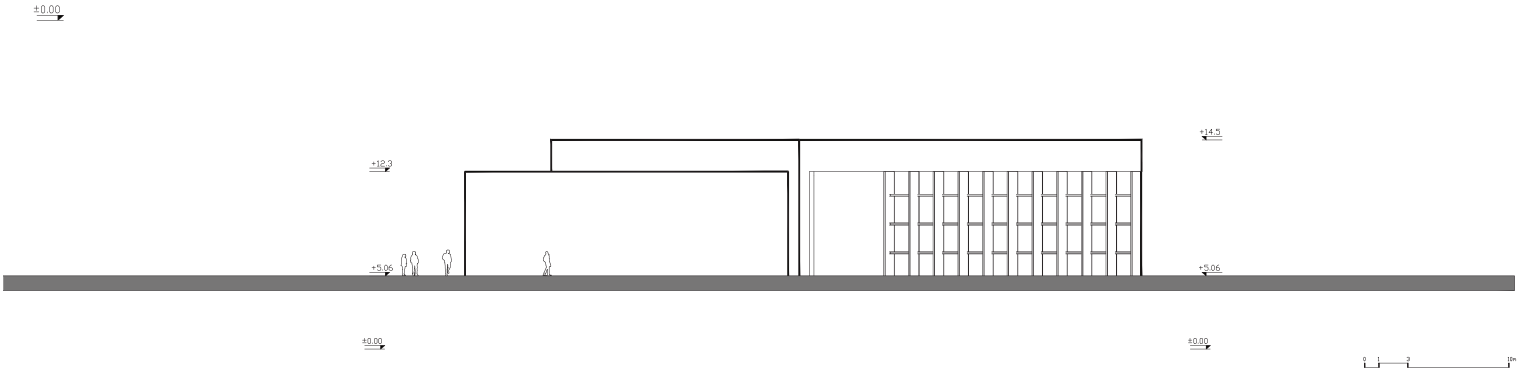
ill. 93 north facade



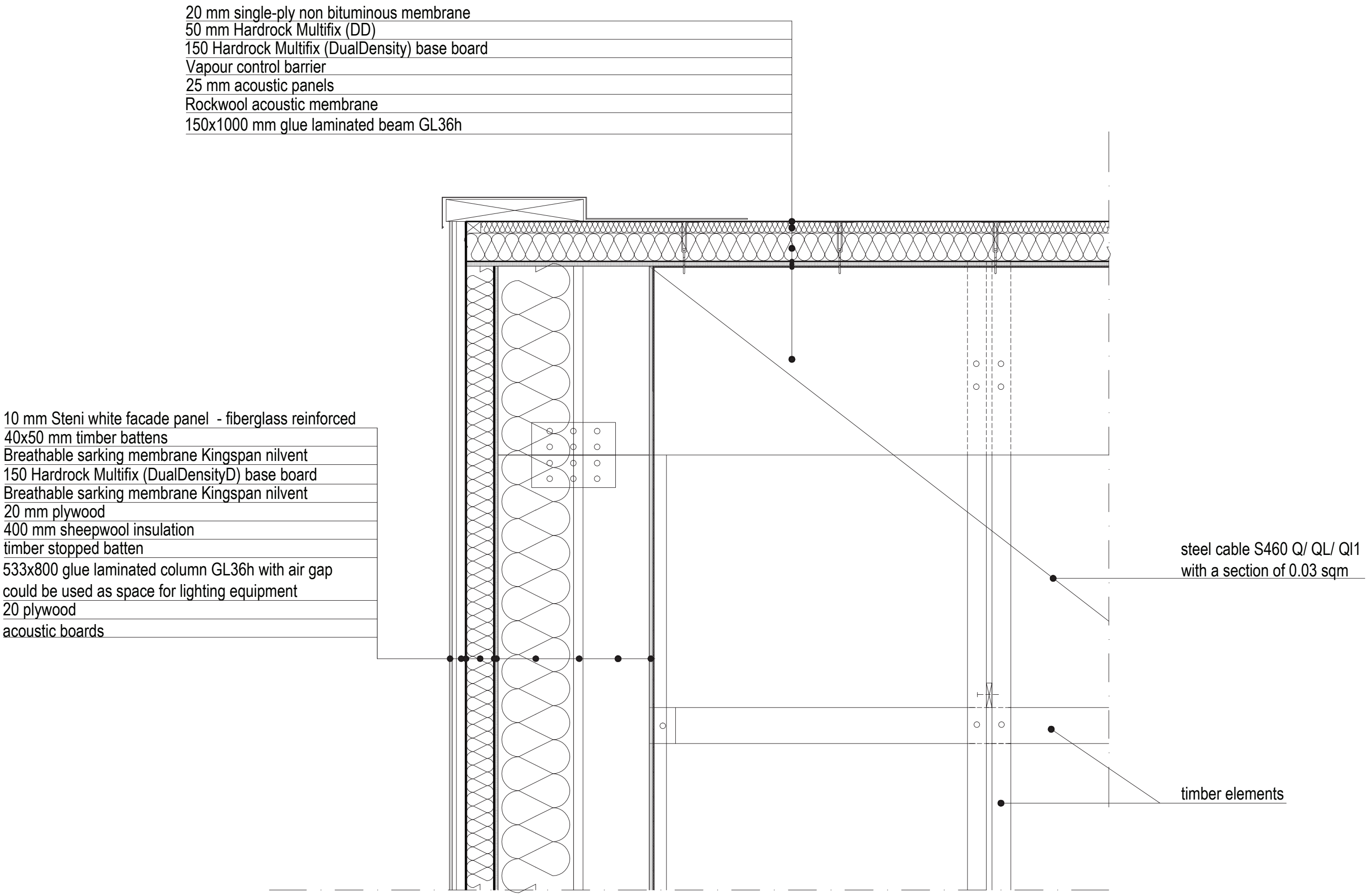
ill. 95 east facade



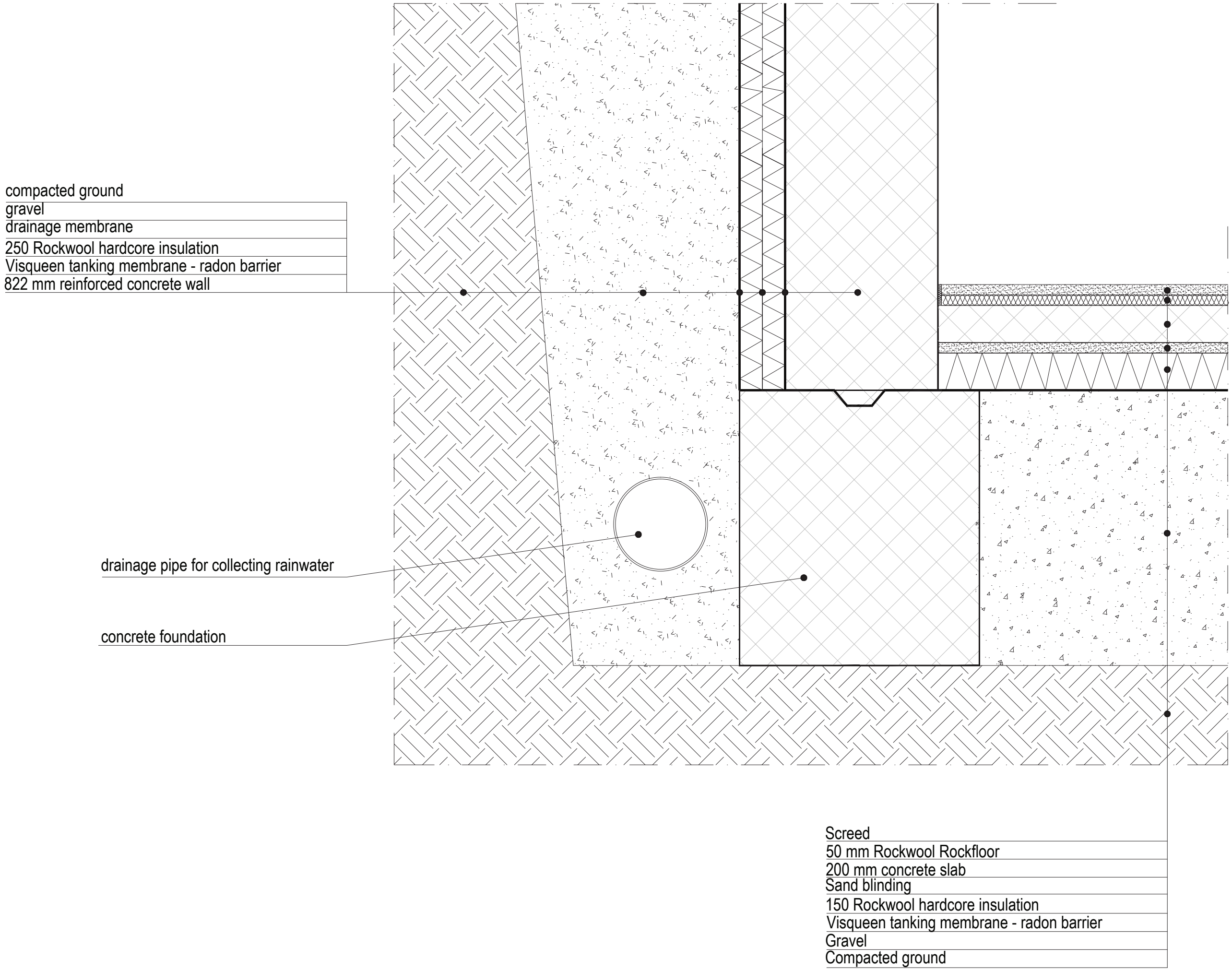
ill.94 west facade



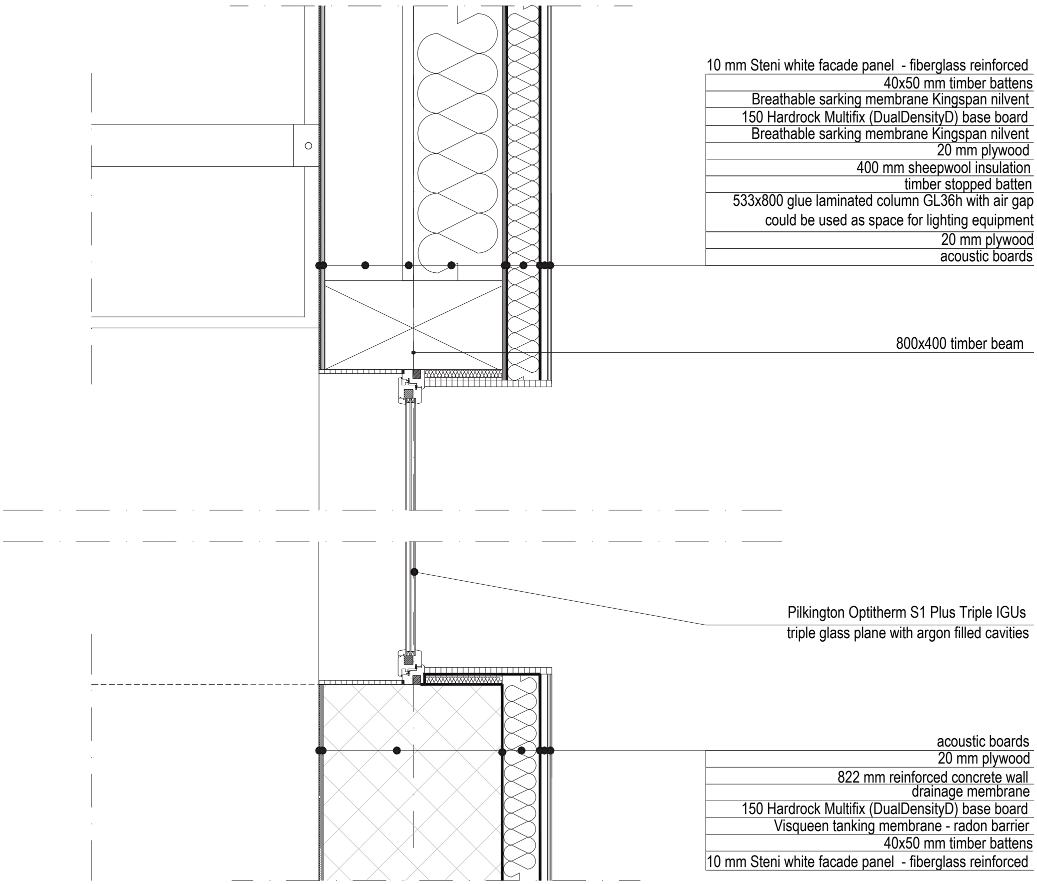
ill.94 south facade



ill. 97 D1 - joint between roof and wall



ill. 98 D2 - joint between basement wall and groundfloor



ill. 99 D1 - window head and sill

VIII. appendix 1
structure

Construction elements and design values

Construction Element	Thickness	Surface	U-value	Density	Load
Roof		1246 m²	0,18		37,58 kN
Single ply non bituminous membrane	1,5 mm			1.92 kg/m²	0.082 kN
Rockwool Hardrock Multifix dual density	60 mm			2.4 kg/m²	4 kN
Rockwool Hardrock Multifix dual density base board	150 mm			6 kg/m²	25,58 kN
Plywood	20 mm			13.6 kg/m²	7,73 kN
Acoustic panels	25 mm			0.26 kg/m²	0.185 kN
Walls		455,045 m²	0,07		
steni white boards- reinforced fiberglass	10 mm				
timber battens	40 mm x 50 mm				
Rockwool Hardrock Multifix dual density base board	150 mm				
Plywood	20 mm				
Sheepwool insulation	400 mm				
Plywood	20 mm				
Concert hall wall		528,205 m²	0,04		
steni white boards- reinforced fiberglass	10 mm				
timber battens	40 mm x 50 mm				
Rockwool Hardrock Multifix dual density base board	150 mm				
Plywood	20 mm				
Sheepwool insulation	400 mm				
Air gap	340 mm				
Plywood	20 mm				
Acoustic panels	25 mm				
Windows / Curtain walls		221,98 m²	0,5		
Pilkington Optitherm S1 Plus triple IGUs (g = 0.45)					
Outer pane	4 mm				
Argon gas-filled cavity	16 mm				
Pilkington Optitherm™ S1 Plus pane	4 mm				
Argon gas-filled cavity	16 mm				
Pilkington Optitherm™ S1 Plus pane	4 mm				
Basement wall		530 m²	0,1		
Kingspan Styrozone H350 rigid insolation	250 mm				
Reinforced concrete	800 mm				
Foundation		1246 m²	0,1		
Screed	56 mm				
Rockwool Rockfloor	50 mm				
Concrete slab	200 mm				
Kingspan Styrozone H350 rigid insolation	200 mm				

Dead Load

The dead load is calculated using the load values from the table of Construction elements and design values. The values were a result of multiplying the density with the thickness of each material according to the construction drawings. A further multiplication with 9.8 m/s^2 gave the final result of 37.58 kN for the dead load of the roof.

The distance between the axis of the trusses is 2.9 meter, thus each trus supporting hald of this span. And by taking into consideration that the span is 23.2 meters the value for dead load is:

$$37.58\ kN / 23.2\ m = 1.61\ kN/m$$

Live Load

