Our Brewhouse
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David Sztarinka & Kim Bendsen | Aalborg University | A&D 2012 | Ark24 Msc 4

Title Page

Theme: Sustainable design in a historic context

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Group: ark24

Achitectural supervisor: Michael Lauring

Technical supervisor: Peter Vilhelm Nielsen

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David Sztarinka

Kim Bendsen

Synopsis'

English

This project was developed by group 24 on the 4th semester master Architecture and Design at Aalborg University. The theme of this project is sustainable design in a historic context. The project is based on an architectural competition from 2011, where the Carlsberg Group set the challenge of designing a new Brand and Experience Centre for Carlsberg in the historic context of the Carlsberg breweries in Valby. The context of this new building is currently being redefined by a new master plan based on a competition from 2007 to revitalize the Valby site after Carlsberg moved its production to Fredericia. The building should be able to serve as the sole presence of Carlsberg in the area after this, unifying all its current function under one roof. The technical focus of the project is energy, specifically net-zero energy.

Dansk

Dette projekt er udført af gruppe 24 på 4. semester master Arkitektur og Design på Aalborg Universitet. Temaet for projektet er bæredygtigt design i en historisk kontekst. Projektet er baseret på en arkitekturkonkurrence fra 2011, hvor Carlsberg Gruppen fremlagde design udfordringen om at skabe et Brand and Experience Center for Carlsberg i den historiske kontekst, Carlsberg bryggerierne i Valby. Konteksten for den nye bygning er i øjeblikket ved at blive redefineret via en konkurrence fra 2007, der har formålet at forny området i Valby efter Carlsberg flyttede produktionen til Fredericia. Bygningen skal kunne fungere som Carlsbergs tilstedeværelse i området efter dette, ved at samle alle de nuværende funktioner under et tag. Det tekniske fokus i projektet er energi, specifikt net-zero energi.

The golden words

"In the operation of the brewery Gamle Carlsberg it shall be our constant aim, without regard to immediate profit, to develop the manufacture of beer to the greatest possible perfection, such that this brewery and its product can always stand as an example, and ensure that the brewing of beer in this country will be held to a high and honorable standard"

- J. C. Jacobsen [Arkitekturens Forlag, 2008]

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Ill. 1: Elephant gate

Introduction

"The Carlsberg Group wants to create a world-class Brand & Experience Centre. They are targeting Copenhageners and tourists of all ages who are looking for exciting new experiences and who wish to be challenged, engaged and entertained. It should be a unique type of meeting place with multiple and diverse ways to connect and communicate with people." (Carlsberg Group, 2010)

This competition is focused on the revitalization of the 3rd extension to the Ny Carlsberg Brewery and its connection to the surrounding area, more specifically the building to the north of Carlsberg's iconic Dipylon and Elephant gates. A previous competition from 2007 shows how the area is going to be developed, thereby giving a hint to the future context of the building.

The Brand and Experience Centre should reflect Carlsberg's values. Hereunder sustainability which is a focus of Carlsberg and will also be a focus for this project. The aim is to meet the low energy 2020 standard in order to insure that the building can act as an example, and strengthen Carlsberg's position as a leading environmentally conscious company. As this project takes place partly in a rich historic context, and partly in a, at the time of this writing, not yet realized but very promising sustainable context, this will be the basis for the analysis. This context analysis as well as case studies will form the basis for the functions placed into the building. After this the third major part of the analysis will focus on the idea of sustainability and its impact on the design of the new Carlsberg Brand and Experience Centre.

In aiding in the process of developing this project the group would like to extend thanks to the following people and organizations:

Sebastian Campion (Carlsberg Group)
Mathilde Brolund-Jensen (Carlsberg Group)
Christian Cold (Entasis)
Michael Frederiksen (Utopian City_Scape ApS)
Rasmus Lund Jensen

Methodology

Integrated Design Process
In developing this project the group will use the Integrated Design process, in order to reach a result that is not only of high architectural value but is functional and structurally sound. The integrated design process has been a stable at Architecture and Design in Aalborg since the education was founded. This approach main asset is that it demands that technical and indoor climatic considerations are brought in early in the process in order to achieve the best results. [Knudstrup M., Hansen H., 2005]

PHASES
The project will be divided into four phases, analysis, sketching, synthesis and presentation.

Analysis
The initiator for the project will be the design brief produced by the Carlsberg Group, this will serve as a base for the following analysis. This process will end out with a problem statement followed by design criteria that will have to be fulfilled by the final design.

Sketching
Architectural ideas are described and produced with connection to the context, construction, energy consumption and indoor environment. The main concept is going to be specified in this phase.

Synthesis
Conceptual ideas, functional and room programs are being developed to make it work with the design parameters which were set at the analysis phase. The development should be done by using précised tools for evaluating and optimizing the properties of the selected concept.

Presentation
Finally the project is presented by the use of drawings, story, digital and physical models.

Tools

Monthly average spread sheet
This spread sheet is going to be used to calculate monthly and yearly average energy consumption for heating, cooling and other equipment's. The input is construction details regarding external structure and ventilation rate for summer and winter as well as internal heat loads.

BSIM
This program is going to be used to calculate the indoor environment in a section (selected area) of the building. The program works with large number of input and output and therefore it allows us to create much more accurate results than spread sheet calculations. Beside the accuracy of the program we also have to fulfil the Danish BR2020 energy frame therefore we are going to use BE10 along BSIM.

BE10
BE10 is going to be used to find balance between energy losses and gains, to minimize energy usage in the whole building. BE10 calculates according to BR2020.
AutoCad
3D Studio Max
Adobe CS
Rhinoceros

Vision

In creating the new brand and experience centre for Carlsberg, this project aims to create a building that respects and draws upon the rich culture and history of this important area but also the same time looks to the future. The building should integrate into the surrounding historic buildings while still maintaining its own identity. As an extension of the Carlsberg site it should, as the previous extensions did, represent state of the art in building design and represent the values that the Carlsberg brand stands for, e.g. sustainability, science and quality. The visitor centre in the heart of the Carlsberg area should be a place what caters to the public as well as investors and shareholders.

Initial problem formulation

How to create sustainable architecture in a context with a rich cultural heritage; that focuses on:

- Contemporary architecture
- Zero Net Energy
- Indoor climate

Context

Ill. 2: Gamle Carlsberg

History

Ever since Jacob Christian Jacobsen in 1847 moved his brewery from the city streets behind the walls of old Copenhagen to the fresh air and unpolluted water of Valby bakke, it has maintained a strong presence on this location. The location that also, along with J. C. Jacobsens son Carl, provided the name of the brewery; Carlsberg. [Arkitektens Forlag, 2008] Over the years and through numerous expansions the brewery was turning into a small city unto itself even as Copenhagen grew larger and engulfed it, it maintained its independent status. This evolution created an area that is at the same time part of the city and detached from it, an island in Copenhagen. [Arkitektens Forlag, 2008] With Carlsberg now long since having moved most of its brewing facilities out of the area, the challenge is to integrate this once segregated part of this city while telling the story of this most remarkable area of Copenhagen. The first leg of this process was begun in 2007 with the "Our City" (Vores By) competition, won by the Danish architectural firm Entasis. The next part, this part, of the process is bringing new life into one of the historical buildings, more specifically the brew house on Ny Carlsberg Vej, that were left over when Carlsberg moved its production.

Development of the site

This comparison between the Carlsberg breweries and a city also extends to the way in which it expanded. Because of the amount of space afforded by the relocation to the Valby site the brewery was not confined in its expansion. This along with the lofty ambitions of the owners and the demands of the consumers saw the brewery grow from a single building to the expansive network seen today. Most of this growth happening during the reign of J. C. Jacobsen and his son Carl Jacobsen, whose bitter rivalry led to the split of the brewery into Old Carlsberg and New Carlsberg before a later reconciliation merged the breweries back together.

Ill. 3: Entasis masterplan public space


Ill. 4: Entasis masterplan trainstation

Entasis master plan

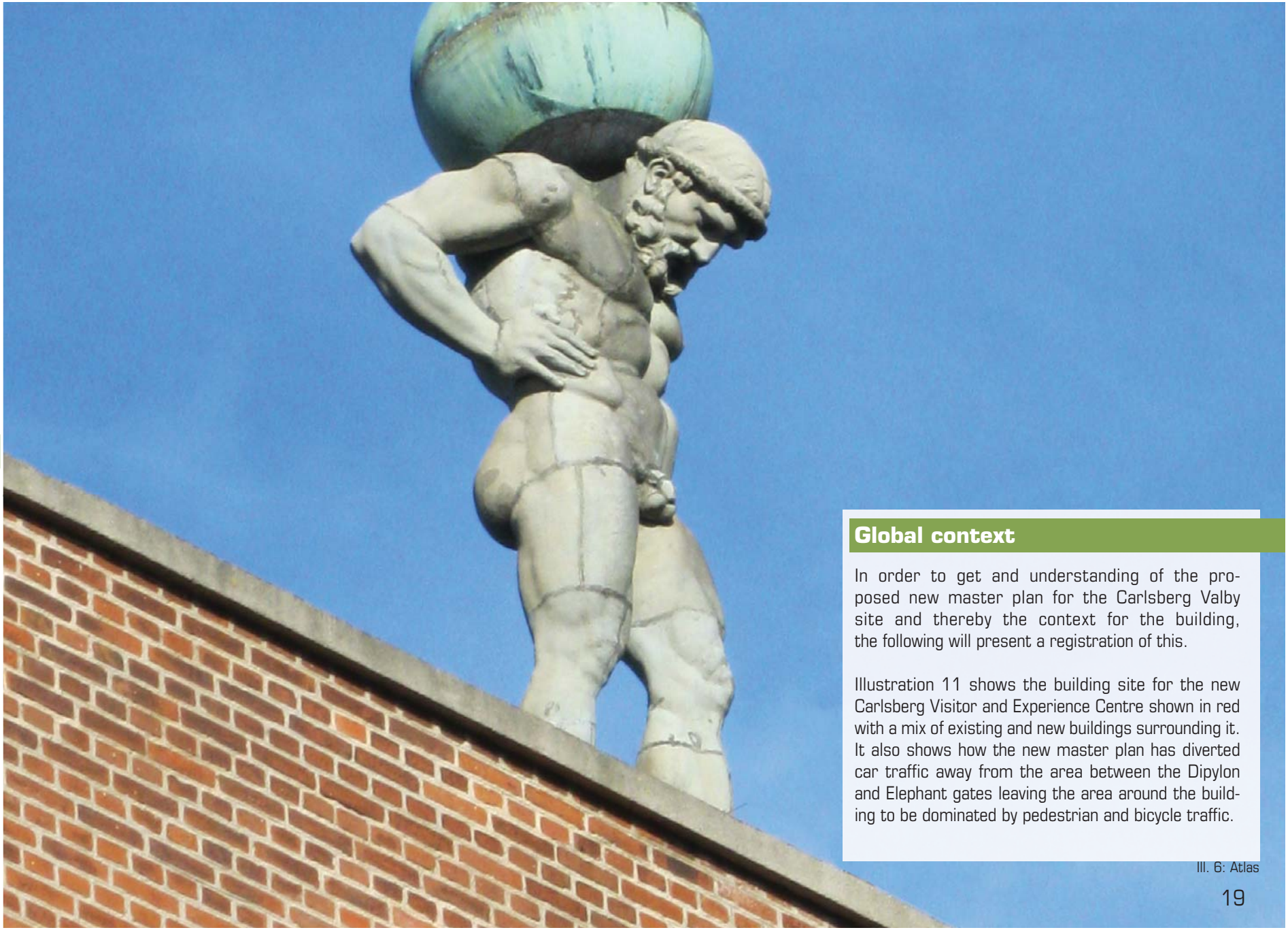
As mentioned previously the future development of the Carlsberg Brewery complex at Valby bakke in Copenhagen got commissioned via an international planning competition that was won by the Danish architecture firm Entasis. The concept of the winning proposal revolves around the network of basements that were left empty after the brewery moved out, these are given a new purpose. They form the basis of the master plan by indicating the location of important squares and meeting places, as well as providing the functions for these. These functions will vary from square to square, with an outdoor swimming pool in one and so forth. These squares will also be marked with high-rises, which will act as visual markers for them while also creating a analogy to the towers Copenhagen is known for. [Arkitekturens Forlag, 2008]

The area is bordered by the railroad tracks to the South, Gammel Carlsberg Vej to the West and Vesterfælledvej to the East. To the North the definition is much looser with the area merging into the city to a higher degree. Ny Carlsberg Vej will remain the primary traffic access through the area, and along with Gammel Carlsberg Vej they will act as the primary roads for cars in the area. In addition to this a network of bicycle paths will be introduced into the area. These squares vary in size but generally are kept in human scale, to ensure that the spaces feel lively and to articulate to the user that they are in the dense city. Looking at the impact this new master plan will have on the close context of the new Visitors Centre, it is clear that the urban space directly North of the building will see the most change. With the planned construction of two new buildings along the perimeter of this space it will be a much more defined area after the completion of the new master plan. This will provide a much more tightly defined close context for the building. Besides this change most of the surrounding buildings are preserved so the impact of the masterplan on the very close context is limited.

Ill. 5 Traditional Carlsberg

Building on a historic site

When designing most buildings the context of said building is very important, there are of course some exceptions to this, but never the less. When designing in a context with a rich history it becomes even more important, regardless of whether or not the design aims to integrate or differentiate itself. This project aims to follow the precedence set by the previous expansions at Carlsberg by creating a building that can represent Carlsberg's image as a progressive company that is looking towards the future. In other words, this project does not aim to create a building that will reflect the style of the historic buildings in the area, instead it aims to create a contemporary building that draws upon the references and general themes of the old while representing state of the art building technology.



Global context

In order to get and understanding of the proposed new master plan for the Carlsberg Valby site and thereby the context for the building, the following will present a registration of this.

Illustration 11 shows the building site for the new Carlsberg Visitor and Experience Centre shown in red with a mix of existing and new buildings surrounding it. It also shows how the new master plan has diverted car traffic away from the area between the Dipylon and Elephant gates leaving the area around the building to be dominated by pedestrian and bicycle traffic.

Ill. 6: Atlas

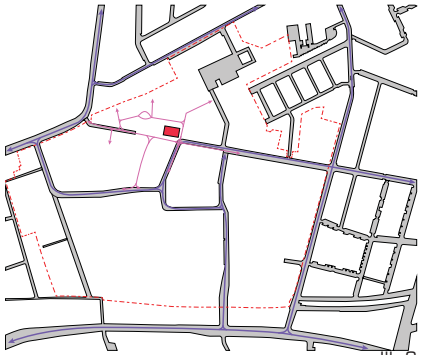
Preserved buildings

Most of the buildings constructed during the period where J.C. and Carl Jacobsen ran Carlsberg have been preserved and will therefore continue to exist in the new master plan, though most of these buildings have lost their function when Carlsberg moved it's production to Fredericia in 2008.

Ill. 7

Main roads

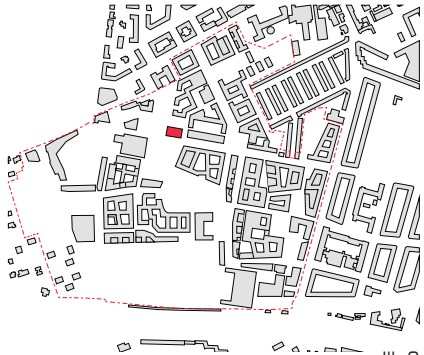
Most of the roads that are present in the area now are left untouched by the new master plan, though there has been made a few important changes. Most notably the area between the Dipylon and Elephant gates has been closed off for car traffic and been re-directed south along Pasteursvej. This change has opened up for a more free pedestrian flow around the building.



Ill. 8

New Building mass

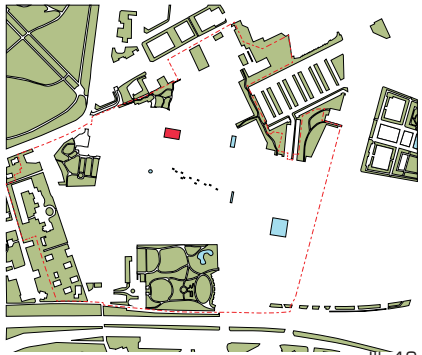
Entasis has suggested a master plan with a building percentage of 185; this generates a very dense environment, and suggests a new context that more closely reflects the sites location in the heart of Copenhagen. The new city grid is dominated by block buildings that reflect what is seen in most of Copenhagen, with city streets that emerge organically between them.



Ill. 9

Green blue

The context features several large and small parks the largest of which is Søndermarken to the North West. To the south is J.C Jacobsen's garden which marks the south edge of the Carlsberg area. These are supplemented by several other patches of green of varying sizes that are scattered around the area. Several smaller blue elements are also planned in the new master plan, these will consist of a few larger bodies of water and a line of "reverse stepping stones" that mark a path besides the twisted chimney.