Since there are no intermediate floors within the timber structure the live load is considered to be 0.

Snow Load

According to [33], the values for Norway are:

$\psi_0 - 0.70$

$\psi_1 - 0.5$

$\psi_2 - 0.2$

The equation for persistent/transient design situations is defined as follows [33]:

$$\boxed{S = \mu_i \cdot C_e \cdot C_t \cdot S_k}$$

Where:

- μ_i is the snow load coefficient shape. $\mu_i = 0.8$ for monopitched roofs with $\alpha = 0^0$ [1].
- S_k is the characteristic value of snow load on the ground. According to [1],

$$S_k = 0.79 \cdot z - 0.082 + \frac{A}{336}$$

Where z is zone number given on the map and A is the site altitude above sea level in meters.

For values of $z = 4.7$ and $A = 2\ m$ the equation results as follows:

$$s_k = 0.790 \cdot 4.7 - 0.082 + \frac{2}{336} = 3.6$$

- C_e is the windswept exposure coefficient . According to [1], $C_e = 0.8$.
- C_t is the thermal coefficient. $C_t = 1$.

Including all the parameters previously calculated:

$$S = \mu_i \cdot C_e \cdot C_t \cdot S_k = 0.8 \cdot 0.8 \cdot 1 \cdot 3.6 \rightarrow S = 2.3 \, {}^{KN}/_{m^2}$$

Taking into consideration that the distance between trusses is $2.9m$, the resultant load per square meter is:

$$\boxed{S = 2.3 \frac{KN}{m^2} \cdot 2.9m = 6.67 \, {}^{KN}/_{m}}$$

Wind Load

According to [34], the wind load is defined as:

$$\boxed{W_e = q_p(z_e) \cdot C_{pe}}$$

Where:

- C_{pe} is the pressure coefficient for external pressure.
- $q_p(Z_e)$ is the peak velocity pressure.

1. The pressure coefficient used for the design of the overall load-bearing structure for loaded areas of 10m^2 is defined as [2]:

$$C_{pe} = C_{pe,1} - (C_{pe,1} - C_{pe,10}) \cdot \log A$$

Where:

- A is the loaded area. $A = 2.9 \cdot 10 = 29m^2$
- $C_{pe,1} = -1.8$
- $C_{pe,10} = -1.1$

Then,

$$C_{pe} = -1.8 - (-1.8 + 1.1) \cdot \log 29 = -0.78$$

Coefficients $C_{pe,1}$ and $C_{pe,10}$ are calculated based on the following figure:

2. The peak velocity pressure is calculated as follows:

$$\boxed{q_p(z) = [1 + z \cdot l_v(z)] \cdot \frac{1}{2} \cdot \rho \cdot v_m^2(z) = C_e(z) \cdot q_b}$$

With:

- $C_e(z)$ is the flat terrain exposure factor. For category 0, $C_0(z) = 1.$ $C_e(z) = 1.3.$ [2]
- $q_b$is the basic velocity pressure. For class 0, $Z_0 = 0.003.;\ Z_{min} = 1;\ Z_{max} = 200.$

  To calculate q_b,

  $$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2$$

  - v_b is the basic wind velocity. $v_b = 27\ m/s.$

- ρ is the air density. $\rho = 1.25\ Kg/m^3$.