Ill. 10

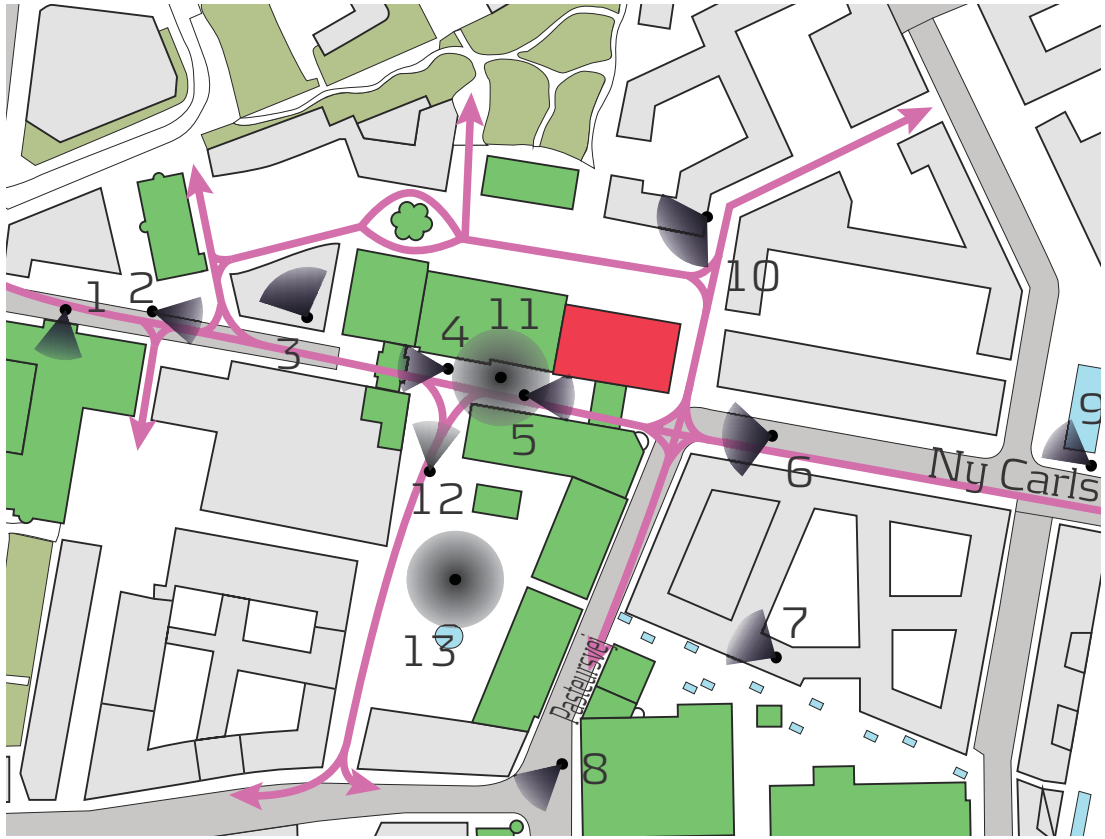
Conclusion

The new Carlsberg Brand and Experience Centre it will be designed in a very varied context some of which is presently only undefined building mass while the other is well documented historical buildings. This duality between the two gives the site a tension that the new building will seek to exploit. Also the suggested changes to the traffic flows around the site will create an area that is more conducive to slower moving traffic, and thereby create the basis for a lively and vibrant area. The green aspects of the Carlsberg area are mostly confined to the edges of the area while the planned blue elements will predominately be placed in the centre. This lack of natural elements in physical connection to the site in conjunction with Carlsberg's desire to be seen as a sustainable brand, could present the opportunity to add these in the design.

Ill. 11 Future masterplan

Local context

Most of the local context for the new Brand and Experience Centre is made up of historic, preserved buildings. These will remain in their current form in the new master plan. Only the buildings to the East and North of the building will change character. This will change the spatial character of the area directly north of the building, but the rest of the areas around will maintain their spatial character. Because of this relatively low impact the new master plan will have on the local context of the site, the current state of this can be analysed and provide a pretty accurate picture of the future conditions for the building. The biggest change in the sites local context is the removal of car traffic from the area between the gates. This completely changes the dynamic of this area, bringing it from a strictly transit oriented area to something more closely resembling a public plaza. This combined with the area north of the building getting opened up to the public will allow for pedestrian and bicycle traffic all around the building, thereby demanding a building that provides engaging facades in all directions. To this end an understanding of the local context is necessary. A serial vision has been established to introduce the local context of the building site. The serial vision explain the conditions of the area, but it`s relation according to physical connection, styles and architectonic qualities will be evaluated in the upcoming paragraphs.



Ill. 12 Local context

Ill. 13

View from Ny Carlsberg Vej to Carlsberg Museum. Curently it works as a Business centre, but the upcoming Visitor and Business Centre questions it`s future functionality.

Ill. 14

View from Ny Carlsberg Vej to the Elephant gate and the Ny Carlsberg Brewhouse. The elephant gate is the best known landmark in the area.

Ill. 15

Following Ny Carlsberg Vej, a parking lot can be found in front of Ny Carlsberg Brewhouse. These parking lots will be removed and replaced by an underground parking lot next to the Carlsberg Headquarters, therefore this view will completely change as a new residential building is going to be erected here.

Ill. 16

After passing by the Elephant gate, looking back towards the Museum. As this is a main attraction for tourists in the area, it`s likely that they get access to the new Visitor and Experience Centre through the Elephant gate.

Ill. 17

Turning around and heading towards the Headquarters, looking at the Dipylon gate clearly shows the confinement of the area.

Ill. 18

Standing next to the HQ and looking back at the Dipylon gate shows a barrier created by historical buildings at the east to south east part of the area.

Ill. 19

View from the Twisted Chimney towards the barrier mentioned before that consist of the second and third Ny Carlsberg, the Dipylon gate and the Ny Carlsberg Brewhouse.

Ill. 20

The entrance, Star Gate of the Old Carlsberg Brewery/ First Ny Carlsberg Brewery and the famous lighthouse from Pasteursvej.

Ill. 21

The Headquarters from the ground parking lot next to it. The underground parking lot will be situated just next to the Headquarters.

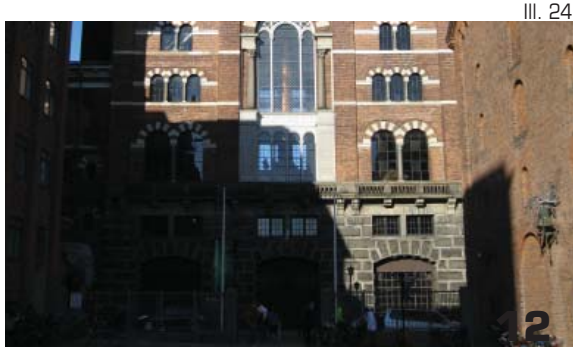
Ill. 22

View from "Behind the Elephants" plaza which is a private area at the moment, but will in the future be rehabilitated and be given back to the people visiting, living and working in the area.

Ill. 23

View from the area between the Elephant and Dipylon Gates to the historic part of the new Brand and Experience Centre building.

Ill. 24



Straight on view on the entrance of the historic part of the building that will house the Brand and Experience Centre.

Ill. 25

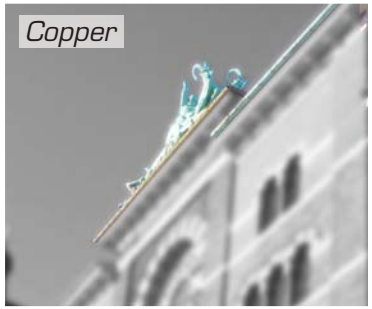
This view is showing the back side of the second extension to the Ny Carlsberg brewery with the new glass tower that used to house the Headquarters of Carlsberg.

Relation to sorrounding buildings

The new Brand and Experience Centre will with its central location and its physical connection to two iconic landmarks in Copenhagen, namely the Dipylon and Elephant gate, enter into the rich narrative that is the Carlsberg Valby site. This presents a great opportunity to create a building that will act as a landmark in an area filled with iconic buildings and at the same time presents the challenge of creating a building that can act as a logical extension of the existing. In the proposed master plan by Entasis the building takes on a role of mediator between the historic buildings to the South and West and the new buildings to the North and East. This presents an interesting duality in the very close context of the building where on the one side there are the historic buildings which are a known quantity and on the other the new buildings that at the time of writing are still undefined. The only known characteristics of the new buildings are their footprints suggested in the master plan as wells as that the area will be low energy. Therefore the following architectural studies will focus on the existing buildings.

Primarily used to accent the various spires of the buildings, though the largest concentration is found on the spire of the elephant gate.

Besides being the window material, glass is also used in the elephant gate to form archways to the adjacent buildings. The glass used in the historic buildings is single pane glass, this poses a problem if these buildings should be used today because they represent a massive heat loss, and would have to be replaced.



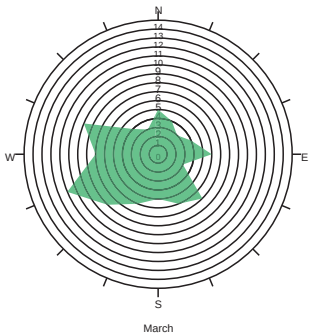
Used in different places throughout the exterior of the buildings. Seen on the roofs of some of the buildings and on ornamental gargoyle heads besides its use in the statues that adorn the tops of the buildings.

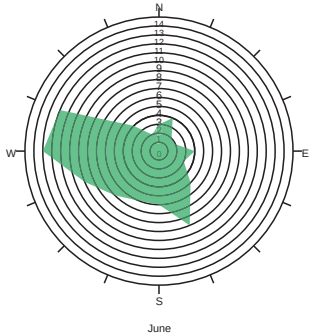
Only seen in the northern building where it is used in the middle entrance part of the building, in order to accentuate this as the primary entrance of the building. This limestone cladding is attached to the underlying brickwork.

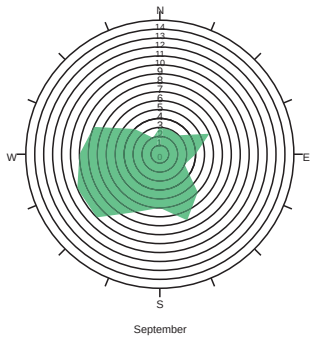
Besides being the material that the elephants of the elephant gate are made of, stone is also used throughout the buildings as accents to emphasize the openings of the building be it windows or doors.

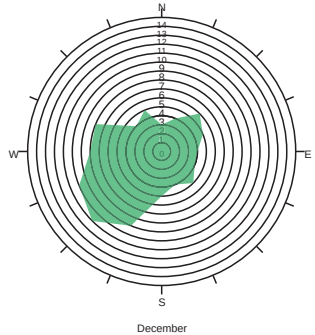
The primary building material in this part of the Carlsberg site is bricks, the colour varying from a lighter to a darker shade of red. The brickwork is quite varied in the area, with some facades ornamentation being purely fashioned in brick.

Ill. 26

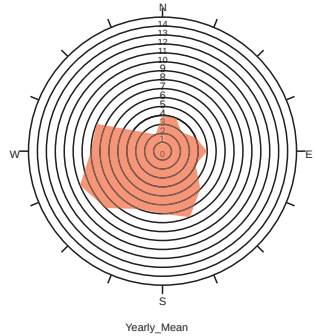








Ill. 27 Wind



Ill. 28 Wind mean

Micro Climate

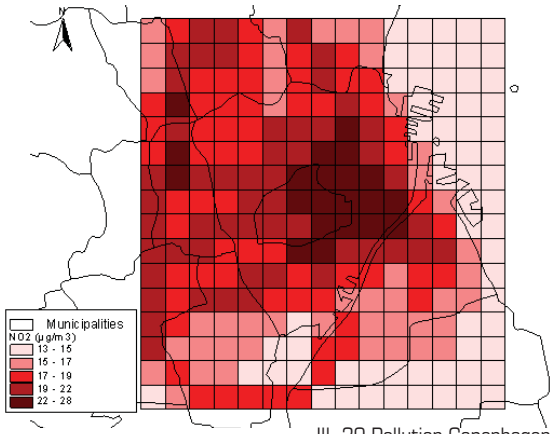
Taking microclimate into consideration is crucial when designing a sustainable building since the effect of the local climate affects the building design as well. Diagrams of different aspects of the microclimate will be presented with explanations and conclusion regarding microclimate effect on design principles.

Wind (wind speed and direction)

As a previous illustration showed [ill. 11] the future urban layout is even denser than the existing, therefore to make a sustainable building for the future. Wind will be a driving force for natural ventilation during the summer season, but will also affect the outdoor spaces connecting to the Visitor and Business Centre. The wind roses [ill 27] show the main direction and the frequency of the directions on the chosen months, solstice and equinox. The table [ill 29] shows a summary of the wind speed in the chosen months in knots and in m/s for further calculations. The dominant wind direction is West of Southwest (WSW) but southern wind is also likely to occur especially in the natural ventilation period (April – October) The height of the surrounding buildings will have a major effect on the buildings natural ventilation. Because of high density of the area the natural ventilation can only work with low efficiency. As a conclusion, the building has to adapt to the dense urban environment the best natural ventilation solution has to be implemented with the highest efficiency ratio.

Month	February	March	June	September
Direction	ESE & WSW	WSW	W	SW &WSW
Speed (knots)	12	12	11	11
Speed (m/s)	6,173	6,173	5,659	5,659
Air temp (°C)	2	5	18	16

Ill. 29 Wind table

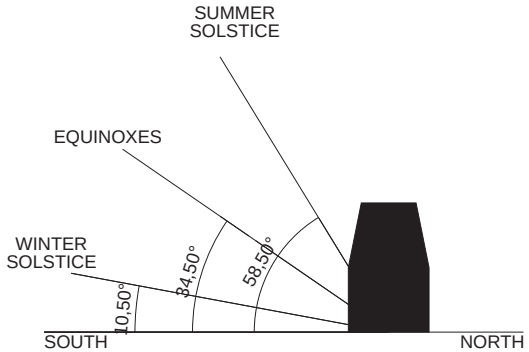


Ill. 30 Pollution Copenhagen

Air quality

The city of Copenhagen is characterised by a combination of high population and high vehicle emission density. Copenhagen is located in a coastal area with flat terrain and relatively high average wind speeds that provide for favourable air quality conditions. However, the local building topography with many heavy trafficked street canyons restricts the dispersion of emissions and cause a lowering of the air quality. Recent scenario studies have shown that a large number of streets in Copenhagen will not be able to comply with European Union air quality limit values for nitrogen dioxide (NO2) in 2010. [www.asset-eu.org, 2012]

Based on the study from 2010, the site is one of the polluted areas in the heart of Copenhagen with an average of 17-19 NO2 level, although the future urban layout has to be considered as the vehicle traffic will be prohibited in the close area of the site. [Ill. 30]



Ill. 31 Sun angle of incidence

Sun (daylight, sun path, shadow)

An important part of sustainability is to supply high quality indoor environment. Daylight has a great effect on the indoor environment. Commercial areas like offices only require daylight, since direct sunlight creates a distracting working environment. The new building has to consist of bright areas which are exposed to direct sunlight and areas with indirect sunlight. Illustration 31 shows a simplified version of the height of the sun at critical days of the year.

Connection to other buildings

In respect of the buildings preserved status only the newer non preserved eastern part of the building will be redesigned. This leaves the new building with two physical connections to the existing historical buildings. These being to the south the dipylon gate and to the west the preserved part of the brewhouse building. In designing the new building care has to be given to solve these connections.

Ill. 32 Physical connection to surrounding

Far

Ill. 33 Koldinghus context

Medium

Ill. 34 Koldinghus facade

Near

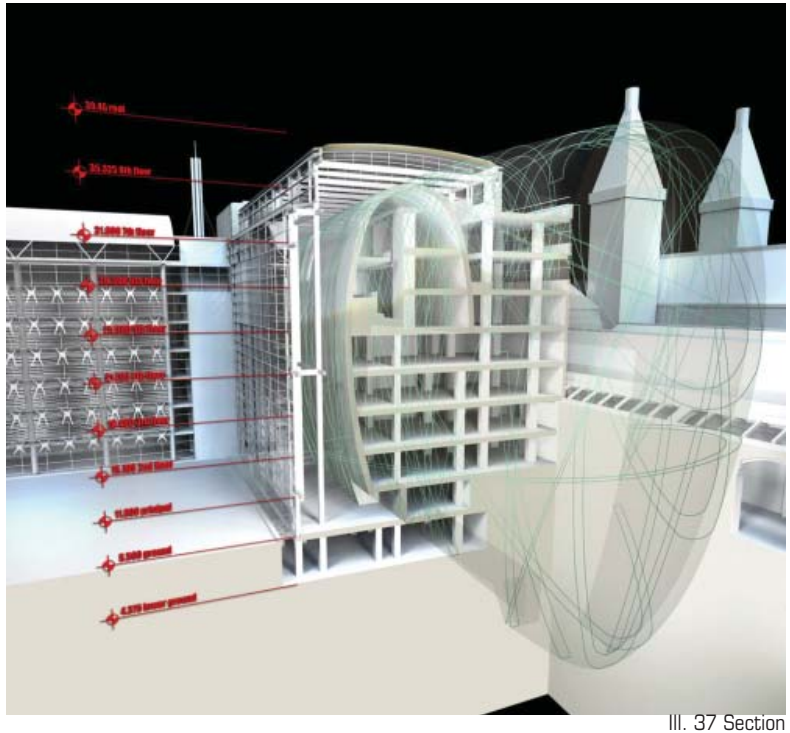
Ill. 35 Koldinghus detail

Case study Koldinghus

This former royal castle in the Danish city Kolding was founded in 1268 as a fortification to protect the Danish border against the duchy of Slesvig. Between 1400 and 1723 the castle was extended and modernised several times, during this time it changed function from a royal to a civilian castle, and styled after the baroque ideals. [Denstoredanske, 11/2 2012] In 1808 disaster struck, a fire broke out and burned the castle to a ruin, and with the country's financial situation in shambles an immediate reconstruction was not an option. In 1972 the castle was finally restored, this task was given to the Danish architectural firm, Exner Architects. The restoration work was accomplished with an addition principle where the idea was to maintain the remaining structure of the castle while adding removable modern parts that references the lost architecture. [Denstoredanske, 11/2 2012]

This case is an example of an approach to restoration that is rarely seen; Exner Architects show a great deal of respect for the history the remains of Koldinghus represent. Where many would make changes to the old in order to get a more accurate expression of how the building would have looked when it was created, this restoration has no interest in turning back time. Doing so would also obscure the signs of history the worn material tell, instead they create a reinterpretation of the building in modern material to offset the old, creating a clear divide between what is new and old. When creating a new addition to an existing building, especially in a context with a rich history, much care and attention has to be given to solving the interaction between the new building and the existing. Solving this meeting between new and old is paramount to creating an architecture that feels like a natural extension, whether or not it contrasts or complements the existing. This case is a good example of how to solve this; by respecting the existing and creating a clear distinction between new and old, Exner has created a design that is at the same time is contrasting and complementing.

Ill. 36 Darwin Centre Old and Extention



Ill. 37 Section

Case study Darvin Centre 2nd

This extension of the National History Museum in London by Danish architects C.F. Møller, represent a very different approach to the question of designing in a historic context. In contrast to the approach in Koldinghus it is not materiality that references the historic neighbouring building, on the contrary, the materials contrast the old. Where the old building is a highly ornamented heavy building the new addition is light and remarkably simple and clean in its expression. The way this building references the existing museum is in the expression and the images this creates. The extension appears as a large silk cocoon in a glass container, this strong reference to its natural museum functions makes it feel like a natural extension of the existing museum despite of its radically different style. This symbolism along with the scale of the building helps communicate the scale and value of the exhibitions and specimens contained within. The sense of scale is emphasized in the design by not allowing an overview of the entirety of the cocoon when inside in order to further instil a sense of the scale of the collection within. [Archdaily.com, 2009] In addition to the referential connection to the older part of the museum, it also connects physically with the existing. Thereby creating a strong dialog between the buildings by creating a larger variety of spatial experienced and creating a link between the past and the present. This approach to designing a contemporary building in connection to a historic building will serve as a good example of how to create a contrast while still respecting the context. The strength of the concept and the clean and simple execution of it is what makes this building work so well in relation to the old. It doesnt aim to mimic the old but the reference of the form is strong enough to enable the visitor to make the connection. [Archdaily, 1/3 2012]

Ill. 38 Interior View

Ill. 39 Section

Ill. 40 Interior View

Styles in the area

The existing architecture in the area can roughly be separated into three categories, Gamle Carlsberg, Ny Carlsberg and the extensions made after the death of Carl Jacobsen. The buildings that make up Gamle Carlsberg were primarily designed by J.C. Jacobsen who was first and foremost a brewer, so the buildings were very well suited to the production of beer, but they also show a refined stylistic taste. The buildings have a very clear rhythm in the facade with alternating pilaster stripes and arches. The facade material is yellow bricks with red moulded bricks to emphasize details. [Arkitektens Forlag, 2008] Ny Carlsberg's buildings were designed by Vilhelm Dahlerup with guidance from Carl Jacobsen. The style in this area is characterized by the fact that both men were well-travelled with borrowed elements from the entire European architectural history as well as from the orient. Again as with Gamle Carlsberg a very clear symmetry and rhythm is found in the architecture, but where the older buildings relied on materiality and colour to convey details the newer buildings of Ny Carlsberg rely more heavily on borrowed elements from antiquity and elsewhere, with modified Corinthian columns and spires reminiscent of Russian architecture. [Arkitektens Forlag, 2008] After the death of Carl the new direction of the breweries initiated large expansions, these were designed by Carl Harild and presented a shift in the architecture at Carlsberg, from a very individualistic-historical style to a very refined Neo-classicistic style with very subtle refined effects. These Neo-classicistic buildings were a very clear response to the free use of classic symbolism in the previous architecture, therefore the style in these buildings are much more restrained. [Arkitektens Forlag, 2008] Of these different styles the one that has the most immediate impact on the design of the new building is the style of Ny Carlsberg as it is this style that surrounds it.

Ill. 41 Gamle Carlsberg style

Ill. 42 Ny Carlsberg style

Ill. 43 Neo-Classicistic

Conclusion

The change from the relatively low density of the current situation in the site area to a much denser one with the implementation of the new Entasis master plan will have to be considered when designing the building. Even though the surrounding buildings are at present undefined, the design still has to address them. In addition to this the buildings along the site's edge that physically connect with the new building impose their own set of limitations on the design. One of the design challenges in this project will be to create a building that reflects the stylistic qualities of the surrounding buildings while at the same time looking towards the future. In order to create a building that will naturally join in to the rich existing narrative that is the Carlsberg Valby site. The orientation of the site in conjunction with the increased density proposed in the new master plan imposes some interesting technical challenges. On the one hand the East-West orientation creates the possibility for a large roof surface facing south thereby increasing the effectiveness of solar energy collection. Though at the same time the close proximity of the tall building to the south creates a situation where during most of the year the south facade will be in shadow, thereby removing the possibility for solar collection on this. The implementation of natural ventilation will also present a considerable challenge partly due to the dense context of the site and partly due to the building sharing the facade facing the dominant wind direction with the adjacent building. When choosing the materiality of the new building two different approaches could be considered in order to achieve the goal of creating a contemporary building that relates to the context. Either the Koldinghus approach could be used where similar modern versions of the material were used or completely different materials could be used, creating the connection to the existing with the use of similar rhythms or elements in the facade. This project does not aim to create a building that mirrors the old. In the tradition of the previous extensions to the Carlsberg Valby breweries, the new building will represent state of the art in building design.

Functions

Carlsbergs suggested functions

The Carlsberg Group wishes to create a world-class commercial attraction in the Brand and Experience Centre in the heart of Copenhagens Carlsberg District. In the project brief they described the possible functions that should be built in the future Visitor and Business Centre.

Brand Store

Ill. 44

Visitor Centre

Ill. 45

Restaurant

Ill. 46

Meeting & Conference Facilities

Ill. 47

Commercial Event Areas

Ill. 48

Contemporary experience room

Ill. 49

Additional functions

The functions suggested by Carlsberg in the brief will form the basis for this discussion, these will be elaborated upon and end up forming the basis for the room program. Additionally the registration of the current Carlsberg visitors Centre will provide an understanding of the spatial requirements of functions that will be moved from there to the new building.

The meeting functionality of the building will be made up of several meeting rooms, a conference room and an auditorium. The meeting rooms will vary in size to be able to cater to meetings between consumer groups of varying sizes among other things. The conference room will be utilized for press event while the auditorium will be used for stakeholder meetings. In addition to this a catering room will be created in order to service the various meetings and conferences that will be held in the building.
Besides the restaurant suggested by Carlsberg a pub/sports bar will be placed in the building in order to cater to a very important part of the Carlsberg brand i.e. sports, and thereby broadening the potential target audience for the Brand and Experience Centre.
Additionally various service and functionality related functions will also be added to the building, for example restrooms, kitchen and a technical room.

Visit Carlsberg study

This paragraph is going to discuss the functions built into the Visit Carlsberg exhibition and the Carlsberg Museum and Business Centre.

Visit Carlsberg
Visit Carlsberg is currently the only public visitor centre in the Carlsberg district. It attracts approx. 180,000 visitors per year. [www.ritzauinfo.dk, 2012] The visitor centre has a very deliberate route through it, enabling it to focus its narrative throughout.

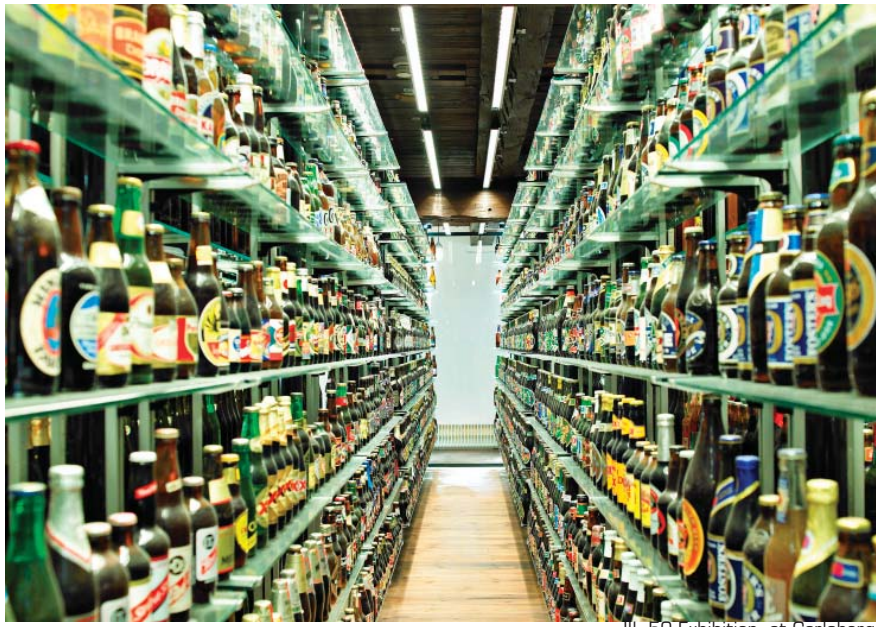
Brand store
The journey starts and ends with the Brand store where visitors can buy their entrance ticket to the exhibition and visitors who finished the exhibition route can purchase Carlsberg theme gifts.

Exhibition
The exhibition area tries to tell a story of making beer starting from a very prehistoric vision to the development of the Carlsberg beer itself.

Stables
One of the highlights of the trip through the exhibition is the tour through the stables that house the enormous brewers horses that used to pull the massive horse drawn drays that carried the beer around.

Jacobsen bar
The tour ends on the first floor in the Jacobsen Brewhouse, in Bar Jacobsen. The bar has a view to the Jacobsen Brewhouse bottling plant, up to 220 guests can fit in so it has plenty of space for dinner events. They even have an aroma room where guests can discover their favourite smells. [www.visitcarlsberg.dk (1), 2012]

Conclusion
Looking through the tour created by Visit Carlsberg, an idea has been created to move this exhibition to the historic part of the new Carlsberg Brand and Experience Centre, where it can represent a connection between new and old. To fulfil the wish of the Carlsberg group and to create a gathering point for people, exhibitions will be centralized within the Brewhouse`s Building. For the future exhibition, it is also important to create certain logic for a tour where the moved existing exhibition can be implemented as a part of the tour. Other functions, such as the Jacobsen Brewery, the Jacobsen Bar and the stables as a part of the Historical route have to be kept in place, as removing them would break the natural environment created by the authentic industrial site.



Ill. 50 Exhibition at Carlsberg

Ill. 51 Aroma room

Ill. 52 Exterior shot of the museum

Ill. 53 Old fashioned beer transportation

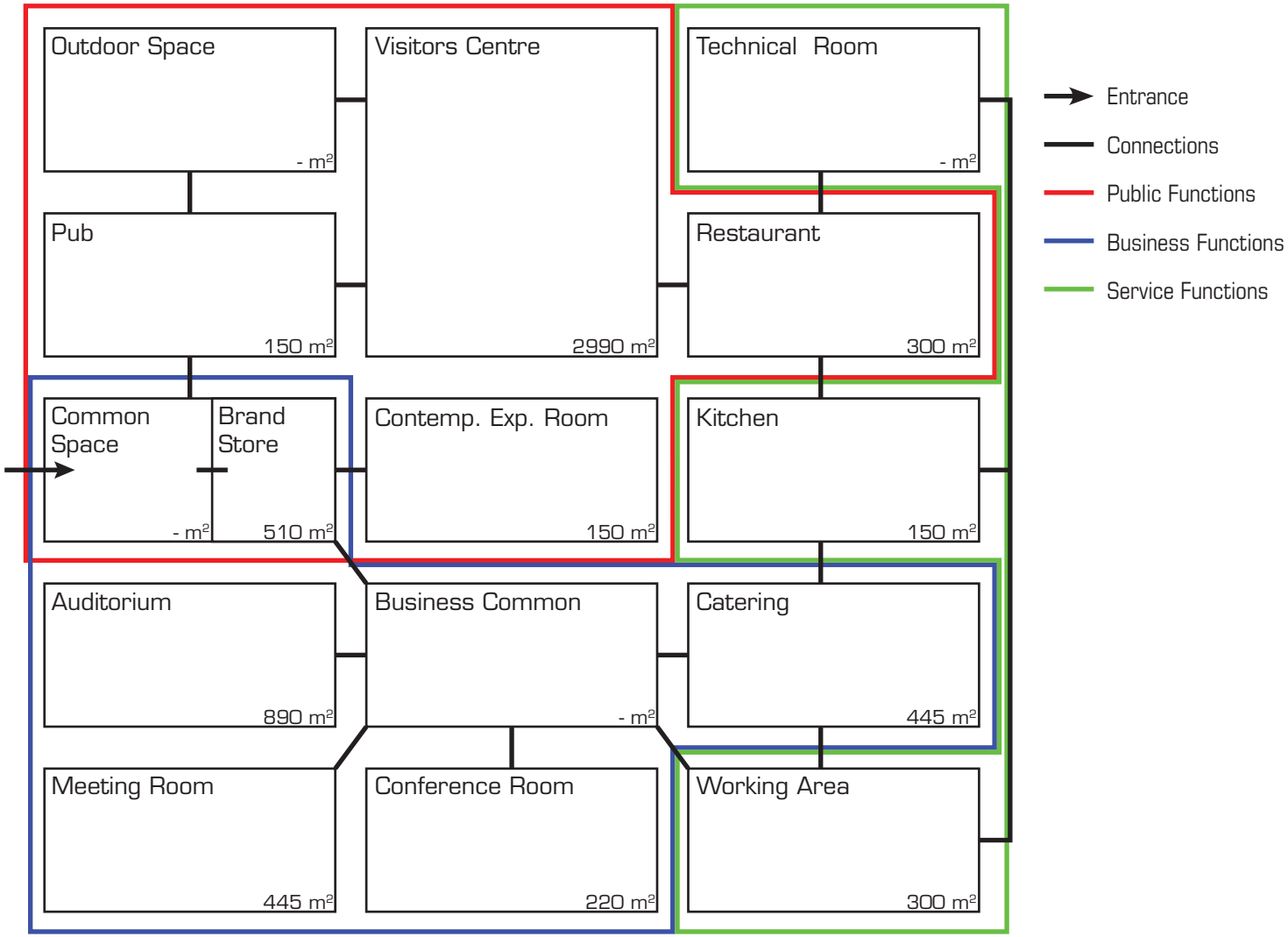
Room Program

The following table is based partly on measurement of the existing facilities that are presently in the Carlsberg area and that will be moved into the new building, and partly on spatial requirement from neufert. The orientations of the rooms are based on the light requirements, and these are judged based on personal experience.

Room	Area (m^2)	Light Req.	Orientation
Visitor Centre	2900	Medium	Mixed
Meeting Rooms	445	Medium	North
Conference Room	220	Medium	North
Auditorium	890	Medium	North
Catering Room	445	Medium	North
Restaurant	300	Medium	South
Kitchen	150	Low	-
Pub	150	Low	North
Contemporary Room	150	Varies	-
Brand Store	510	High	South
Common Space	-	High	South
Working Space	300	Low/Medium	North
Restrooms	360	Low	-
Technical Room	-	Low	-
Sum	6820		

Ill. 54 Room table

Functional program



Ill. 55 Room relationship diagram

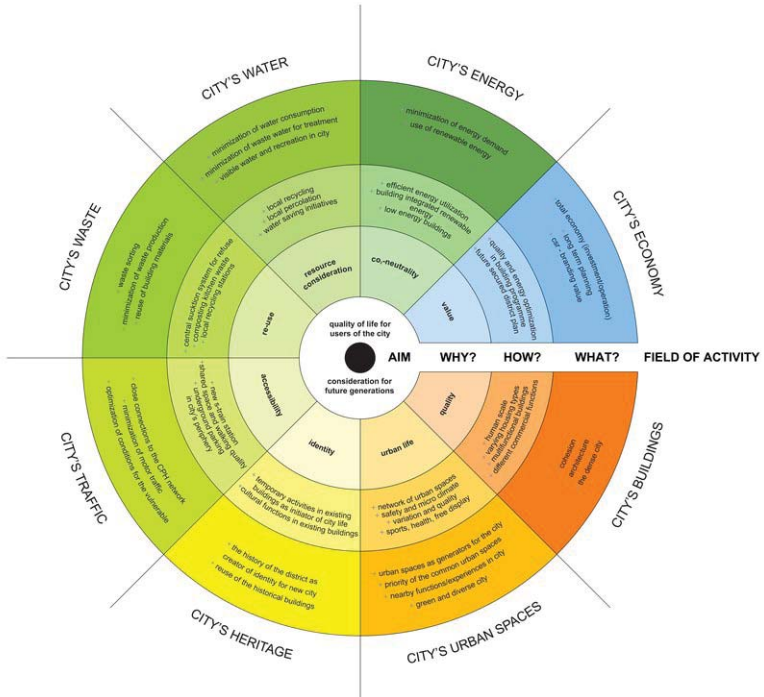
Conclusion

The most space demanding function to be placed into the new building is the visit Carlsberg exhibition, this function alone would take up more than half of the new extension by itself leaving very little room for the other functions. Therefore it is envisioned that this function is mostly placed in the historic remaining part of the building. This has other benefits besides clearing up floor area for other functions in the new part, it also can act as a strong connection between the two and it creates a more authentic atmosphere for the museum. One of the challenges in planning out the functions of the building will be to create a layout that will optimize the usability of the building for the two very different user groups. These two will also have to be separated as much as possible so that the business aspect doesn't interfere with the more entertainment characterized and vice versa. Creating a natural flow for both these user groups will be paramount in creating a functional building.

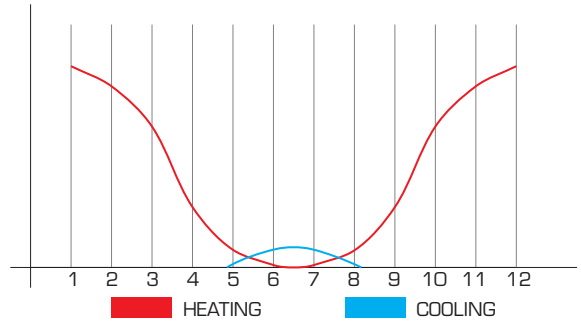
Sustainability

Carlsberg and sustainability

All throughout Carlsberg's history technological advances and cutting edge technology has been a vital focus for the company; this mentality has also led to Carlsberg being a company that take an active interest in sustainability. Therefore it is a demand from Carlsberg that its new Brand and Experience Centre is a sustainable building. This will also be in line with the suggested use for the rest of the Carlsberg area. Creating a sustainable building in the context of a major company is not only important for keeping the running costs and local impact down, it is even more valuable to the brand value of the company. Presenting the company as a sustainable and green business is a powerful marketing strategy and greatly improves the public perception of the Company and its products.



III. 56 Sustainable actions in the new Carlsberg area



Ill. 57 Heating /Cooling demands over year

Net zero energy

Within the building category there are four types of building to be separated: residential, commercial, public and institutional structures. As Carlsberg is planning to create a Visitor and Experience Centre with both commercial and public functions, the project will focus on commercial buildings energy efficiency and how Zero Net Energy (ZNE) principles can be implemented in the design process to be able to reduce and turn down energy consumption.
Generally speaking the ZNE is defined as a building that can produce the same or greater ammount of energy to the grid as it consumes from it, this definition will be slightly revised in this project to also include renewable energy sources off site into the calculation. There are various ZNE methods, but further on, only the project relevant methods will be discussed.