Hence,

$$q_b = \frac{1}{2} \cdot 1.25 \cdot 27^2 = 455.62\ N/m^2$$

Thus,

$$q_p(z) = C_e(z) \cdot q_b = 1.3 \cdot 455.62 = 592\ {}^{N}/_{m^2} = 0.6\ {}^{KN}/_{m^2}$$

3. Integrating the calculated coefficients in the wind load equation:

$$W_e = q_p(z_e) \cdot C_{pe} = 592 \cdot 0.78 = 461.7\ {}^{N}/_{m^2}$$

Scaling with the distance between the trusses:

$$W_e = 0.462 \frac{KN}{m^2} \cdot 2.9m = 1.3\ {}^{KN}/_{m}$$

Load Combinations

Load combinations calculations are defined as:

$$K_{FI} \cdot \gamma_{Gjsup} \cdot G_{kjsup} + K_{FI} \cdot \gamma_{Q,l} \cdot Q_{k,l} + K_{FI} \cdot \gamma_{Q,i} \cdot \psi_{Q,i} \cdot Q_{k,i}$$

This is a combination of the permanent load, the dominant variable load and other variable loads.

Permanent Load

The permanent load it is considered to be the dead load (G_{kjsup}).

According to [35],

- For high consequence class, CC3 $K_{FI} = 1.1$.
- Considering the contribution of the structure, $\gamma_{Gjsup} = 1.0$.
- The dead load is extracted from Robot results

Dominant Variable Load

The Dominant Variable Load is considered to be the snow load($Q_{k,l}$).

According to [35],

- $K_{FI} = 1.1$.
- $\gamma_{Q,l} = 1.5$.
- The snow load is extracted from Robot results

Other variable loads

The other variable loads are considered to be the wind load ($Q_{k,i}$).

According to [35],

- $K_{FI} = 1.1$.
- $\gamma_{Q,i} = 1.5$.
- For wind load (other categories), $\psi_{Q,i} = 0.3$
- The wind load is extracted from Robot results

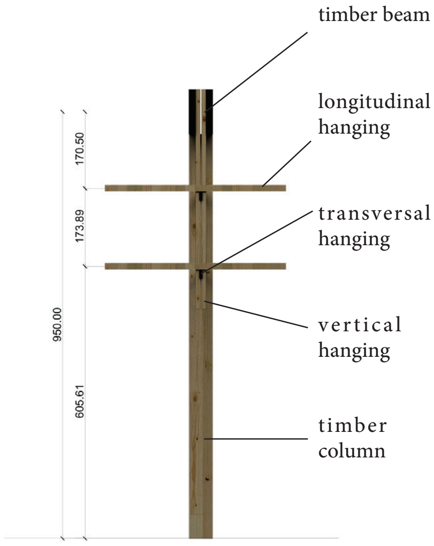
Including the values for each coefficient in the equation, the load combinations results:

$$\begin{aligned} K_{FI} \cdot \gamma_{Gjsup} \cdot G_{kjsup} + K_{FI} \cdot \gamma_{Q,l} \cdot Q_{k,l} + K_{FI} \cdot \gamma_{Q,i} \cdot \psi_{Q,i} \cdot Q_{k,i} \\ = 1.1 \cdot G_{kjsup} + 1.1 \cdot 1.5 \cdot Q_{k,l} + 1.1 \cdot 1.5 \cdot 0.3 \cdot Q_{k,i} \\ = 1.1 \cdot G_{kjsup} + 1.65 \cdot Q_{k,l} + 0.5 \cdot Q_{k,i} \end{aligned}$$

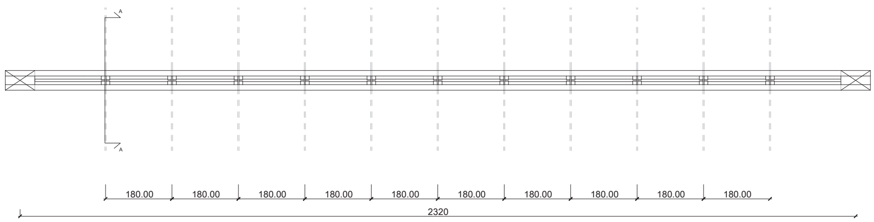
Dimensions of elements. Definition of static system

The structural system has been simplified from a 3d structure to a 2d truss structure, by ignoring the longitudinal slender elements which presumably, as seen at the end of the analysis could provide stability in the Z direction for the vertical hanging elements defined with a fixed and pinned support. The assumed span between the supports taken into the calculations is 23.2 m, with and distances between the trusses of 2.9 m. However, during the design process and dimensioning of the elements, different values have been used and tested until the final grid configuration has been set according to the existing metal structure.
For the purpose of this report and analysis the following names and sections have been defined:

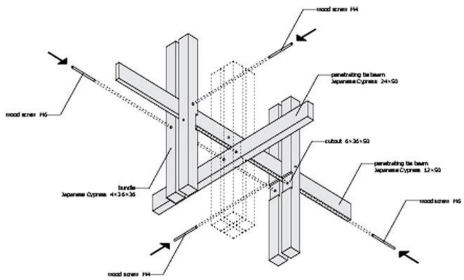
ELEMENT	MATERIAL		REALITY	ROBOT
timber beam	GL36H	b=150 mm l = 1000 mm		
timber column	GL36H	b=800 mm l = 533 mm		
vertical hanging	timber C30	b=10 mm		
transversal horizontal	timber C30	b=66.7 mm l = 190 mm		
longitudinal horizontal	timber C30	b=35 mm l = 138.9 mm		ignored



ill. 100 section A-A



ill. 101 truss plan

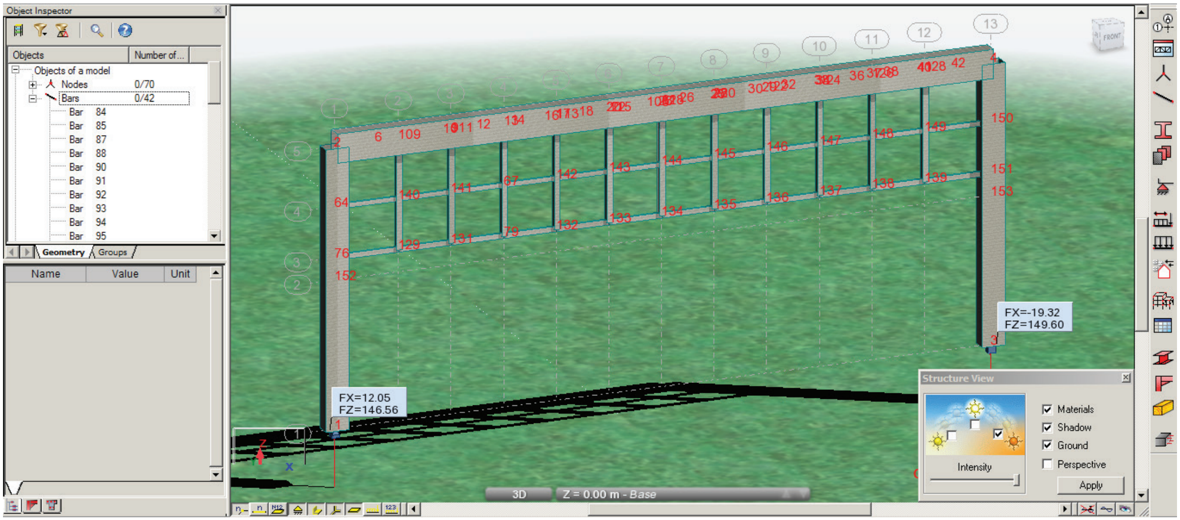


ill. 102 joint in the Archery Hall by FT Architects

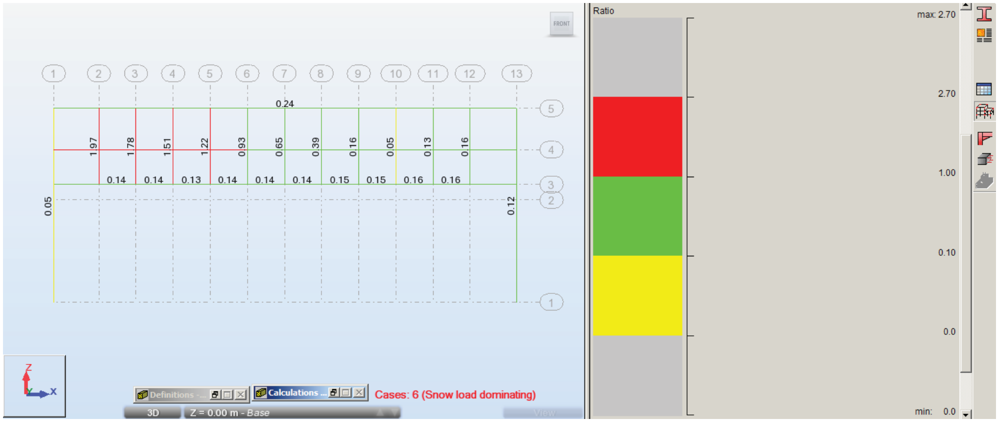
Following the mentioned analysis chriteria has been created in Autodesk Robot Structural Analysis with the applied previously calculated loads and load combinations. In order to get a better understanding of the forces into the system, an analysis of several cases has been done. However, the definition of the releases have been done after a study of the joint connection mentioned in the study case for the timber structure in the Archery Hall by FT Architects, which shows that the nodes can be considered fixed in all directions. Therefore, the transversal hanging is devided into smaller elements between the vertical hanging and defined with a pinned-fixed release.

The analysis has been done for several different cases, with different dimensioning, however the resulted ratio in Autodesk Robot Structural Analysis was in many cases bigger than 1, which meant the elements did not have the required capacity to support the structure and the loads. The studies, however, provided a good idea for the forces the elements have to endure and thus direct the process towards a better solution.

Initial hand calculations have been done in order to make a brief assumption weather the transversal hanging can take the tension and compression forces. The supports have been considered pinned-fixed, therefore the moment in the supports shouldn't become problematic.

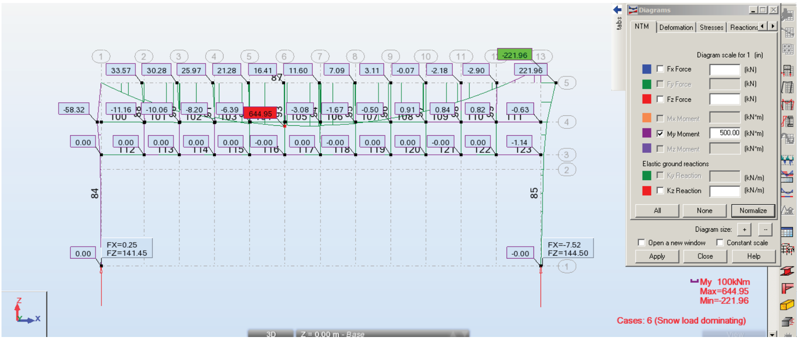


ill. 102 3D geometry of the truss in Autodesk Robot Structural Analysis

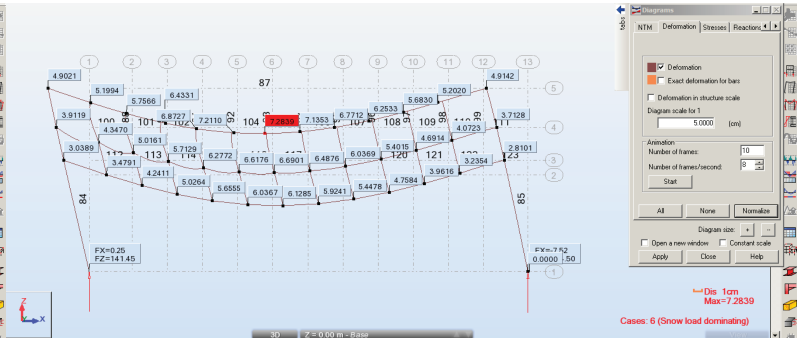


ill. 104 map of rendered elements according to their ratio

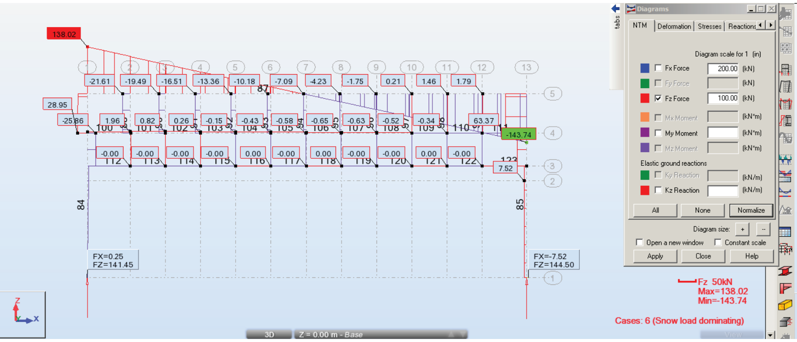
Map of elements rendered according to the ratio calculated in Autodesk Robot Structural Analysis. Several elements do not have the proper capacity and, as seen in the following detailed results of forces, most of the elements have the difficulty of taking both tension and compression. The negative values of Fx shows that the element s are taking compression forces



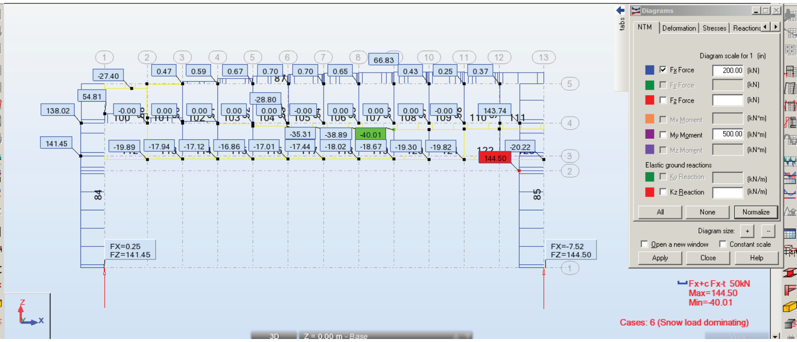
ill. 105 moment diagram



ill. 106 deformation diagram



ill. 107 shear forces diagram



ill. 108 normal forces diagram

A detailed report of the vertical hanging elements with a ratio of 1.51 shows the following results

Symbol	Value	Unit	Symbol Description

Cross-section properties: vertical hanging

Ax	0.040	m2	Cross-section area
Ay	0.020	m2	Shear area - Y-axis
Az	0.020	m2	Shear area - Z-axis
Ix	0.00	m4	Torsional constant
Iy	0.000	m4	Moment of inertia of a section about the Y-axis
Iz	0.000	m4	Moment of inertia of a section about the Z-axis
Wely	0.001	m3	Elastic section modulus about the Y-axis
Welz	0.001	m3	Elastic section modulus about the Z-axis
ht	0.20	m	Height of cross-section
bf	0.20	m	Width of cross-section
tf	0.10	m	Flange thickness
tw	0.10	m	Web thickness
ry	0.06	m	Radius of gyration - Y-axis
rz	0.06	m	Radius of gyration - Z-axis

Material

Name		-	WOOD
gM	1.30	-	Material safety coefficient
f m,o,k	17236.90	kPa	Strength for bending
f t,o,k	8618.45	kPa	Strength for tension
f c,o,k	12410.57	kPa	Strength for compression
f v,k	723.95	kPa	Strength for shear
f t,90,k	2757.90	kPa	Strength for transversal tension
f c,90,k	3895.54	kPa	Strength for transversal compression
E o,moyen	12410566.99	kPa	Average modulus of axial elasticity
E o,05	7308445.01	kPa	5% modulus of axial elasticity
G moyen	827371.13	kPa	Average modulus of transversal elasticity
Class	1	-	Service class
Beta c	0.20	-	Shape coefficient (rectangular sections or others)

Internal forces in section characteristic points

N	0.59	kN	Axial force N
MY	25.97	kN*m	Bending moment MY
TZ	-16.51	kN	Shear force in direction Z

Stresses in characteristic points of cross-section

Sig_c,o,d	14.83	kPa	Normal stress due to compression
Sig_m,y,d	19480.82	kPa	Base edge normal stress due to My
Tau z,d	-619.07	kPa	Tangent stress in direction Z

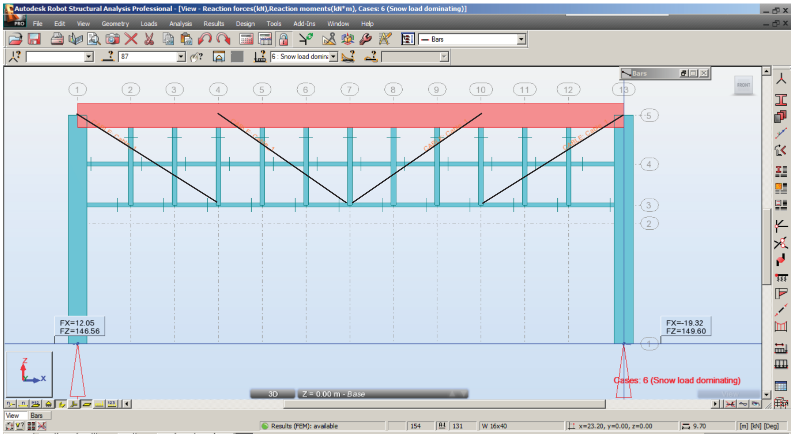
Allowable stresses

f c,o,d	10501.25	kPa	Allowable normal stress due to compression
f m,y,d	14585.07	kPa	Allowable normal stress from bending
f v,d	612.57	kPa	Allowable longitudinal shear stress