The principle of ZNE buildings is to strongly reduce energy use and carbon emission. This can be done in three ways which all should be implemented during the design process to achieve the goal:

1. Integrate decisions early (energy usage reducing decisions)

2. Increase energy efficiency

3. Invest in on-site energy production
(Buildings, 2007)

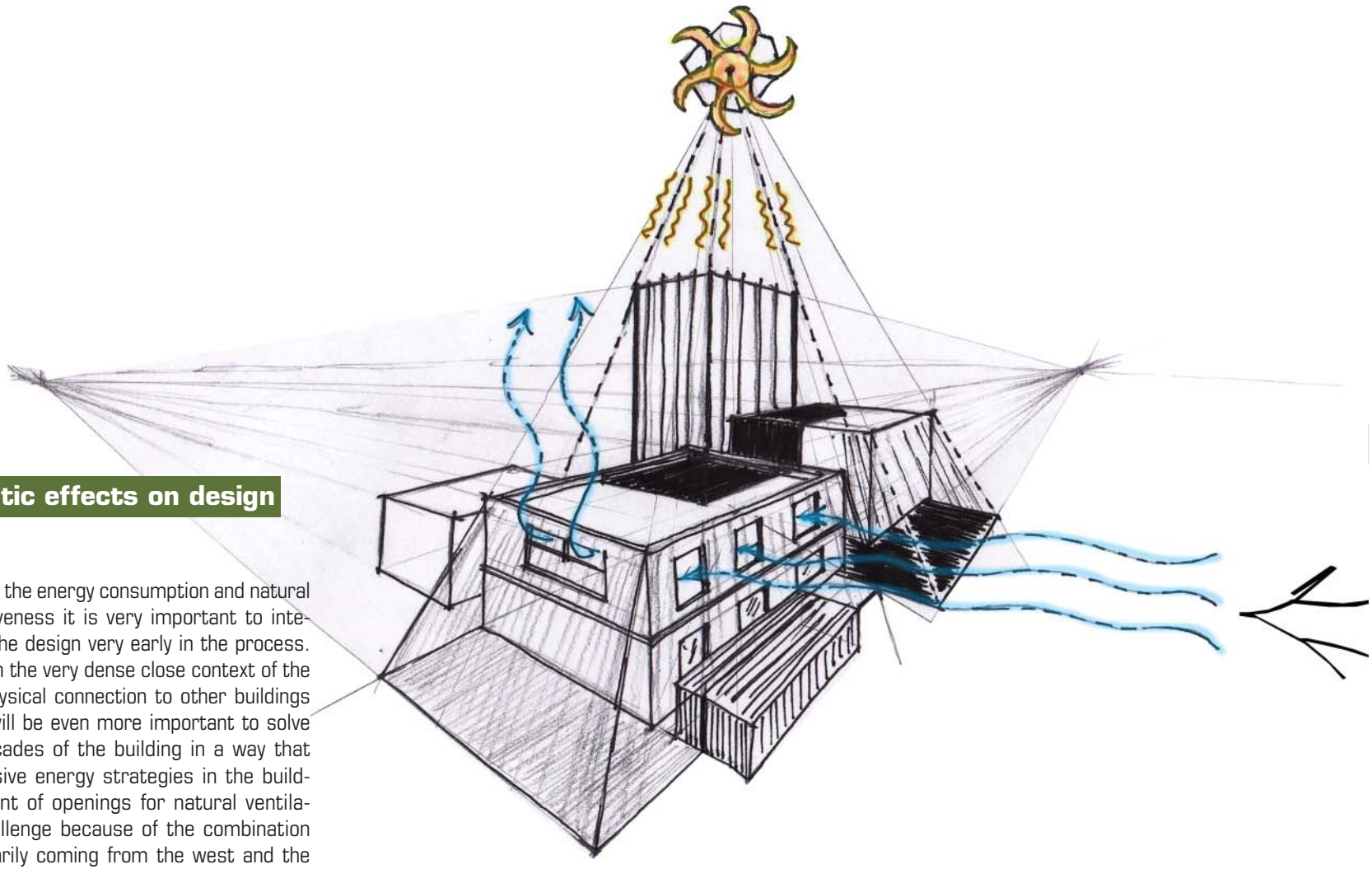
Building regulations 2020 for low energy buildings indicates energy consumption of heating, cooling, DHW and ventilation. For zero energy buildings, the aim has been set around 20kWh/m2 in order to use applicable amount of PV panels to cover the energy consumption.

	BR 2020	ZNE
Heating (temperature)	20 °C	22 °C
DHV	250 l /m^2	375 l /m^2
Ventilation		
Appliances		
Max. U values (Structures)	External wall:0,1 W/m^2K; Floor: 0,08 W/m^2K; Roof 0,07 W/$m2^K$; Windows: 0,9 W/$m2^K$	

Zero energy balance is based on gain and loss equality. (Ill. 57) It aims for minimum amount of cooling energy consumption and lowering down heating consumption to a reasonable level.

Micro climatic effects on design

I order to optimize the energy consumption and natural ventilation effectiveness it is very important to integrate these into the design very early in the process. In this project with the very dense close context of the site and it the physical connection to other buildings on two sides, it will be even more important to solve the remaining facades of the building in a way that will help the passive energy strategies in the building. The placement of openings for natural ventilation will be a challenge because of the combination of the wind primarily coming from the west and the building sharing this façade with another building.



Ill. 58 Micro climate

Indoor climate

Quality of the indoor climate is a very important factor in case designing a Brand and Experience Centre and even more important in case of Zero Net Energy principles. The time visitors spend in the Centre can vary from 1-8 hours, and they mostly use the space on low intensity work level. A good quality indoor climate has positive effects on work, concentration and relaxation. It is defined by through a variety of factors such as daylight, thermal comfort, acoustics and air quality. These factors and good indoor climate could be acquired by implementing them early in the design phase.

Daylight

Daylight is a factor not only because it creates well lit rooms for occupancy, whether it is for residential or non-residential purposes, but also because it greatly reduces the energy consumption spent for lighting as the need for artificial light will occur later in the day. Windows should be designed to allow direct solar access at functions where it is mandatory and indirect at certain functions. It also should be considered that high glazing areas may cause overheating, and end up higher energy consumption on cooling. The glazed area to floor area ratio should not exceed 10 % and daylight factor should be 2% at non-residential areas with private access and 5% at non-residential areas with public access. [Building Regulations, 2010]

Thermal Comfort

Thermal comfort can affect how visitors will experience an exhibition, meeting, conference. Non-residential buildings thermal comfort can be influenced by six basic factors: the temperature of the air and surfaces, humidity of the air, air velocity and turbulence intensity, clothing and also by the intensity level of work done indoor. During the winter, the most visited areas (e.g. public areas) should be exposed to passive solar heat gain to make it comfortable for visitors, but the structure should prevent overheating as it greatly lowers the comfort level. Advised temperature during winter is +22 °C, during summer it is +24.5 °C in case of target level of dissatisfaction is 6%. The alteration between the two periods is cause by the assumption of different clothing. [Hjem (1), 2012]

Air Quality

Occupants decrease the quality of the indoor air therefore its required to supply fresh air to be able to maintain good indoor quality. This can be done by natural and mechanical ventilation systems. There is no specific given guide number for the non-residential buildings air flow rate, but other factors are described, such as:

Air velocity ≤ 0.15m/s if temperature ≤ +24 °C
Air flow rate 10 l/s/person
CO2 level ≤ 460 ppm
[Hjem (2), 2012]

Passive solutions

Passive solutions are solutions which do not necessarily require energy affordance, but it requires considerations in design. As the project building site is not variable in a manner of orientation, the energy minimizing solutions are limited to structure, distribution, shading and opening based solutions. These solutions are:

- Passive solar heat gain (glazed area towards south)
- Shading to prevent overheating (stable indoor temperature)
- Thermal mass (stable indoor temperature)
- Natural ventilation (stack or combined stack and cross ventilation)
- Super insulated, compact structure and air tightness
- Centralized technical room (reduce heat loss along vent. pipes)
- Energy efficient appliances

Active solutions

Despite the energy saving passive methods, active methods have to be applied in order keep the annual energy balance at zero (ZNE). These solutions can be either on or off-site solutions, depending on the relation between the energy producing application and the building site. On site renewable solutions could be solar panel and small wind turbines, but as wind turbines have a negative aesthetic impact in such historical environment, only PV panel going to be applied as on-site solution. Solar panels can be considered as an aesthetic element of the building as nowadays as they can be produced in almost any colour, transparency and efficiency up to 20 % in real life usage (up to 40 % in lab environment). PV panels can be a solution, but they are often expensive and cover massive amount of roof area to cover the energy demand of a single bulding.
On the other hand as Carlsberg Group has always been an innovator, they invested in two 4MW capacity off shore wind turbines to supply energy on the Carlsberg district. This amount of energy (8MW) will be distributed on 607.000 m2 total residential and non-residential area within the Carlsberg district. (State of Green, 2012)

Conclusion

As a part of the concept, sustainability is a major factor in the design. More specifically the new building has to be designed in a way that it meets the Zero Net Energy demands and uses passive and active solutions to do so. While using these solutions, indoor climate quality has to be maintained in a way that the visitors of the Brand & Experience centre would feel comfortable and can live the experience what they meant to, without disturbing them. During the investigation of the possible passive solutions and analysing the future urban plan, the dense area creates a unique environment where only special solutions can be implemented, such as various stack ventilation methods, usage of thermal mass, super insulated structure, utilization of solar energy and double façade system. These solutions need to be analysed furthermore on how to implement them in the best way for this environment in order to lower down energy consumption effectively.

Among the numerous active methods, solar cells have to be considered as an option. Although the roof area of the whole existing building is spacious, the total floor area compared to the roof area is minimal when the different appliances that the future functions use are also considered into energy consumption. Apart from PV cells, the investment in 2 off-shore wind turbines by Carlsberg can also be considered and a possible active method that the project can rely on.

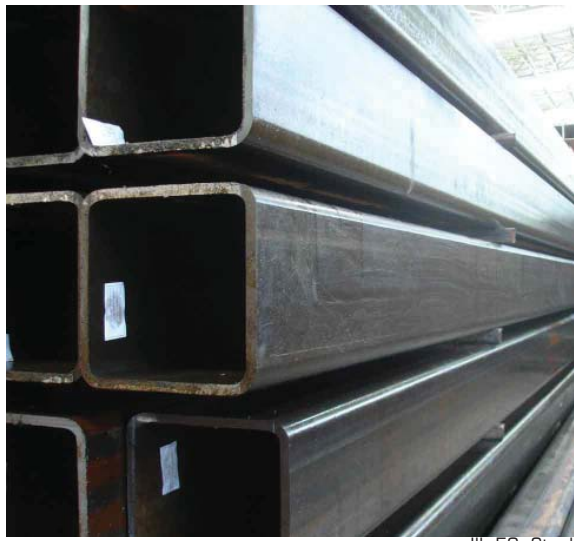
Design Criteria

Materiality

The materials for the new Brand and Experience Centre have been chosen based on several factors. First and foremost the desire to create a building that will represent a contemporary design sensibility, these also fit into the desire to create a light building that can work off the heavy expression of the surrounding buildings. The materials chosen have been divided into two categories, primary and secondary materials. Where the primary will be used throughout the building from facade to interior, where as the secondary material will be confined to details and interior elements.

Steel

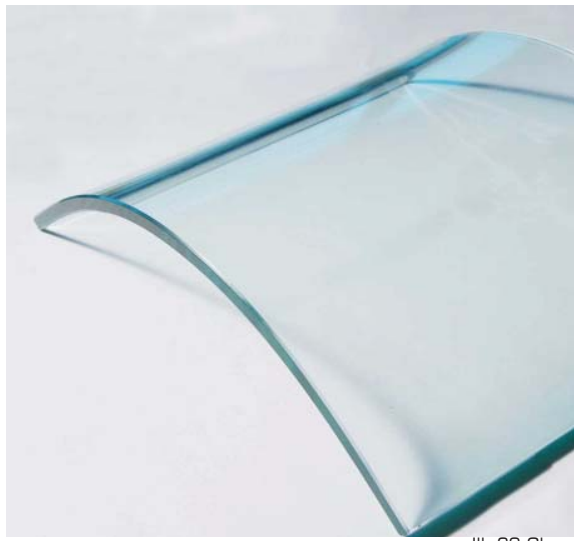
Primary construction material
Will be a prominent part of the expression of the facade
Used all through the building



Ill. 59 Steel

Glass

Along with steel will form the primary elements of the facade
Will see use throughout the building



Ill. 60 Glass

Concrete

Primarily used in the interior of the building
Used to complement and reinforce the steel construction
Can be used for heat accumulation to improve indoor climate

Ill. 61 Concrete

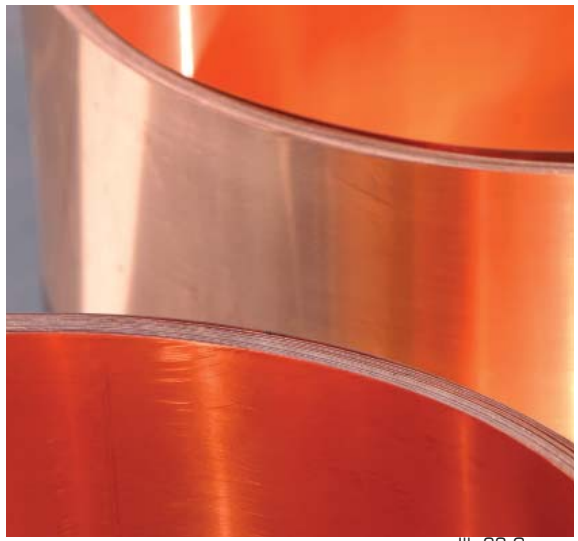
Wood

Primarily used in the interior
Will be used for dividing walls, floors or cealings ect.
Can be used for delailing elements

Ill. 62 Wood

Copper

Will be used primarily for minor details in the intrior of the building
Can be used for specialised functions



Ill. 63 Copper

Conclusion

In designing the new Carlsberg Brand and Experience Centre, the historic buildings both surrounding and connected to it will have to be taken into consideration, in order to create a building that feels like a natural extension. At the same time the building has to represent Carlsberg as a modern and sustainable company. This duality in the building will be achieved by the use of modern materials and building methods while at the same time creating references to the existing with the use of design elements reminiscent of the existing building mass for example certain rhythms or lines. In order to create a functional building the needs of the different user groups will have to be met. This means creating a building with a clear divide between the business and the entertainment aspects that it needs to contain. The technical solutions that will be used in order to reach net-zero energy will be a mix of passive and active. Where the passive solutions will be introduced to as large an extend as possible in order to lower the energy use of the building and then supplemented with active solutions in order to reach zero. The active solutions will be implemented onsite as much as possible, but if this is not feasible an alternative will be to cover the buildings energy need with the use of offshore windmills.

Problem formulation

> “In designing the new Carlsberg Brand and Experience Centre, how to create a building that respects the historic context while also acting as an icon for Carlsberg capable of attracting visitors to the site, and at the same time fulfilling the requirements of the 2020 energy standard.”

Design criteria

Context

- Dense closed area with 5 storey high buildings
- Respect the historical site and to create new that references to the old

Microclimate

- Wind direction from WSW & S
- Orientation of the building is fixed therefore solar gains cannot be influenced in this regard
- Two top floors get direct sunlight in winter, therefore sun light and energy required func tions should be placed there or a method should be proposed how to distribute it else where.