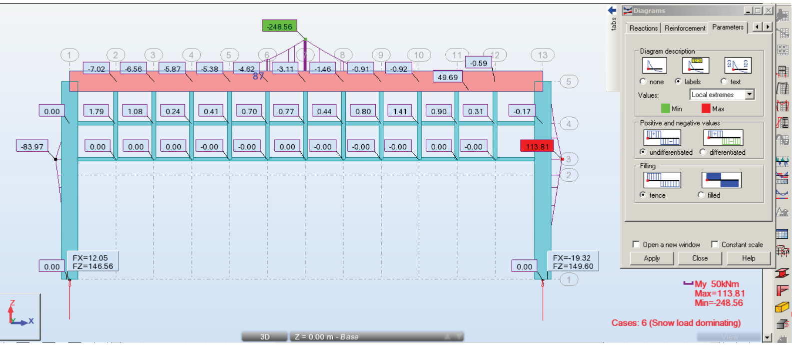
Ratio

Delta	1.51	-	Ratio between normal and allowable stresses

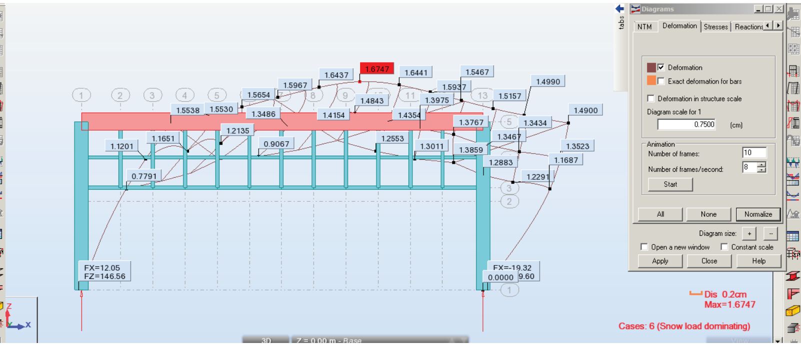
Following these results, several changes have been done to the structure. The frame of the truss (timber columns and timber beam) has been changed into glue laminated elements and cables have been introduced conecting critical points in which they can take up the tension forces of the structure. Thus the system has the following geometry, by including steel cables (S 460 Q/QL/QL1) with a section of 0.03 sqm.



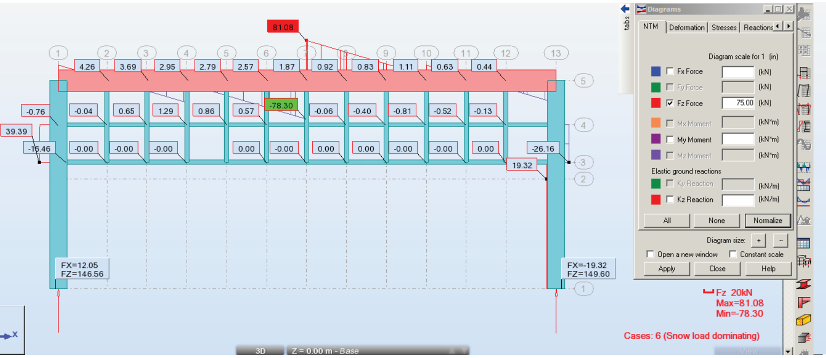
ill. 109 truss geometry



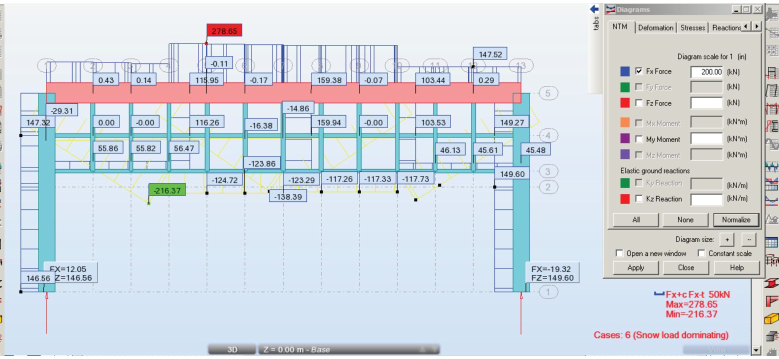
ill. 110 moment diagram



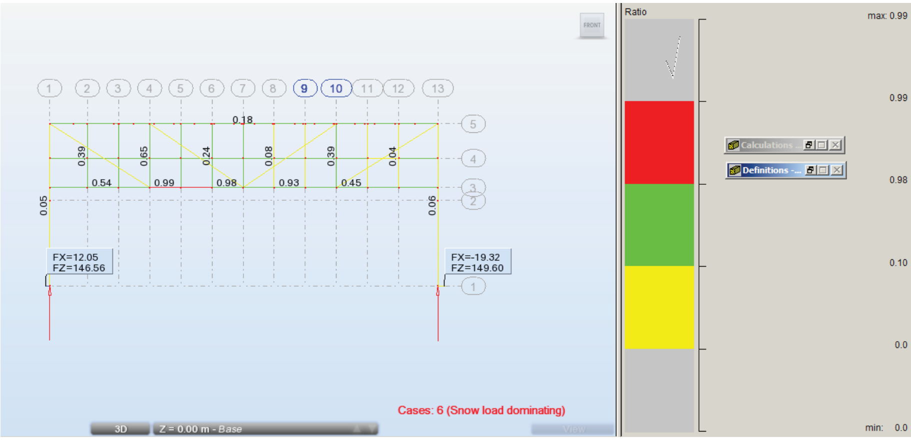
ill. 111 deformation diagram



ill. 112 shear forces diagram



ill. 113 normal forces diagram



ill. 114 map of rendered elements according to their ratio

Map of elements rendered according to the ratio calculated in Autodesk Robot Structural Analysis. Several elements (vertical hanging) have a ratio which is very close to the limit, however this can be neglected since Autodesk Robot Analysis is using lower values for the characteristic of the material compared to the capacities of timber elements class C30). Detailed results of the same vertical hanging element previously analysed show the following values (the materials characteristics are kept the same):

Symbol	Value	Unit	Symbol Description

Cross-section properties: vertical hanging

Ax	0.040	m2	Cross-section area
Ay	0.020	m2	Shear area - Y-axis
Az	0.020	m2	Shear area - Z-axis
Ix	0.00	m4	Torsional constant
Iy	0.000	m4	Moment of inertia of a section about the Y-axis
Iz	0.000	m4	Moment of inertia of a section about the Z-axis
Wely	0.001	m3	Elastic section modulus about the Y-axis
Welz	0.001	m3	Elastic section modulus about the Z-axis
ht	0.20	m	Height of cross-section
bf	0.20	m	Width of cross-section
tf	0.10	m	Flange thickness
tw	0.10	m	Web thickness
ry	0.06	m	Radius of gyration - Y-axis
rz	0.06	m	Radius of gyration - Z-axis

Internal forces in section characteristic points

N	112.71	kN	Axial force N
MY	-5.92	kN*m	Bending moment MY
TZ	3.00	kN	Shear force in direction Z

Stresses in characteristic points of cross-section

Sig_c,o,d	2817.63	kPa	Normal stress due to compression
Sig_m,y,d	4439.27	kPa	Base edge normal stress due to My
Tau z,d	112.62	kPa	Tangent stress in direction Z

Allowable stresses

f c,o,d	10501.25	kPa	Allowable normal stress due to compression
f m,y,d	14585.07	kPa	Allowable normal stress from bending
f v,d	612.57	kPa	Allowable longitudinal shear stress

Factors and additional parameters

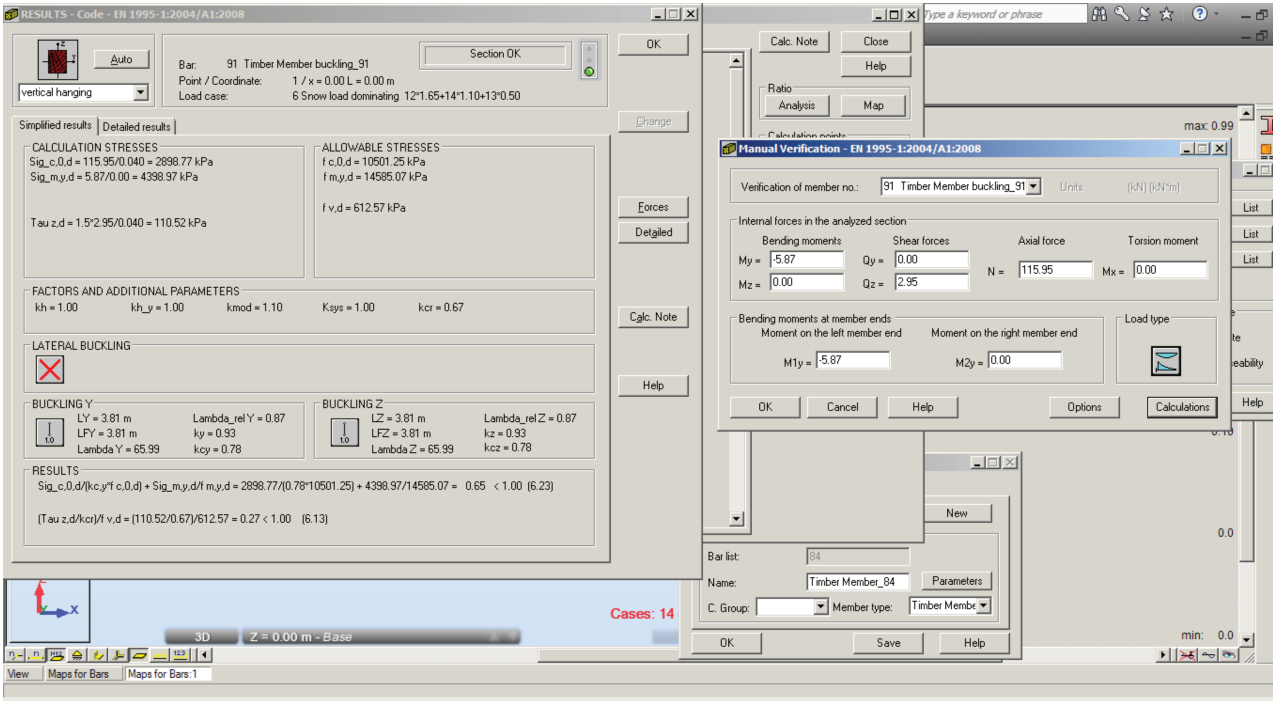
kh	1.00	-	Scale coefficient
kh_y	1.00	-	Scale coefficient
kh_z	1.00	-	Scale coefficient
kl	1.00	-	Reduction factor depending on member length
kmod	1.10	-	Modification factor depending on time of load action
km	0.70	-	Interaction factor due to bending
Ksys	1.00	-	System coefficient
kcr	0.67	-	Factor depending on timber type

Buckling parameters

About the Y axis of cross-section			
LY	3.81	m	Member length
LFY	3.81	m	Buckling length
Lambda Y	65.99	-	Member slenderness
Sig c,crit,y	16563.55	kPa	Critical stress (buckling)
Lambda_rel Y	0.87	-	Relative slenderness (buckling)
ky	0.93	-	Slenderness factor
kcy	0.78	-	Reduction factor due to compression
About the Z axis of cross-section			
LZ	3.81	m	Member length
LFZ	3.81	m	Buckling length
Lambda Z	65.99	-	Member slenderness
Sig c,crit,z	16563.55	kPa	Critical stress (buckling)
Lambda_rel Z	0.87	-	Relative slenderness (buckling)
kz	0.93	-	Slenderness factor
kcz	0.78	-	Reduction factor due to compression

Ratio

Delta	0.65	-	Ratio between normal and allowable stresses



ill. 115 Robot screenshot with detailed results for the vertical hanging analysis and the internal forces in the analyzed section

Detailed results for the glue laminated beam

Material

Name		-	GL36h
gM	1.25	-	Material safety coefficient
f m,0,k	36000.00	kPa	Strength for bending
f t,0,k	26000.00	kPa	Strength for tension
f c,0,k	31000.00	kPa	Strength for compression
f v,k	4300.00	kPa	Strength for shear
f t,90,k	600.00	kPa	Strength for transversal tension
f c,90,k	3600.00	kPa	Strength for transversal compression
E 0,moyen	14700000.00	kPa	Average modulus of axial elasticity
E 0,05	11900000.00	kPa	5% modulus of axial elasticity
G moyen	910000.00	kPa	Average modulus of transversal elasticity
Class	1	-	Service class
Beta c	0.10	-	Shape coefficient (rectangular sections or others)

Internal forces in section characteristic points

N	273.28	kN	Axial force N
MY	-248.56	kN*m	Bending moment MY
TZ	-78.30	kN	Shear force in direction Z

Stresses in characteristic points of cross-section

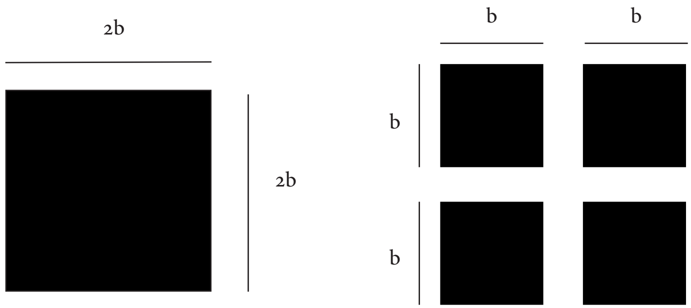
Sig_c,0,d	273.28	kPa	Normal stress due to compression
Sig_m,y,d	-248.56	kPa	Base edge normal stress due to My
Tau z,d	-78.30	kPa	Tangent stress in direction Z

Allowable stresses

f c,0,d	27280.00	kPa	Allowable normal stress due to compression
f m,y,d	31680.00	kPa	Allowable normal stress from bending
f v,d	3784.00	kPa	Allowable longitudinal shear stress

Ratio

Delta	0.18	-	Ratio between normal and allowable stresses



Case 1 Case 2

A further calculation can be carried out related to the vertical hanging elements which have been translated into the statical system in Robot as one element with a square cross section 2bx2b while in reality the structure has 4 elements each with a cross section of bxb. In this case a more throrough analysis can be done by re-calculating the section ratio according to the slenderness coefficient. The elements would have eventually a cross section of 10x10cm, however, for the purpose of this analysis, the calculations have been done taking into considerations factors of multiplication compared to already tested Case 1 in Robot.

Assuming however that tension forces are distributed equally through the 4 elements, Case 2 has to be analyzed in case of compression forces, where the slenderness factor modifies the capacity of the element, because of the direction of the forces. The following condition has to be checked:

$$\frac{\sigma_{c,0,d}}{K_{c,y} \cdot f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} < 1$$

Where:

- $K_{c,y}$ is the slenderness factor.
- $\sigma_{c,0,d}$ is multiplied with a factor of 1 because the tension forces are distributed equally in all four elements (Tension: $\sigma = \frac{P}{A} = \frac{F/4}{A/4}$)

Considering for both cases, case I and II,

$$W = \frac{1}{6}\, 2b\,(2b)^2 = \frac{8}{6} b^3$$

$$W_I = \frac{M}{W} = \frac{M}{\frac{8}{6} b^3} = \frac{6}{8}\frac{M}{b^3} = \frac{3}{4}\frac{M}{b^3} = 0.75 \frac{M}{b^3}$$

$$W_I = \frac{M}{W} = \frac{M}{\frac{8}{6}b^3} = \frac{6}{8}\frac{M}{b^3} = \frac{3}{4}\frac{M}{b^3} = 0.75\frac{M}{b^3}$$

$$W_{II} = \frac{\frac{1}{4}M}{\frac{1}{6}b^3} = \frac{6}{4}\frac{M}{b^3} = \frac{6}{4}\frac{M}{b^3} = 1.5\frac{M}{b^3}$$

Hence,

$$\boxed{W_{II} = 2\,W_I}$$

As a result, $\sigma_{m,y,d}$ is multiplied with a factor of 2.

The following table shows the comparison between case I and case II:

Parameter	Results from Robot for case I	$Case\ II/Case\ I$ Factor	New results for Case II
$\sigma_{c,0,d}$	2817 Pa	1	2817 Pa
$\sigma_{m,y,d}$	4439 KPa	2	8878 KPa
$f_{c,0,d}$	10501 KPa		10501 KPa
$f_{m,y,d}$	14585 KPa		14585 KPa

Slenderness factor calculation

The slenderness factor is defined as:

$$K_{c,y} = \left(K^2 + \sqrt{K^2 - \lambda_{rel}^2}\right)^{-1}$$

Where,

$K = 0.5\left(1 + \beta(0.2 - \lambda_{rel}) + \lambda_{rel}^2\right)$ With $\beta = \begin{cases} 0.1\ for\ glue\ laminated\ beams \\ 0.2\ for\ solid\ timber \end{cases}$

$$\lambda_{rel} = \frac{\lambda}{\pi}\sqrt{\frac{E_{0,k}}{f_{c,0,k}}}$$

To calculate λ_{rel},

$$\lambda = \frac{l_s}{i}$$

$l_s = 0.5\,l$, where l is the length of the elements and $l = 3.81\ m.$

$i = \sqrt{\frac{I}{A}}$; $I = \frac{1}{12}b^4$; $A = b^2$; Then,

$$i = \sqrt{\frac{\frac{1}{12}b^4}{b^2}} = \sqrt{\frac{1}{12}b^2} = \sqrt{\frac{1}{12}\ 0.02} = 0.03$$