Functions

- Building is divided into public and non-public (business) areas with loose connection
- Total area of 13000 m2 including the pre served historical part of the building.
- New attached building part is 3600 m2 in total
- Functions from Visit Carlsberg are moved to the new Brand and Experience Centre

Sustainability

Indoor Climate

- Daylight factors: 2% non-public area; 5% public area
- Thermal comfort: Summer +24.5 °C; Win ter +22°C with 6% dissatisfaction level
- Air quality: velocity ≤ 0.15m/s; air flow rate: 10 l/s/person; CO2 level ≤ 460 ppm

Energy Frame

- BR2020: 30 kWh/m2
- ZNE: 20 kWh/m2
- DHV: 375 l/m2

Passive solutions

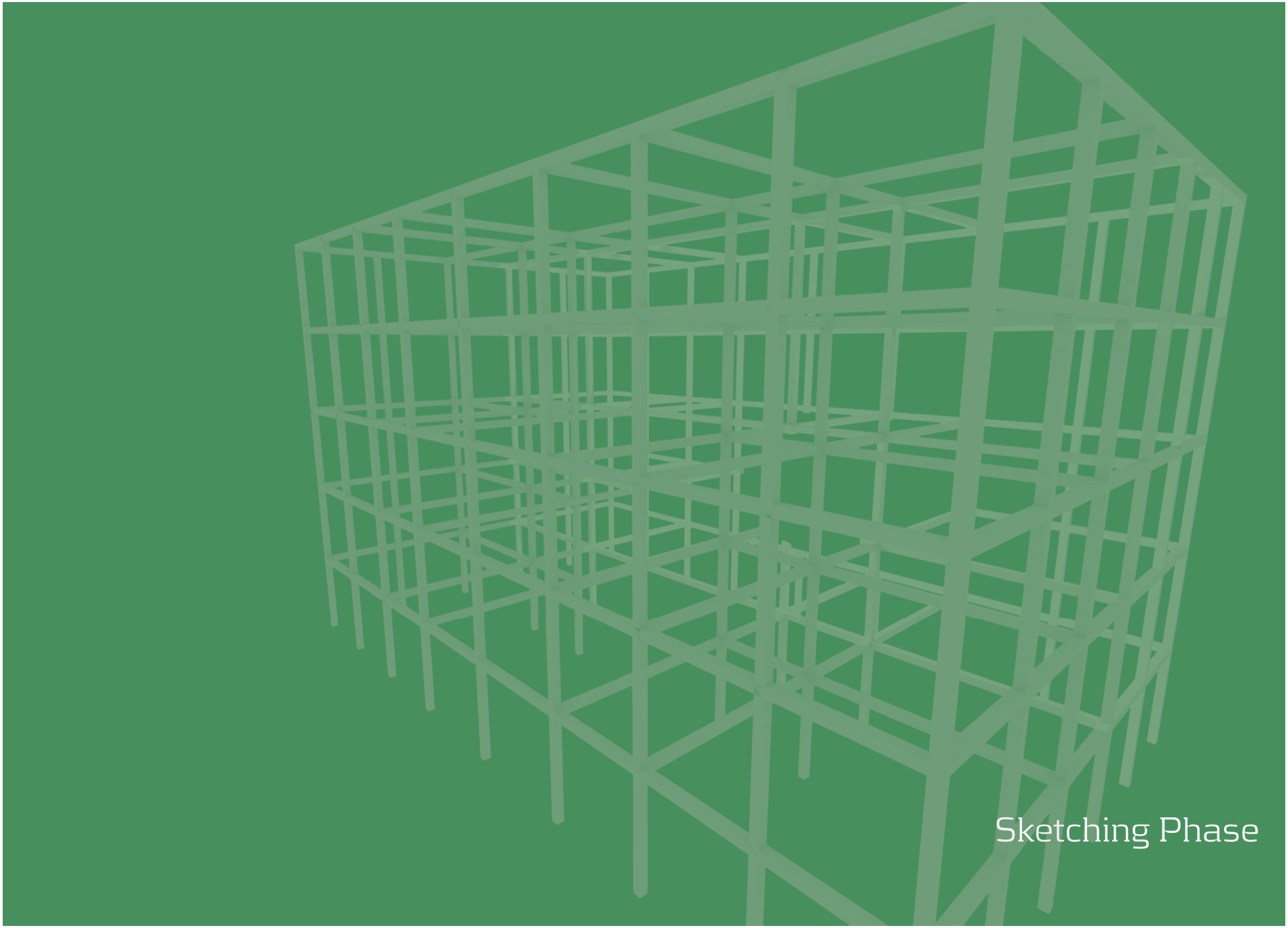
- Thermal Mass with material selection
- Natural, stack ventilation
- Utilisation sun light and energy
- Shading
- Centralized technical room
- Super insulated, compact structure
- Energy efficient appliances

Active solutions

- PV panels with minimum 20% efficiency
- Off-shore wind turbines (2*4MW)

Architectural

- Creating a building that represents Carls berg Group and its activities in different fields In respect of historical site, a modern sustainable building should be designed with 5 storey heights
- Detailing should reflect the quality of the surrounding buildings
- Modern look to make a difference
- Create a story line connecting the new and the old part with various relevant functions
- Separation between public and business based functions



Sketching Phase

Designing in a historic context

Respecting the historic context and allowing it to tell its story while introducing a new element with its own story to tell, requires a lot of care. Do you create a contrasting or a complimentary element? Both have their own set of challenges associated with them. If there is no discernible reference to the existing the building loses its sense of belonging and could end up feeling disturbing. If the building is too similar it risks getting completely overshadowed by the context and lose its identity. The answer seems to lie somewhere in between, something different but similar, a new building with references and links to the existing. Additionally it is important to keep in mind the history and idea behind the historic buildings which the new building will stand beside. These can be a rich source of design inspiration, and if utilized properly can add significant depth to the references between new and old. Besides these building design oriented problems, the architect also has to consider the impact of the new building on the public's perception of the area and the narrative that has been established between the existing buildings. Many have created strong emotional bonds to the site and if not properly handled, the introduction of a new element could destroy it in the eyes of many. Designing in this type of context therefore requires a very different take than designing in a context

that doesn't hold the same emotional weight.
The new Carlsberg Brand and Experience Centre has been designed with all of these considerations in mind in order to create a building that can enter into this historic context and start a new chapter in the ongoing narrative of the area. A very calm and regular façade has been chosen in this project in order to create a building that will allow the historic buildings to still tell their story. The scale and rhythm of the façade will create the reference to the existing while the materiality and lightness of the building will differentiate it.

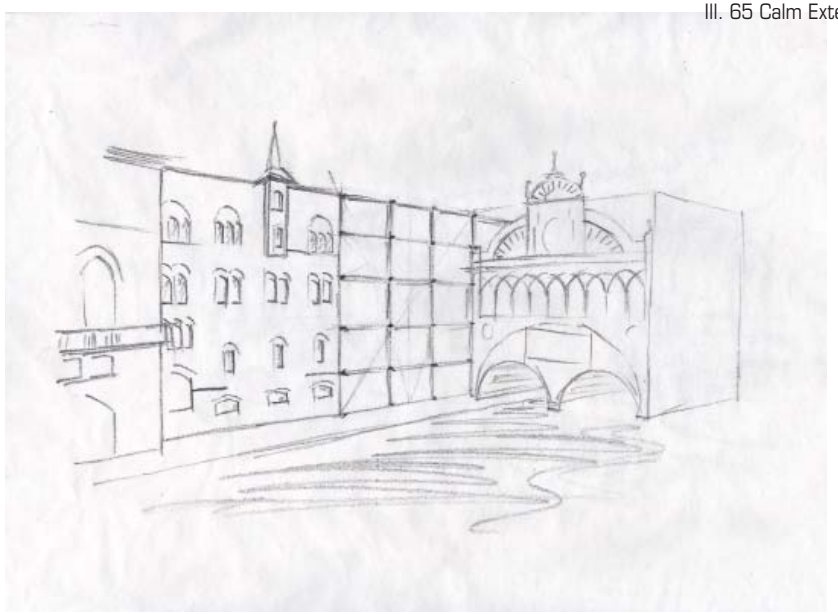
Ill. 64 Elephant context

Concept

Duality

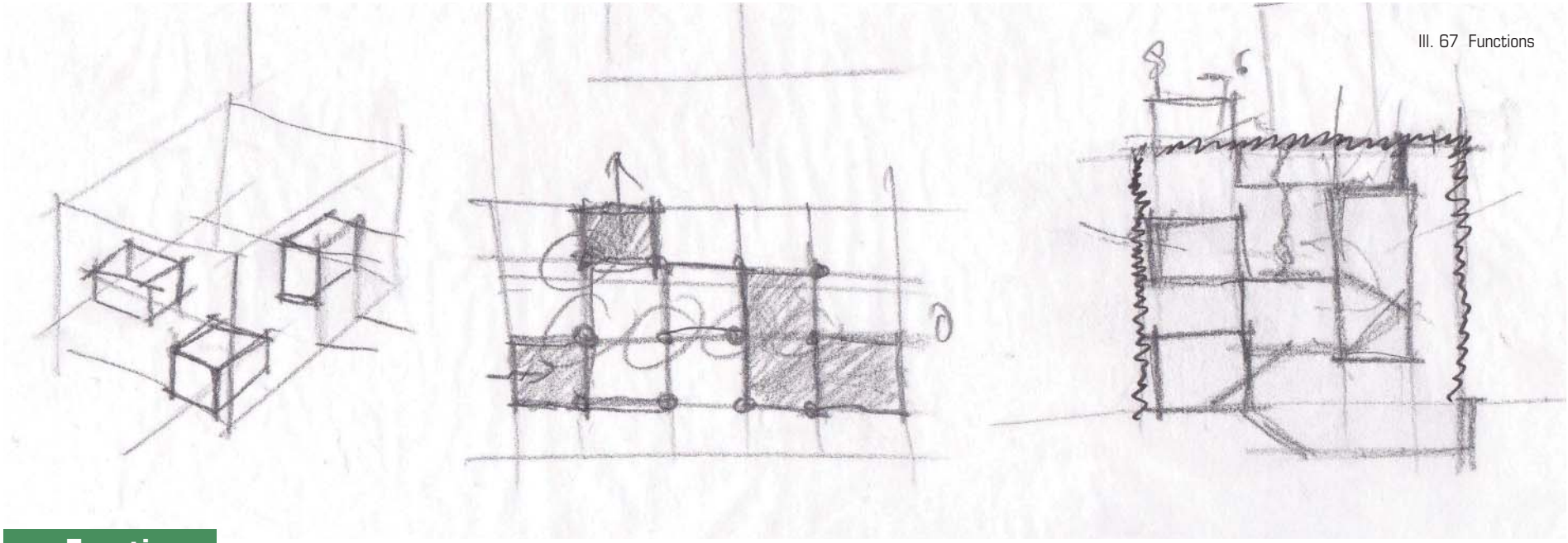
The concept of the building is based on the inherent contradiction of the competition, on one hand it has to be calm and respectful to the historic surrounding buildings in order for them to tell their story without being disturbed by the new building, and on the other hand it needs to be vibrant and dynamic because of its function as a brand and experience centre. This contradiction will be solved by creating a calm exterior and allowing the interior to be dynamic and vibrant.

Ill. 65 Calm Exterior



Calm Exterior / Vibrant and dynamic interior

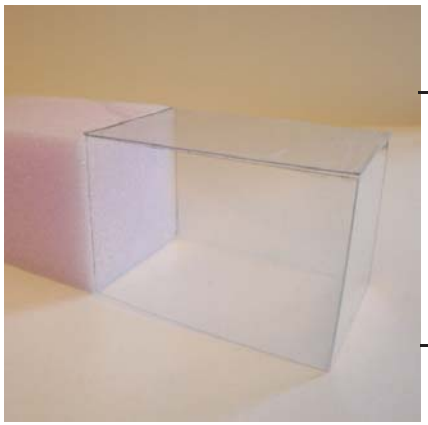
Ill. 66 Dynamic Interior

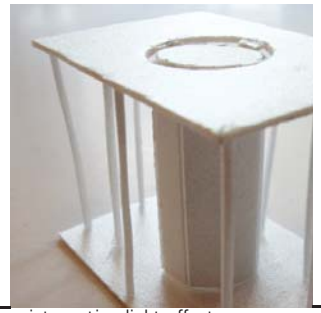


Ill. 67 Functions

Functions

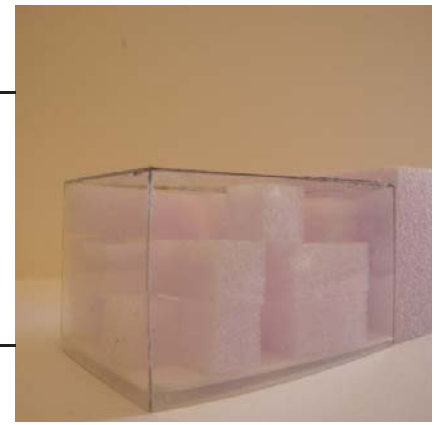
The new Carlsberg Brand and Experience Centre will have to cater to three different user groups, the visitor, the staff associated to servicing the visitor and staff not associated to the visitors. In order to create a functional building it is important to create flows that minimize the interaction between these visitor oriented functions and the staff functions. The functional needs between the two staff group intersect in a lot and can therefore share most of the support functions, like resting areas and cantina. The main difference in the two staff types is their interaction with the visitor. Keeping the office and administrative staff and their service functions from the public functions is relatively simple because their everyday flow doesn't intersect. The visitor oriented staff presents a bigger design problem, they need access to the same functions as the other staff, but at the same time these access points need to be cut off to the public. The solution to this problem suggested in this project is to split the public and private functions into different levels in the building, keeping the staff functions primarily in the middle levels of the new building close to the old building and placing their service functions adjacent in the old part, thereby allowing the lower floors to be focused on public functions.

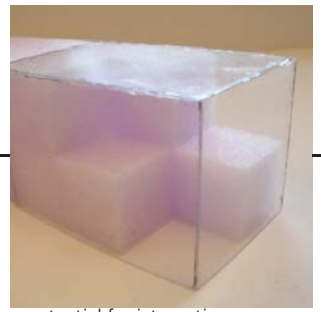




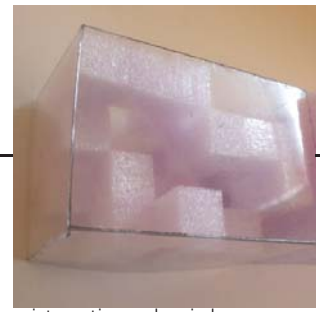
+ interesting light effects
- low light penetration

+ potential for good ventiation and light
- undefined volumes





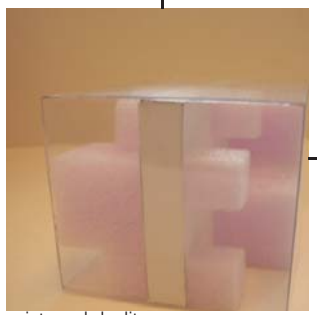
+ potential for interesting spaces
- cubes too big/limits design



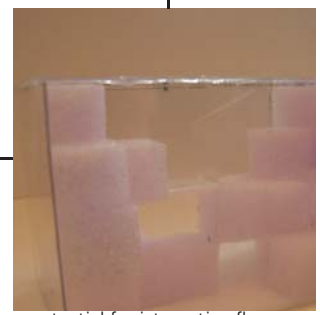
+ interesting and varied spaces
- floor area too small

Initial form studies

In addition to the conceptual considerations for the overall geometry of the building, the relatively small size of the site compared to the function requirements put a rigid constraint on the dimensions and overall form of the building, ending up with a box that fills out the site. With this constraint in place the design process turned to an exploration of the spatial possibilities of the box.

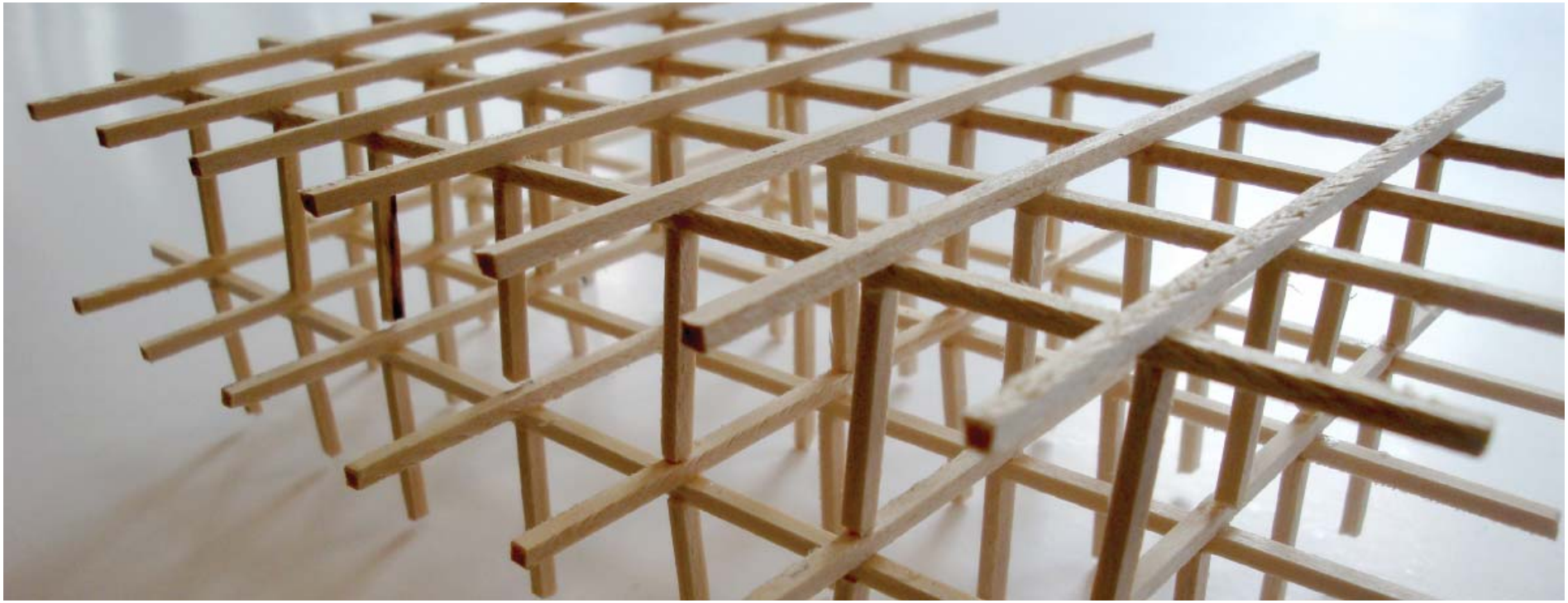


+ internal duality
- issues with light penetration



+ potential for interesting flows
- floor area way too small

These form studies evolved in two significantly different directions. The first of which focused mainly on how to create atrium spaces, while the other worked with creating spatiality via smaller volumes in the bigger box. After analyzing these inital tests, steps were made in order to merge the good aspects of each of these approaches. Thereby creating designs what retained the differentiated spaces in the box in box experiments while incorporating atrium spaces to serve the technical needs of the design.