Including these results in λ formula,

$$\lambda = \frac{l_s}{i} = 0.5\,\frac{l}{i} = 0.5\,\frac{3.81}{0.03} = \frac{1.9}{0.03} = 63.33$$

$$\lambda_{rel} = \frac{\lambda}{\pi}\sqrt{\frac{E_{0,k}}{f_{c,0,k}}} \xrightarrow{using\ Robot\ values} \lambda_{rel} = \frac{63.33}{\pi}\sqrt{\frac{7308\ KPa}{12\ KPa}} \cong 0.5$$

Hence,

$$K = 0.5\left(1 + \beta(0.2 - \lambda_{rel}) + \lambda_{rel}^2\right) = 0.5(1 + 0.2(0.2 - 0.5) + 0.5^2 \cong 0.6$$

Finally,

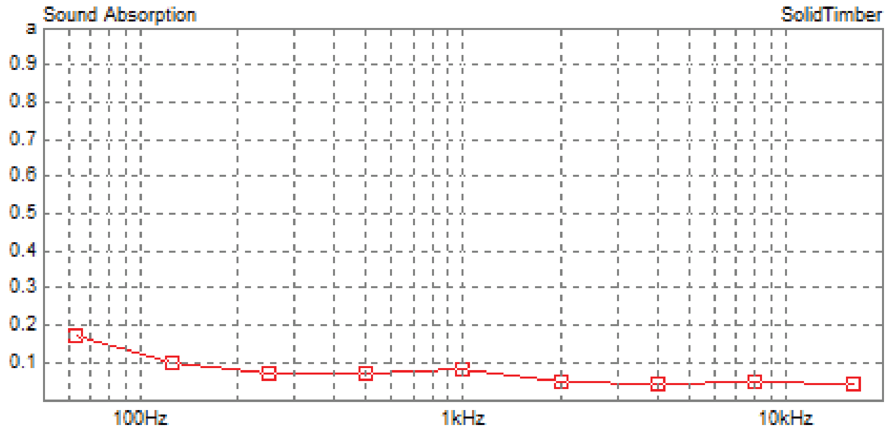
$$K_{c,y} = \left(K^2 + \sqrt{K^2 - \lambda_{rel}^2}\right)^{-1} = \left(0.6^2 + \sqrt{0.6^2 - 0.5^2}\right)^{-1} \rightarrow \boxed{K_{c,y} = 1.5}$$

After calculating these values it is necessary to check if the inequation is still valid:

$$\frac{\sigma_{c,0,d}}{K_{c,y} \cdot f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} < 1$$

$$\frac{2817\ KPa}{1.5 \cdot 10501\ KPa} + \frac{8878}{14585} < 1 \rightarrow 0.17 + 0.6 < 1 \rightarrow \boxed{0.77 < 1}$$

IX. appendix 2 acoustics



ill. 116 absorbtion coeficient for solid timber.

The absorbing coeficients for solid timber are quite high and since the structure is exposed in the concert hall, on the ceiling, in order to reach the proper reverberation time, which is considered to be the time the sound needs to drob with 60dB below the initial level of emition, materials with lower absorbtion properties have been chosen, in order to reflect the sound . Acording to Autodesk Ecotect Analysis, the recommended reverberation time for an auditorium is is 0.99 s for an initial frequency of 500Hz in case of speech and 1.66 s for an initial frequency of 500 Hz in case of music.

Absorbtion coeficients for chosen materials

Solid timber for the structure

Freq(Hz)	63	125	250	500	1000	2000	4000	8000	16000
Value	0.17	0.01	0.07	0.07	0.08	0.05	0.04	0.05	0.04

Glass

Freq(Hz)	63	125	250	500	1000	2000	4000	8000	16000
Value	0.05	0.05	0.02	0.01	0.01	0.02	0.01	0.01	0.02

Concrete slab

Freq(Hz)	63	125	250	500	1000	2000	4000	8000	16000
Value	0.01	0.01	0.02	0.02	0.03	0.04	0.07	0.07	0.05

Plywood for walls and ceiling

Freq(Hz)	63	125	250	500	1000	2000	4000	8000	16000
Value	0.15	0.10	0.07	0.07	0.08	0.05	0.04	0.05	0.05

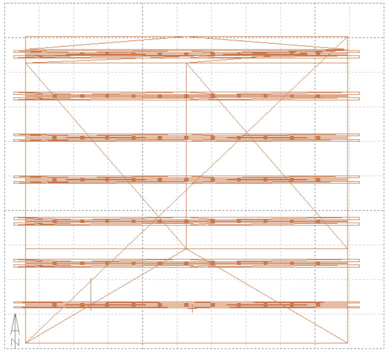
In order to reach the required reverberation time, different geometries have been tested in Autodesk Ecotect Analysis 2012

1. Straight back wall:

Volume: 4199.490 m3
Surface Area: 26927.496 m2
Occupancy: 176 (220 x 80%)
Optimum RT (500Hz - Speech): 0.99 s
Optimum RT (500Hz - Music): 1.66 s

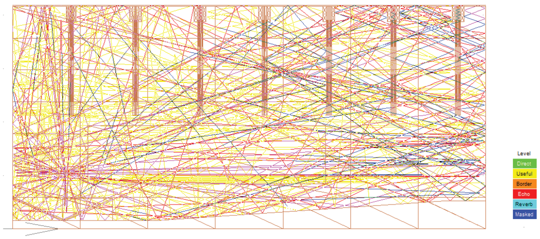
Volume per Seat: 19.089 m3
Minimum (Speech): 4.741 m3
Minimum (Music): 8.733 m3

Most Suitable: Millington-Sette (Widely varying)
Selected: Sabine (Uniformly distributed)
220 auditorium seating hard-backed with a percentage of occupation of 80.

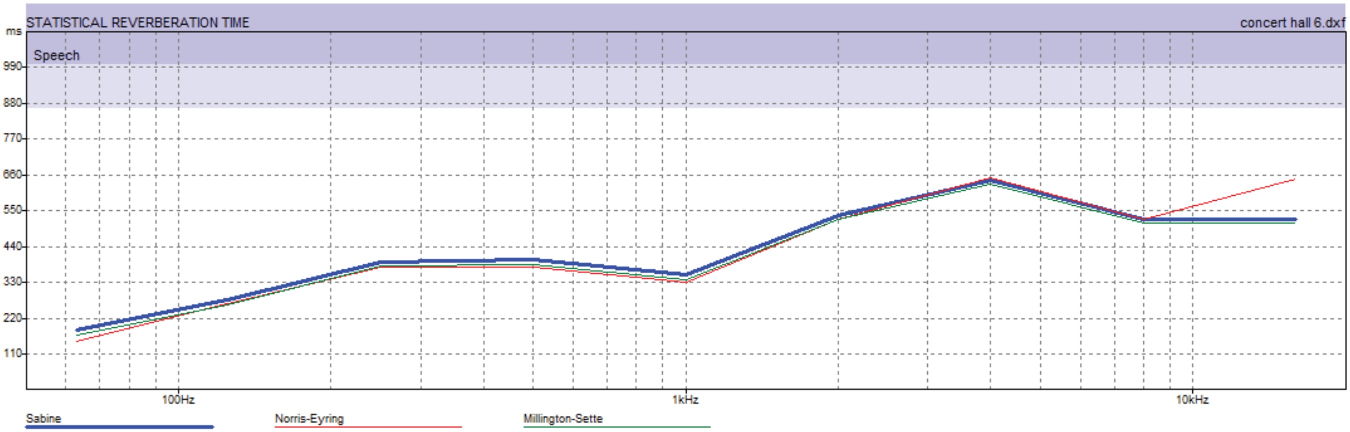


ill. 117 plan view of the analyzed geometry

Frequency	Total Absorbtion	Sabine RT (60)	NOR-ER RT(60)	MIL-SE RT(60)
63Hz:	3860.632	0.18	0.15	0.17
125Hz:	2588.821	0.27	0.26	0.26
250Hz:	1770.268	0.39	0.38	0.38
500Hz:	1744.426	0.4	0.38	0.38
1kHz:	1983.898	0.35	0.33	0.34
2kHz:	1276.333	0.53	0.52	0.52
4kHz:	1054.248	0.64	0.65	0.63
8kHz:	1303.264	0.52	0.52	0.51
16kHz:	1301.229	0.52	0.65	0.51