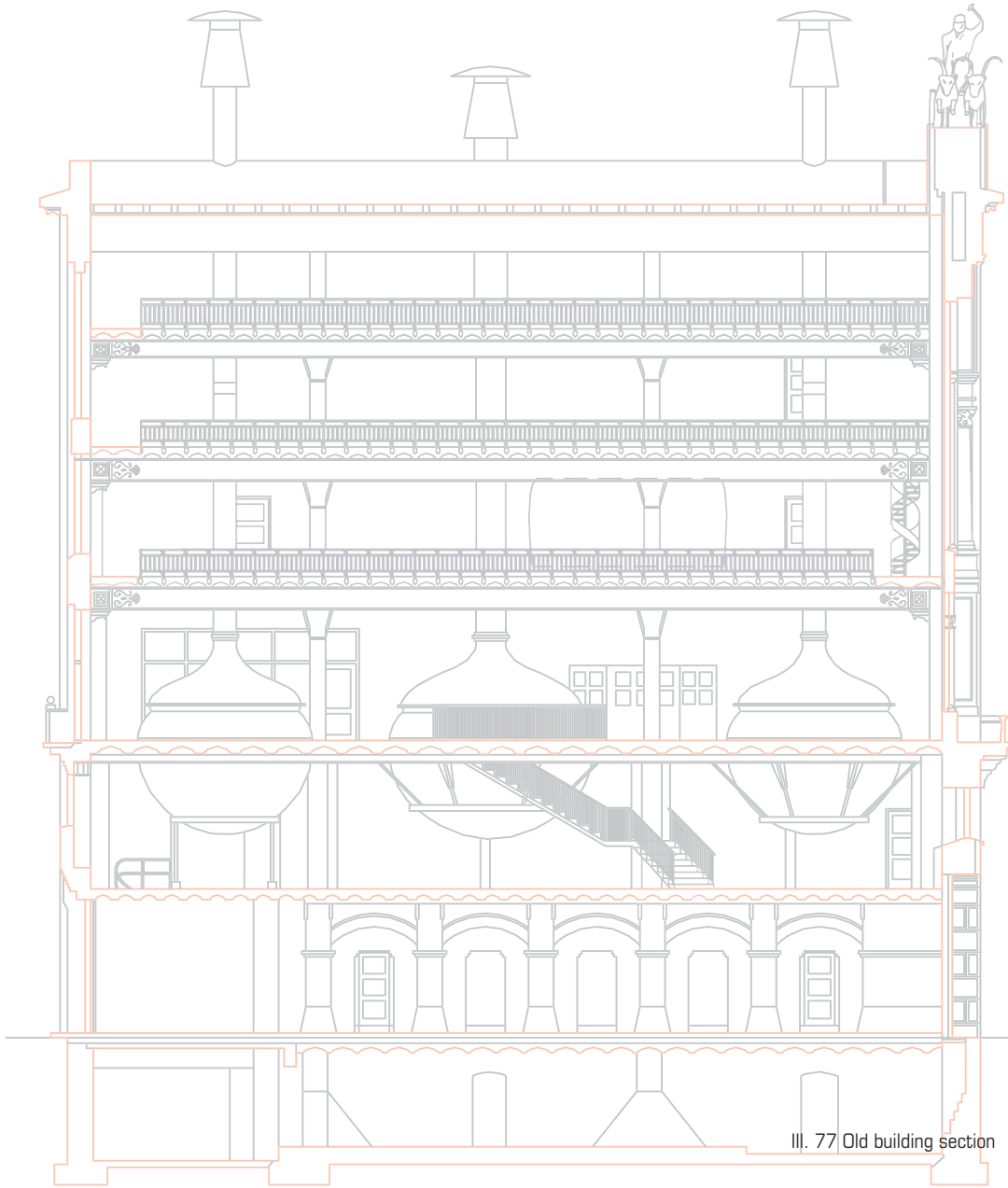
Ill. 76

Structure & climate forms basis for design

After the initial form studies and analyzing the different conceptual suggestions it became clear that we needed a structural system in place early in order to guide the different volumes in the building. Therefore the next phase of the project revolved around creating a system that would not only act as the physical support of the building, but also create its expression and act as a strong reference to the context. A 4,2 m cubic system was found to be able to meet all of these criteria. The regular system will create a very calm and rhythmical exterior for the building, act as a reference by also being used in a nearby building, and its relatively short span will easily be able to take the loads of whatever is placed in the volumes, without resulting in excessive cross sections. In addition to the structural considerations for the design of the building, indoor climate was also a driving factor in the initial design for the building. As the designs called for a glass box construction, the problem arose of how to prevent overheating and maintaining a good indoor climate. In order to solve this problem a double facade solution will be used as it allows for good u-values and natural ventilation, while still maintaining a transparent facade.

Physical Connections

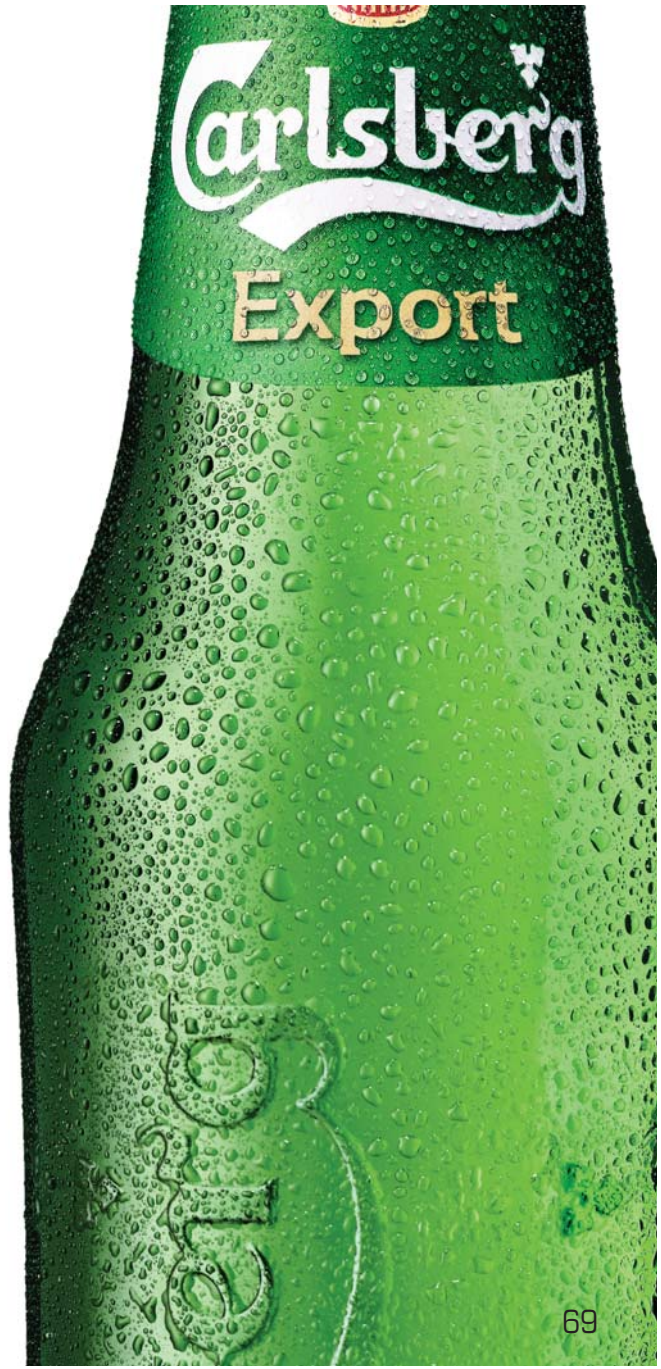
Because of the physical connection to the historical building to the west of the site and the Dipylon gate to the south, it was imperative for the design of the floor plans in the building to look at if it was possible to establish connections between these and the new building, or if such connections were already in place. The Dipylon gate in particular turned out to have a great potential for connections as it already had established connections, these will form both the main entrance into the new building but also serve as a connection on the 2nd floor to the building South of Ny Carlsberg Vej. The building to the West of the new building will serve a crucial role in solving the functional aspects in this project, as it will house several of the functions that couldn't fit in the new building. Most noticeably it will house the majority of the large "Visit Carlsberg" exhibition, but also various service functions like kitchen for the restaurant and staff areas. The choice of using the dipylon gate as the main entrance instead of establishing a new one was chosen to strengthen the connection between the old and new.



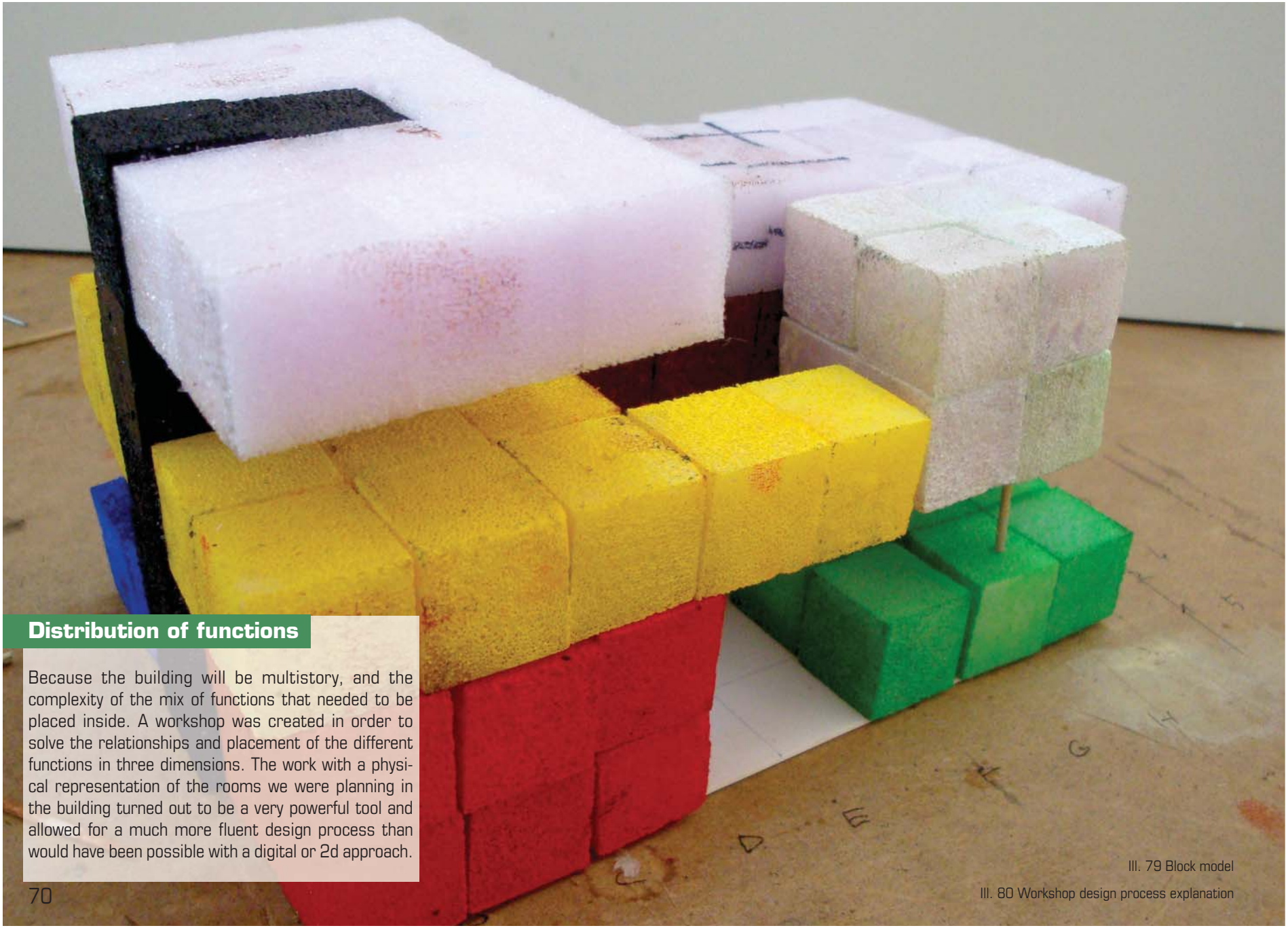
Ill. 77 Old building section

Branding functions

The first thing functions the visitor is exposed to when entering the building are directly related to different aspects of the Carlsberg brand. The Visit Carlsberg exhibition representing the rich history of the Carlsberg breweries on the Valby site, the sports bar, referencing Carlsberg's deep involvement with the sports, and finally the brand store. These functions are the ones most directly linked to Carlsberg from a visitor perspective. The choice of placing these functions that directly relate to Carlsberg on the first floor was made in order to help create an atmosphere that is permeated by everything Carlsberg.



Ill. 78 Beer

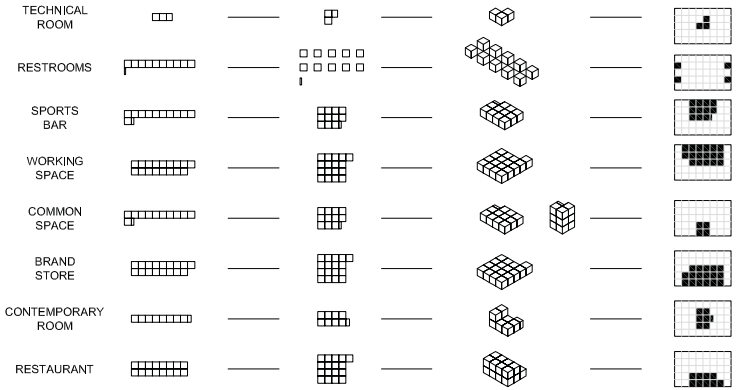


Distribution of functions

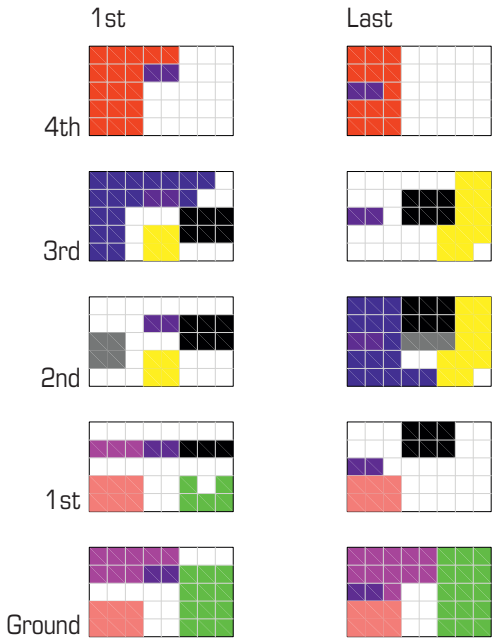
Because the building will be multistory, and the complexity of the mix of functions that needed to be placed inside. A workshop was created in order to solve the relationships and placement of the different functions in three dimensions. The work with a physical representation of the rooms we were planning in the building turned out to be a very powerful tool and allowed for a much more fluent design process than would have been possible with a digital or 2d approach.

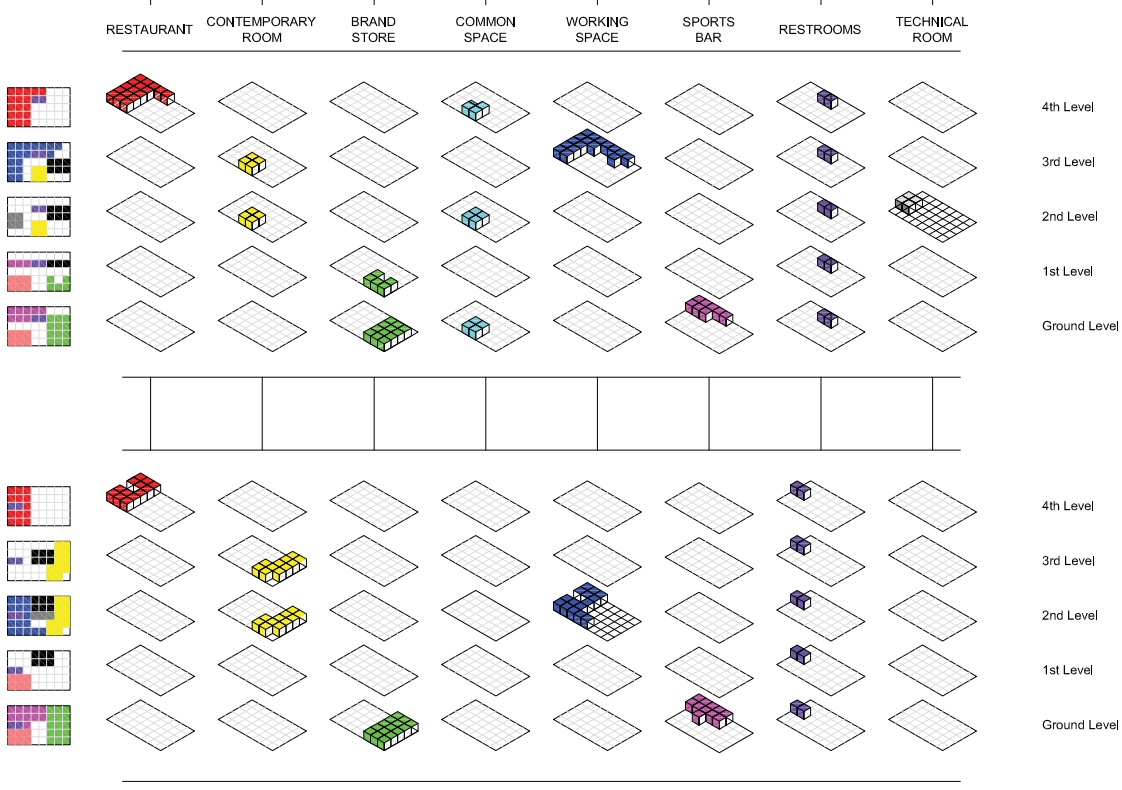
Ill. 79 Block model

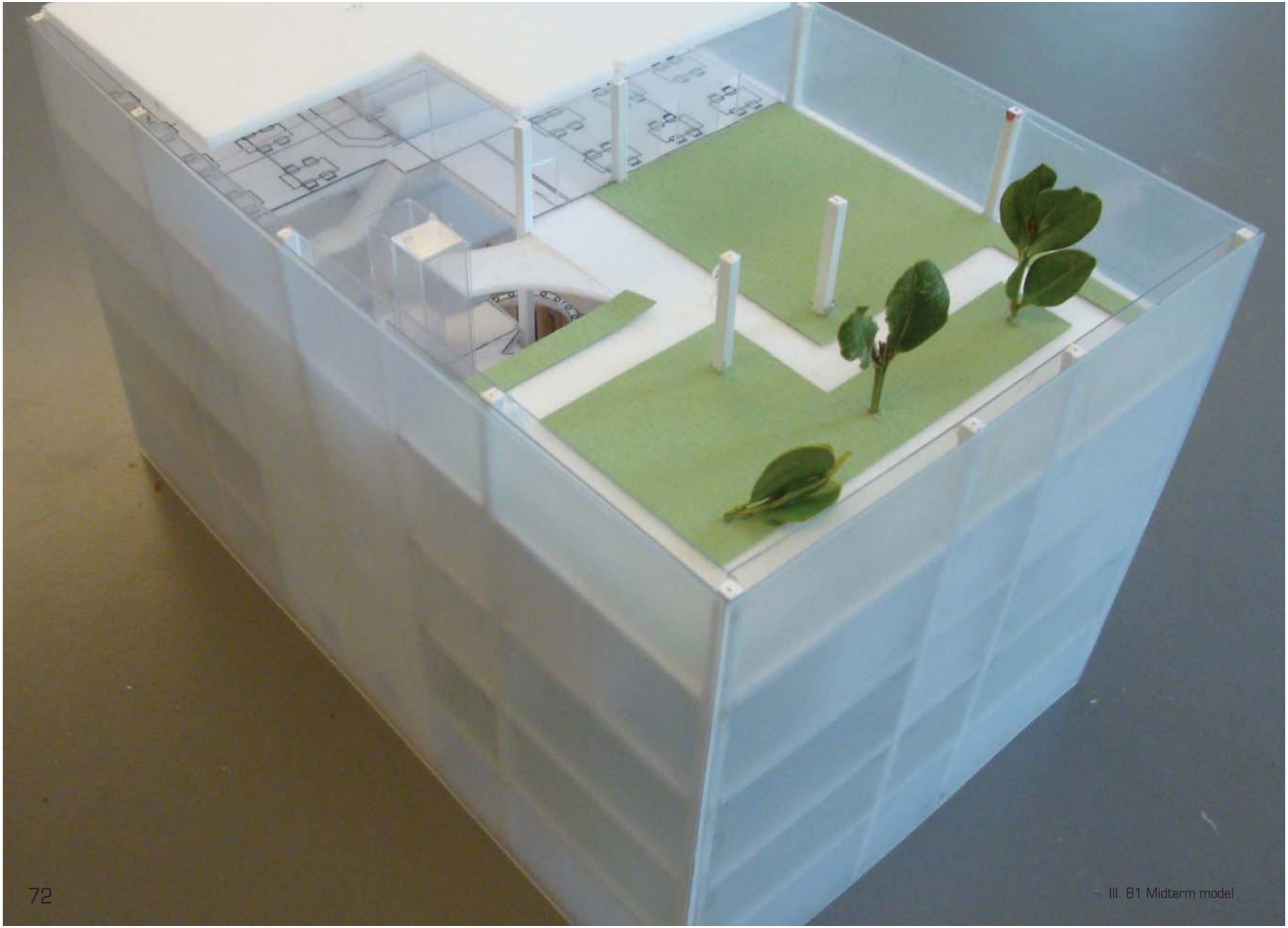
Ill. 80 Workshop design process explanation



Floor plan itterations



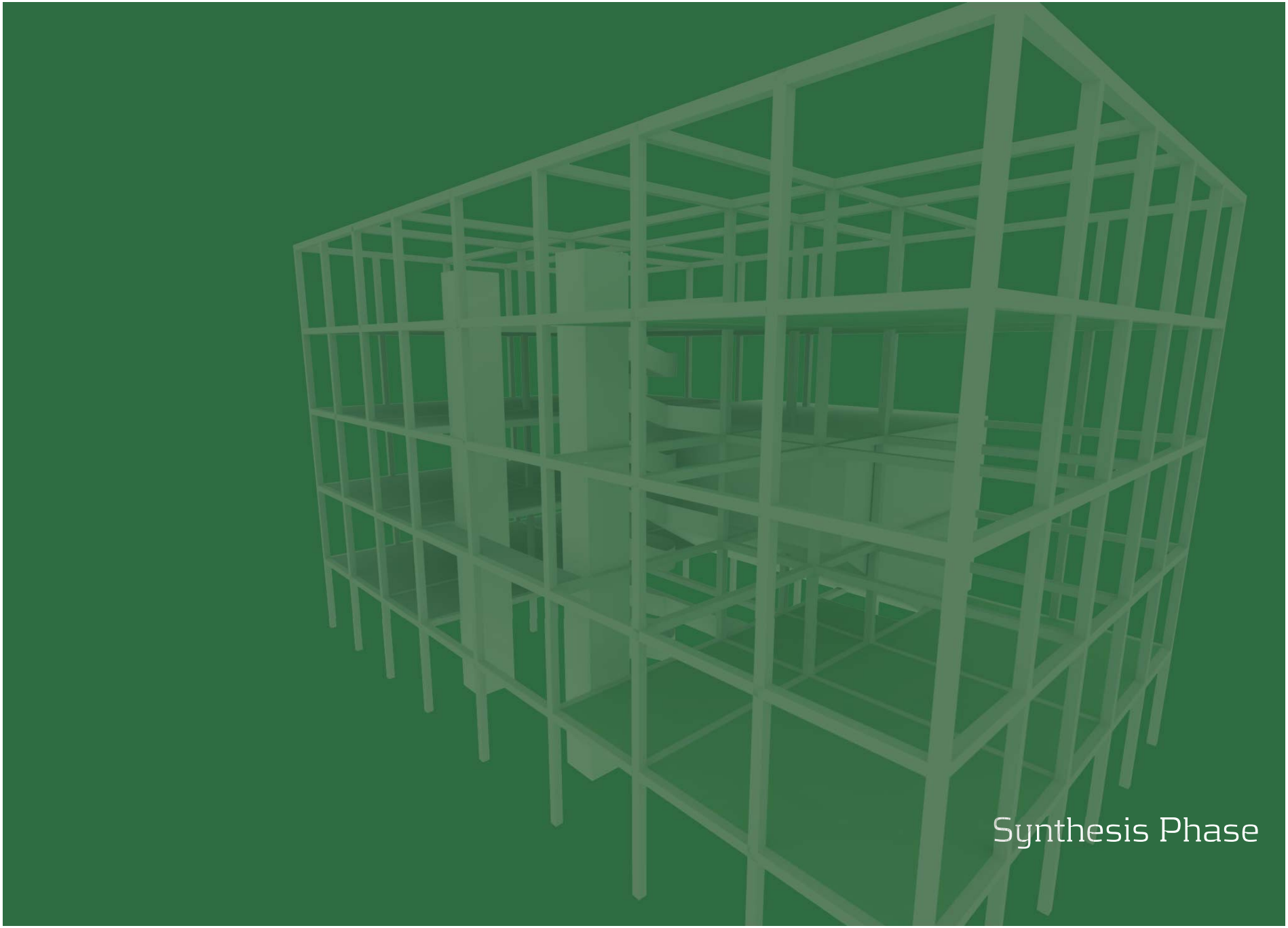




Ill. 81 Midterm model

Linking Sketching and Synthesis

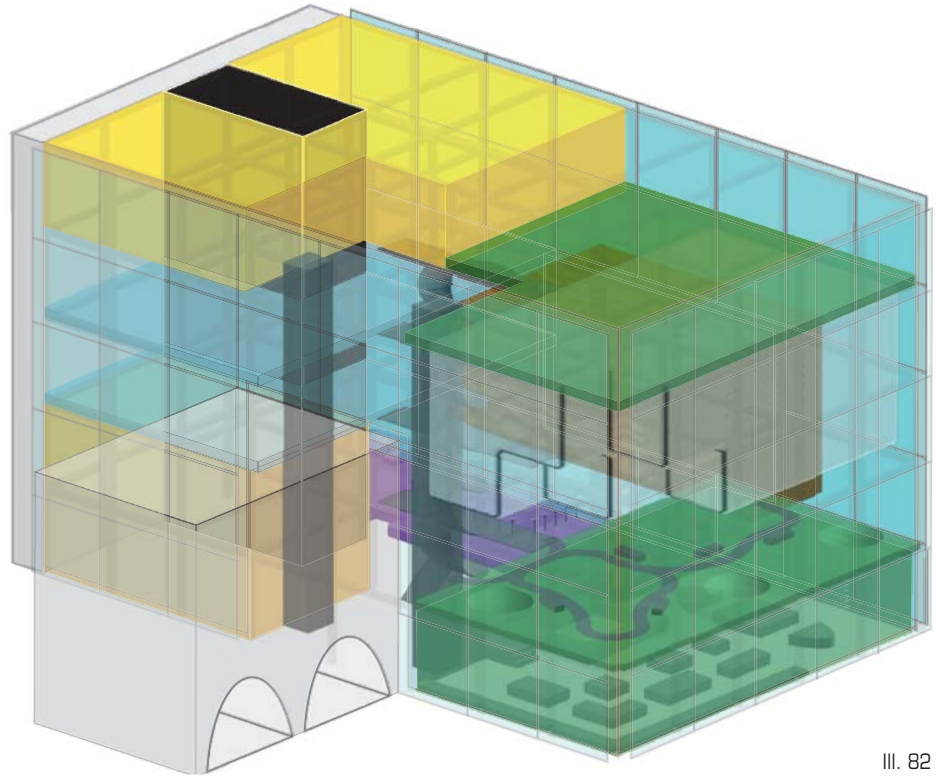
The final part of the sketching phase was producing a detailed physical model of the design in order to get a deeper understanding of what the strengths and weaknesses of it were. Especially this process allowed identification of the various problems that were present in the building and finding solutions while we were building. Most critically the exterior expression of the model showed problems, because the process had made it stray away from the original goal of referencing the surrounding architecture. From this the decision of strengthening the façade expression by introducing more columns to restore the square grid system was made. Additional smaller problem were similarly identified and rectified, for example the atrium space was opened up more to allow a lighter space and the need for more variety in the interior in order to differentiate the functions. Besides being a great tool for indentifying problems it also gave us a great understanding of the strengths that should be showcased in the building. The model making process acted as a transition from sketching to synthesis phase for the project.



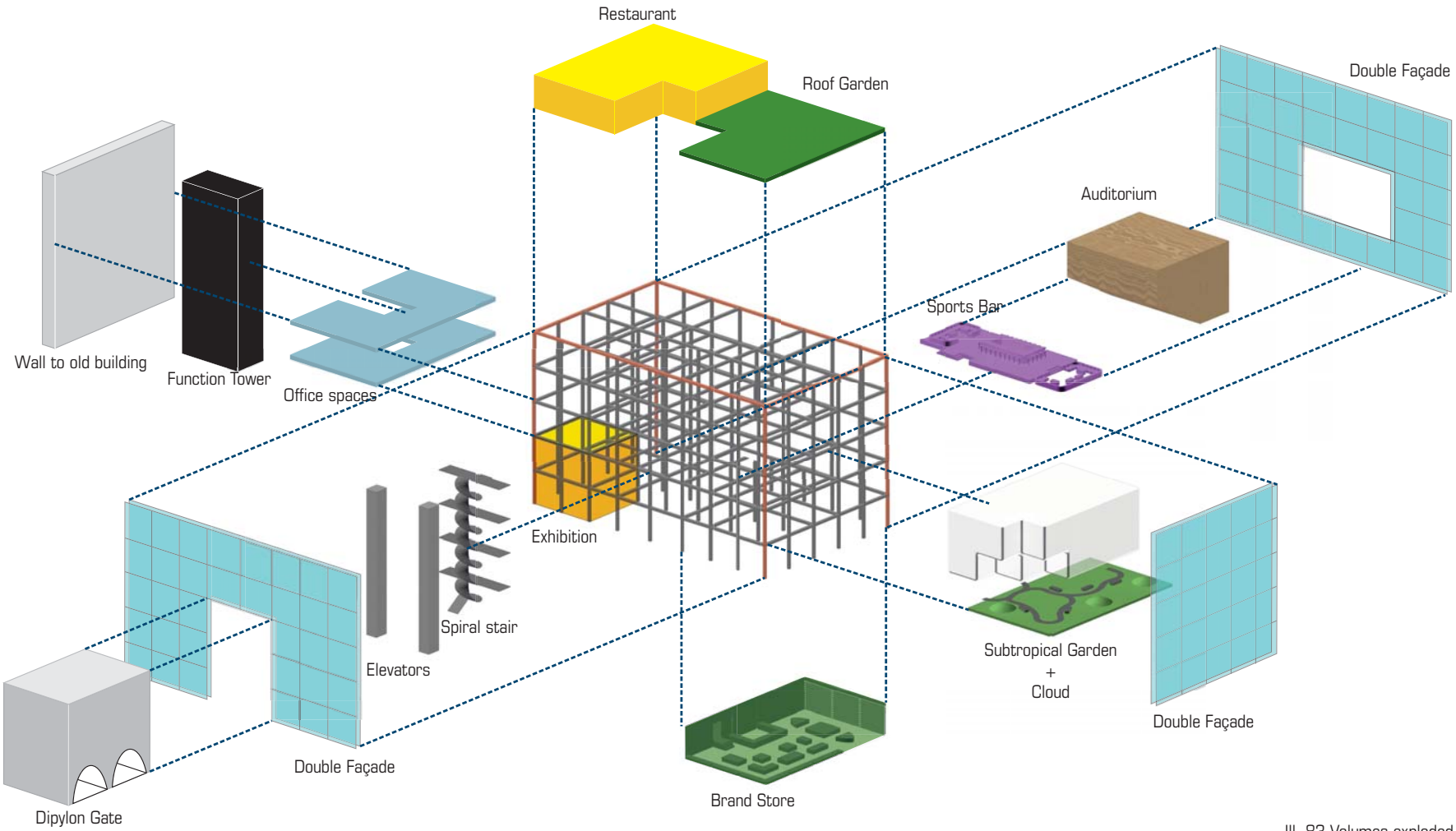
Synthesis Phase

Differentiated Volumes

In order to create an interior that is at the same time dynamic and easily readable, the different functions were given unique forms and materials. On the ground floor the materiality and closed nature of the sports bar in comparison with the very transparent surrounding functions, help underline its function and helps establish that this is something different. When entering into the sports bar the atmosphere changes, you step out of the commercial space and into a more compact and intimate setting. Further up in the building the offices, exhibition, technical room and contemporary exhibition, each have their own unique expression. The floating slabs of the offices, the angular wooden box of the exhibition, the parasitic metallic technical room, the indoor garden and the soft floating cloud of the contemporary exhibition, creates a dynamic and varied interior that betrays the strict grid system and simple understated exterior.



Ill. 82 Volumes together

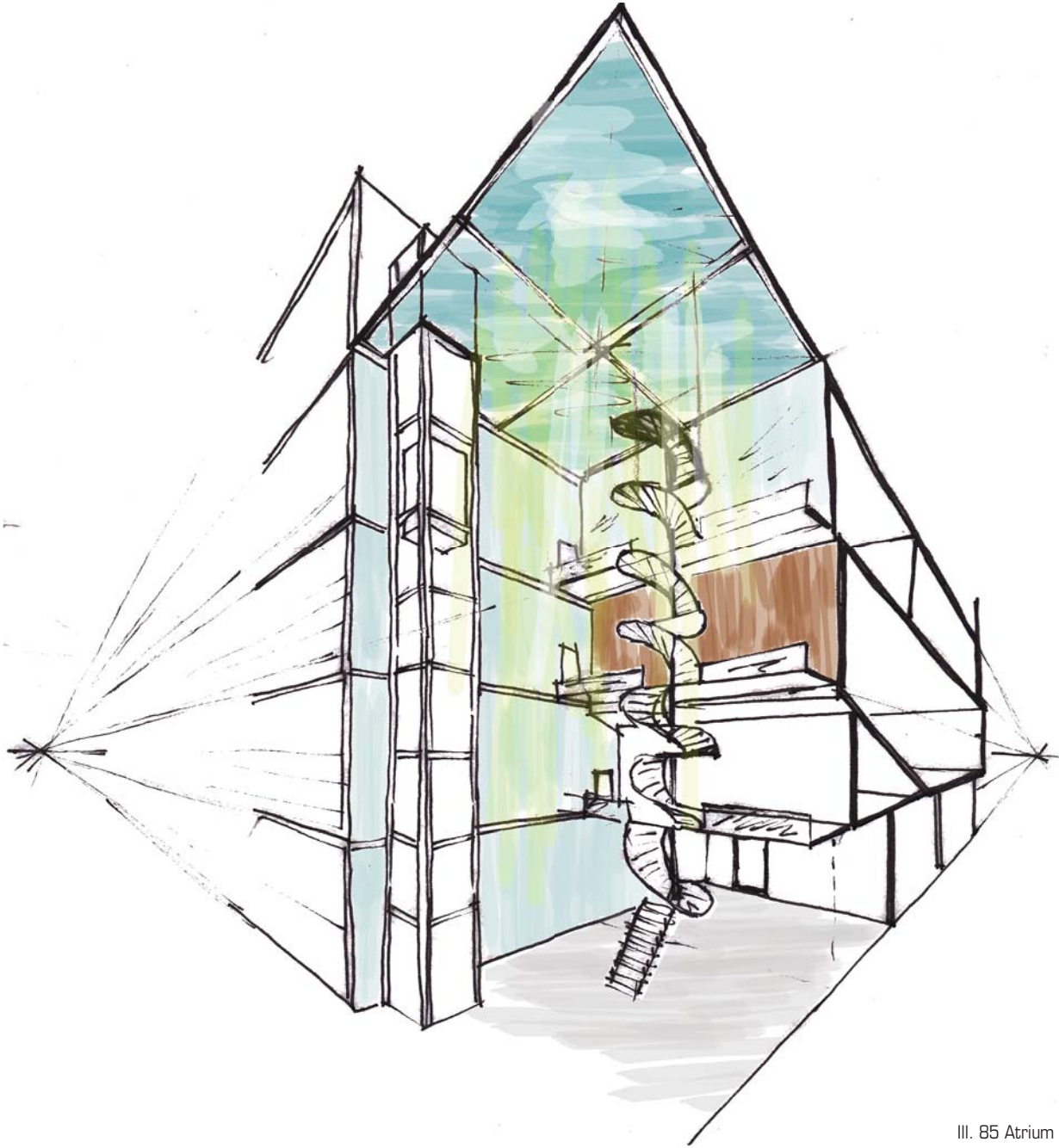


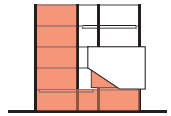
III. 83 Volumes exploded

Evolution of the structural system

The 4,2m cubic grid system presented several problems that needed to be addressed in order to create a functional and aesthetically pleasing solution to the structural system in the building. Primarily the relatively short spans created a system that completely dominated the appearance of the building. This also placed a strict limit on the way the functions could be detailed. This problem primarily presented itself in the atrium where the exposed structural system would disturb the open feel of the space. In order to solve these problems the grid system was softened up by removing nearly half of the pillars in the interior of the building. This change allowed the atrium to be kept free of pillars, thereby creating a more airy feel; also it limited the amount of pillars that would be placed in the different functions. The system only changed in the interior of the building, where as the exterior was kept the same, in order to maintain the calm rhythmical look.