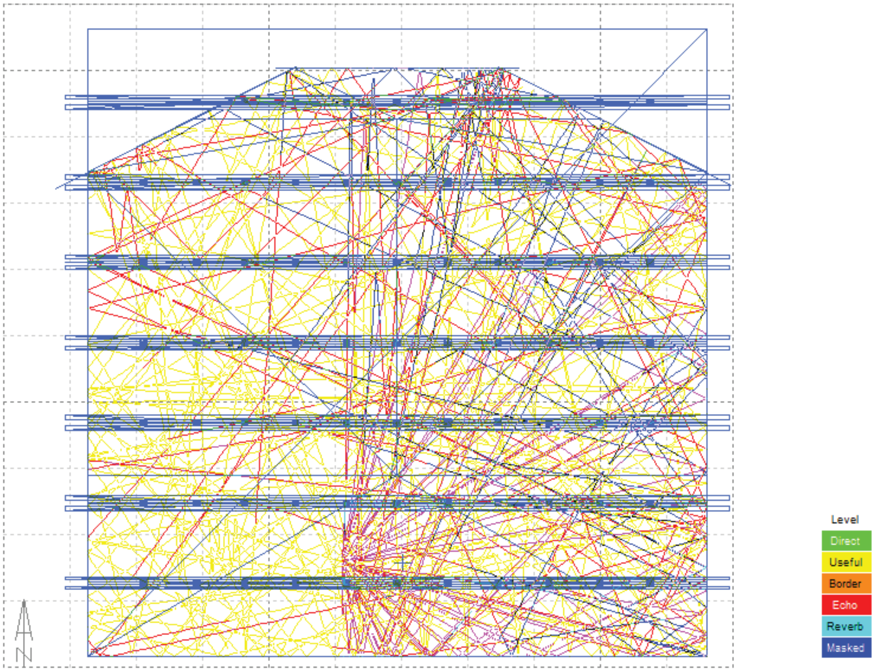


ill. 118 sound rays - side view



ill. 119 reverberation time

1. Alternative geometry for the back wall:

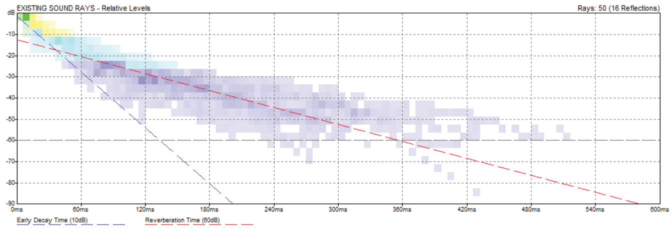


ill. 120 sound rays - plan view

Volume: 4199.490 m3
Surface Area: 26927.496 m2
Occupancy: 176 (220 x 80%)
Optimum RT (500Hz - Speech): 0.99 s
Optimum RT (500Hz - Music): 1.66 s

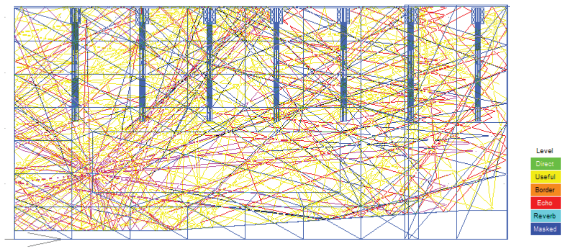
Volume per Seat: 19.089 m3
Minimum (Speech): 4.741 m3
Minimum (Music): 8.733 m3

Most Suitable: Millington-Sette (Widely varying)
Selected: Sabine (Uniformly distributed)
220 auditorium seating hard-backed with a percentage of occupation of 80.

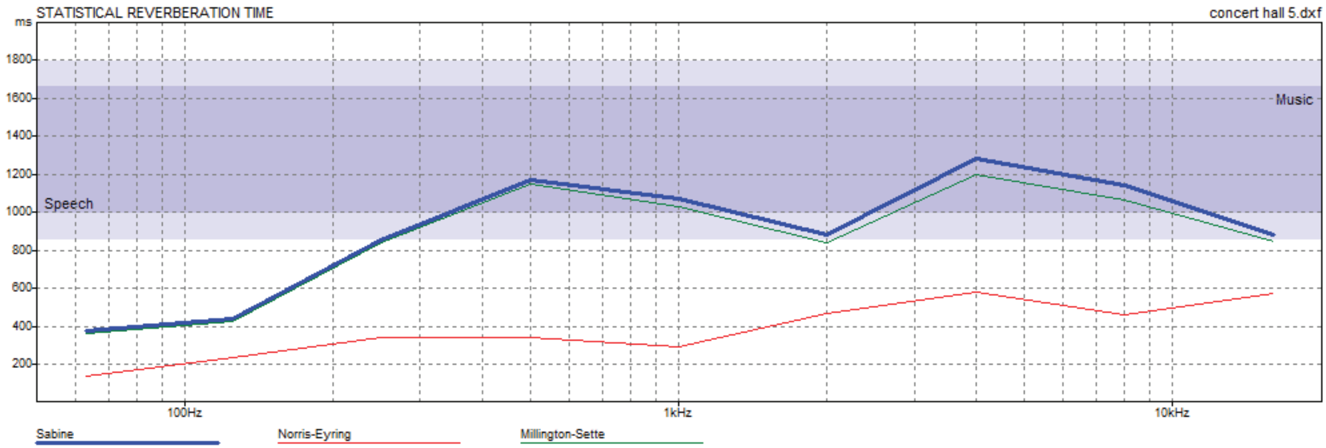


ill. 121 acoustic response

Frequency	Total Absorbtion	Sabine RT (60)	NOR-ER RT(60)	MIL-SE RT(60)
63Hz:	1775.65	0.38	0.13	0.36
125Hz:	1526.501	0.44	0.24	0.42
250Hz:	739.748	0.86	0.34	0.84
500Hz:	523.57	1.17	0.34	1.14
1kHz:	579.465	1.07	0.29	1.03
2kHz:	706.155	0.88	0.47	0.84
4kHz:	458.417	1.28	0.58	1.19
8kHz:	498.921	1.14	0.46	1.06
16kHz:	685.334	0.88	0.57	0.84



ill. 122 Sound rays- side view



ill. 123 reverberation time

X. appendix 3

Sustainability and design considerations . Be10

Considerations in terms of sustainability have been made throught the project, although they did not represent the main focus of it. Firstly, through the idea of creating an community within community and providing a space for social interaction between people of different ages and statuses, *social sustainability* is supported.

--- In terms of *construction costs*, local natural materials could be used, which secure environmnental sustainability, since timber is the only renewable construction material and transportation costs are reduced because the resources can be found in the very proximity of the site.

-- The *compactness* of the building is reached by eliminating thermal bridges and providing insulation in order to reach low U-values. Due to the large dimensions of the timber columns, the gap between them can be filled up with sheepwool, a *environmental friendly* insulating material , in order to reduce the U value of the wall to 0.07.

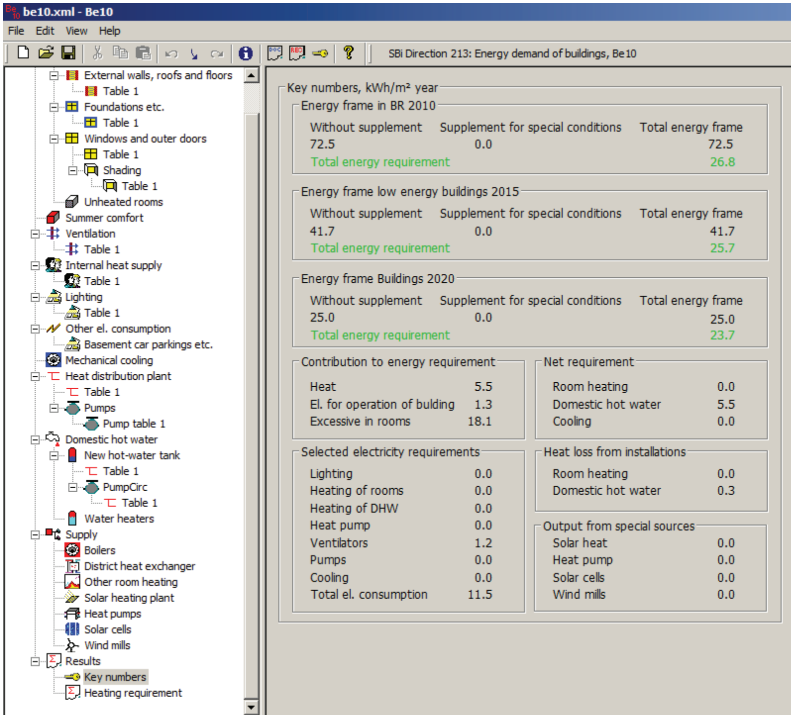
-- The *layouts* of all the buildings on the site are able to ensure a fairly good cross natural ventilation.

	BR 2010	Low energy buildings	Buildings 2020
Energy frame , kWh/m² year	72.5	41.7	25.0
Key numbers	26.7	25.6	23.6

The brief analysis in Be10 has been done considering the Oslo, Norway climatic data base, while the energy frames are according to danish standard regulations. In order to reach however the 2020 energy frame of a value lower than 25 kWh/sqm/year, the following design assumptions have been made:

- the average usage time is 168 hours/week with
- the heating is provided through district heating
- there is a possibility for natural ventilation during summer with an exchange rate of 2 l/sm^2.
- no lighting consumption has been included in the calculations - which would boost the energy consumption

Although there is no overheating in the foayer area because of the orientation of the window - towards west and possibility of natural cross ventilation, the problematic area might be the concert wall, where, due to the small opening and at peak hour when the hall has to host more than 200 people and appliances and lighting increase the heat supply. However this can be fixed by ensuring a better natural cross ventilation system, which, due to the height of the space can be combined corss ventilation with thermal buoyancy.



ill. 124 screen shot of Be10 results

ill. 125 possibility for combined cross ventilation and thermal buoyancy for natural ventilation in the concert hall

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