Ill. 84 Structural grid

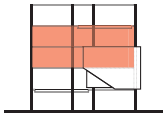




Building Base

The first thing the visitors experiences when entering into the building is the atrium. The space is four stories high and acts as a contrast to the small space under the Dipylon Gate the visitor experiences before entering the building. This sets the stage for the rest of the experiences the visitor will experience, and further emphasizes the contrast between the exterior expression of the building and the interior. The Atrium also serves several important functions for the building. It aids the natural ventilation system and contains the spiral staircase and elevators that all the flow to the higher levels of the building passes through. This spiral staircase also serves as a sculptural element in the building. The brand oriented functions provide a solid base for the building filling out the entirety of the space surrounding the atrium. These spaces being differentiated by the materiality, with the lighter glass brand store and exhibition and the heavy concrete sports bar. Further up in the atrium on the 1st floor the metallic technical room is attached under the floor of the auditorium, cutting into the atrium space and spreading its copper ventilation tubes visibly out into the entire building.

Ill. 85 Atrium



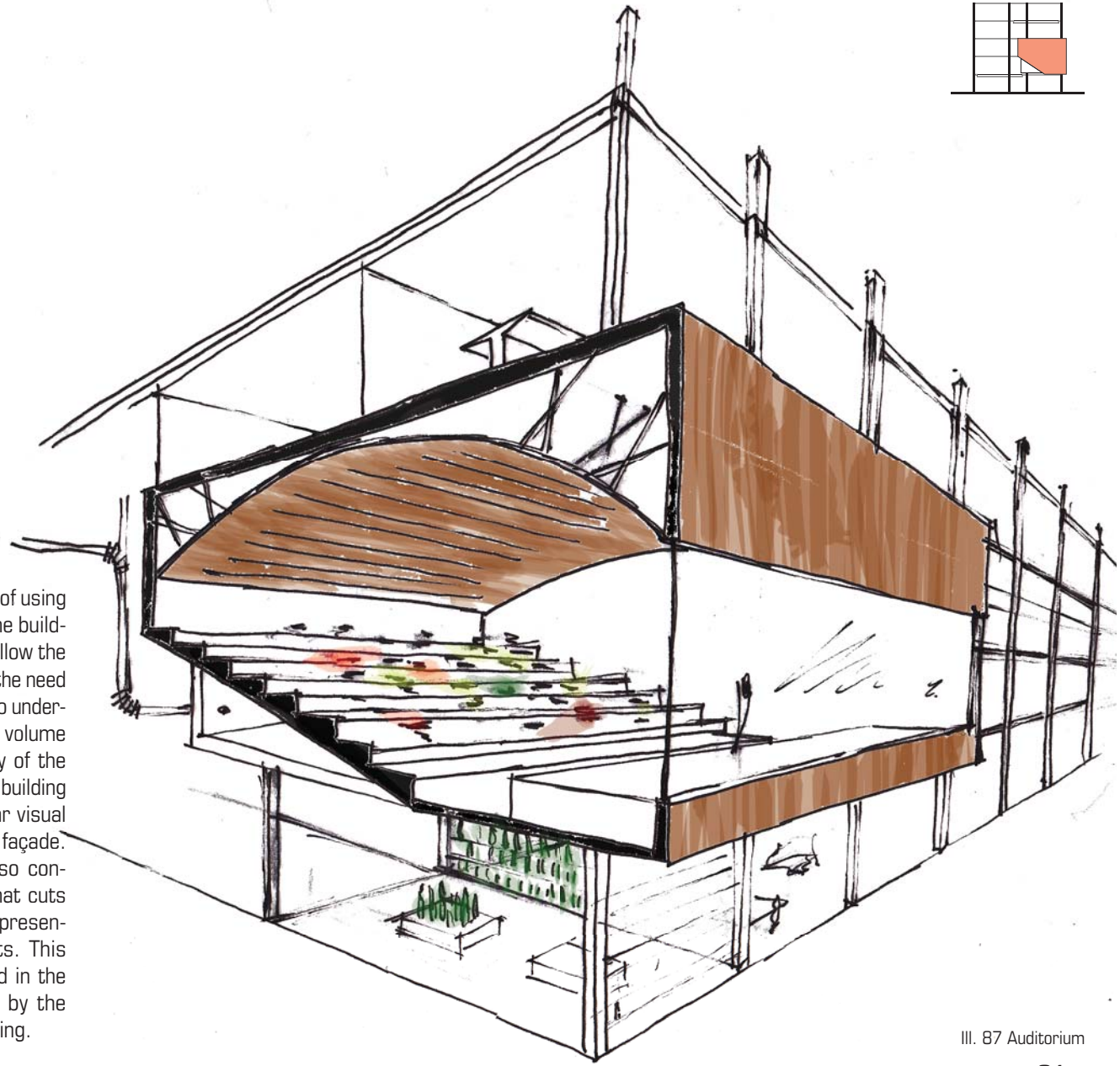
Working spaces

The office spaces are placed close to the existing building and take up two half floors. Both floors are similar in layout with the primary working spaces placed to the North and with fewer working spaces to the south. The areas closest to the south façade are designed for relaxation and discussion; this is done to ensure a high quality environment for the employees. The main difference between the two floors are the meeting rooms placed on the top of the auditorium, one to the north and one opening out to the atrium space. The office spaces envelop the service tower that spans the full height of the building and contains the toilet facilities of the building. In these two spaces the function tower is modified to contain printing and copying functions in addition to its toilet facilities.

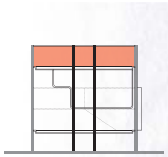
Ill. 86 Office space

Auditorium

In designing the auditorium the possibility arose of using it to engage the public square to the North of the building, by creating a stage on this plaza. This will allow the auditorium to be used as extra audience space if the need arises for bigger events than it has capacity for. To underline this relationship to the plaza the auditorium volume is shifted out from the façade. The materiality of the volume is also differentiated from the rest of the building envelope by being in wood. This creates a clear visual distinction from the regular and homogenous façade. Inside the building the Auditorium volume also contrasts the regular grid with its angled form that cuts into the atrium hall. This angle is a direct representation of the inclination of the audience seats. This creates a unique space both in the atrium and in the auditorium where the space further defined by the sculptural sound diffuser hanging from the ceiling.



Ill. 87 Auditorium



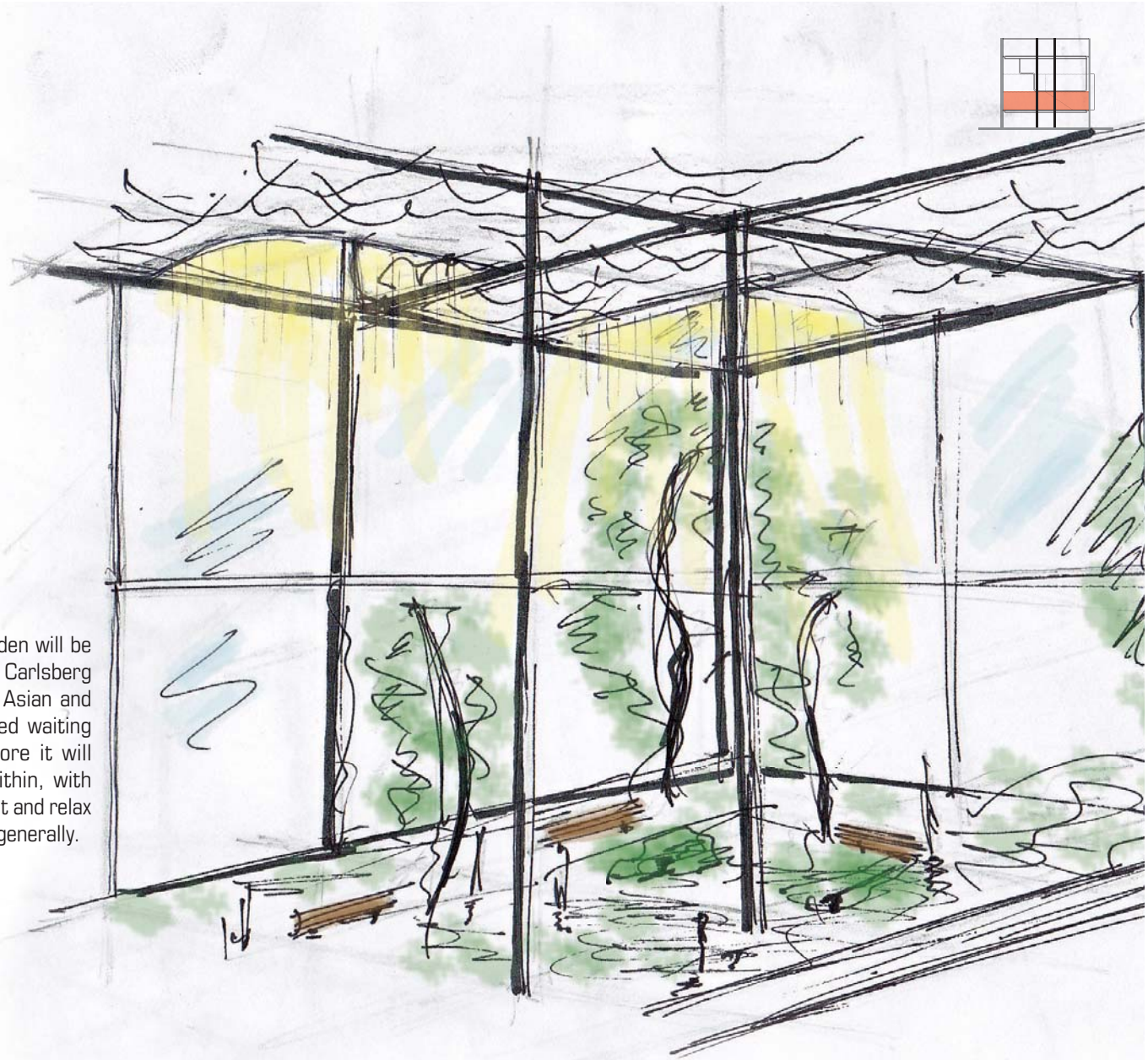
Roof Garden

The negative spaces created by the volumes are used for various functions most predominantly are two large gardens, one inside and one outside on the roof. The two gardens will have very different themes, the interior will be subtropical and the roof will be plants suited to the Danish climate.
The plants in the roof garden will be primarily hops, but apple and pear trees will also be planted in select places, these serving as a reference to the beer and cider production of Carlsberg. The hobs plants of the roof will serve as a space dividing element in the garden in addition to their referential and aesthetic value. Connected to the roof garden is the restaurant that will take advantage of the scenic garden and the great view from the top of the building to set the stage for an atmosphere that represents Carlsberg.

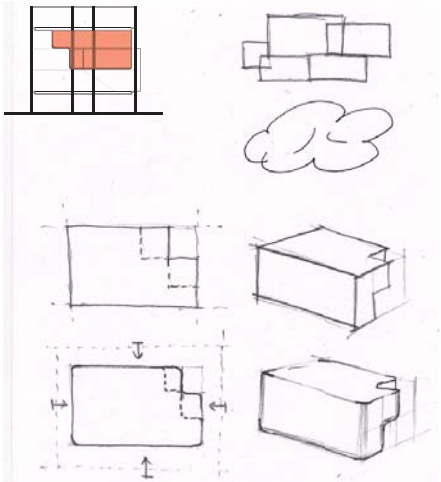
Ill. 88 Hops garden

Sub-tropical Garden

The plants and trees in the subtropical garden will be taken from the different exotic markets that Carlsberg has a large market share in, primarily the Asian and American market. It will serve as combined waiting and exit area for the auditorium. Therefore it will be created with various smaller areas within, with benches and small hills that can be used to sit and relax while waiting to get in, after getting out or generally.



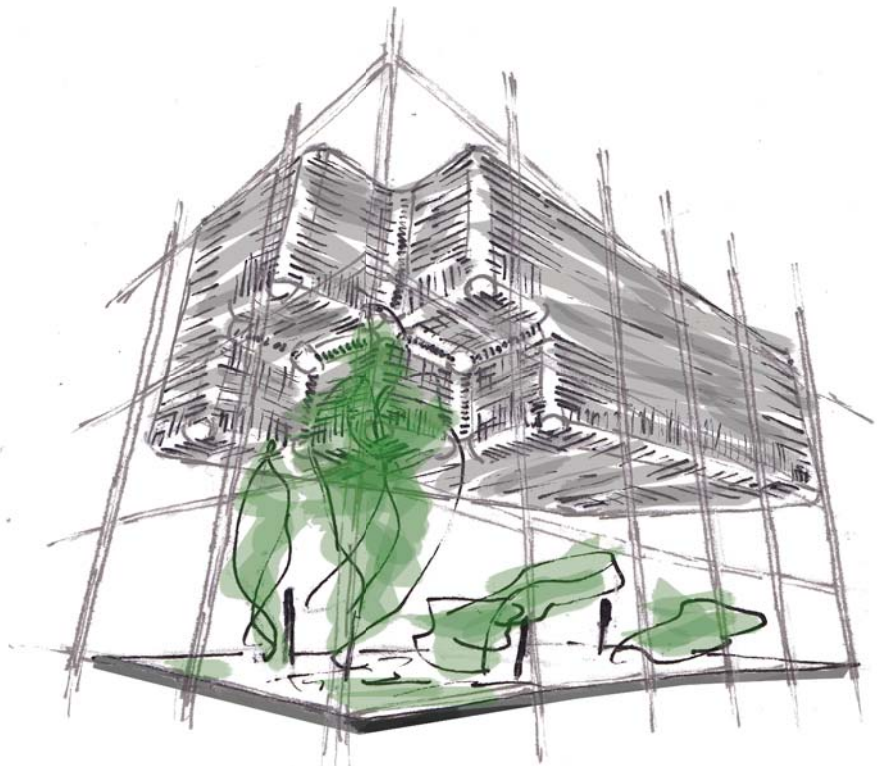
Ill. 89 Sub-tropical garden



Ill. 90 Cloud design

The Cloud

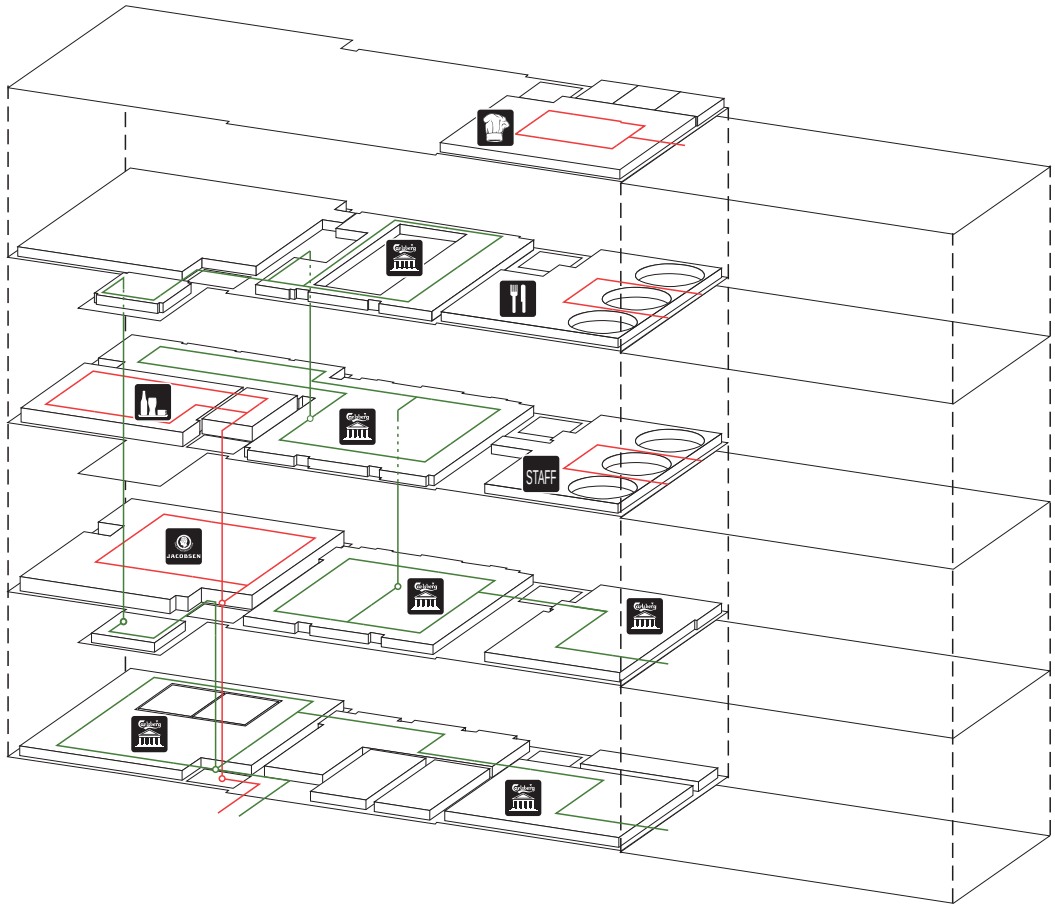
Above the subtropical garden hangs the contemporary exhibition "The cloud". This two story volume can house exhibitions that are not necessarily directly connected to Carlsberg and are not permanent. The shape of the cloud, with its cut in the south east corner, is derived from daylight considerations. Its shape allows light to penetrate deep into the garden while at the same time shielding other areas of the building. The material of the cloud will be polished concrete, thereby creating a heavy element that together with the concrete service tower can act as thermal mass to ensure an even temperature in the building. The contemporary exhibition space will appear to be floating above the garden. This look is achieved by offsetting it from the façade and rounding the edges, giving this heavy structure a light and soft appearance.



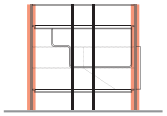
Ill. 91 Cloud

Old building

In planning the layout of the existing building a great deal of care has gone into changing as little as possible in order to make it functional, because of the preserved nature of the building. Therefore the various spaces in the building have been deliberately unchanged, even though this would mean that some functions got assigned more space than was originally intended. In planning the old part the most important aspect was creating the route for the Visit Carlsberg exhibition, this leads through the most iconic rooms in the building, including the four story boiler room and even utilizing the elephant gate. Kitchen and staff facilities are placed adjacent to the new building in order to insure maximum functionality. Additionally the Visit Carlsberg exhibition is divided into two parts, one paid and one free, where the paid take the visitor through the iconic rooms.



Ill. 92 Exploded drawing old part

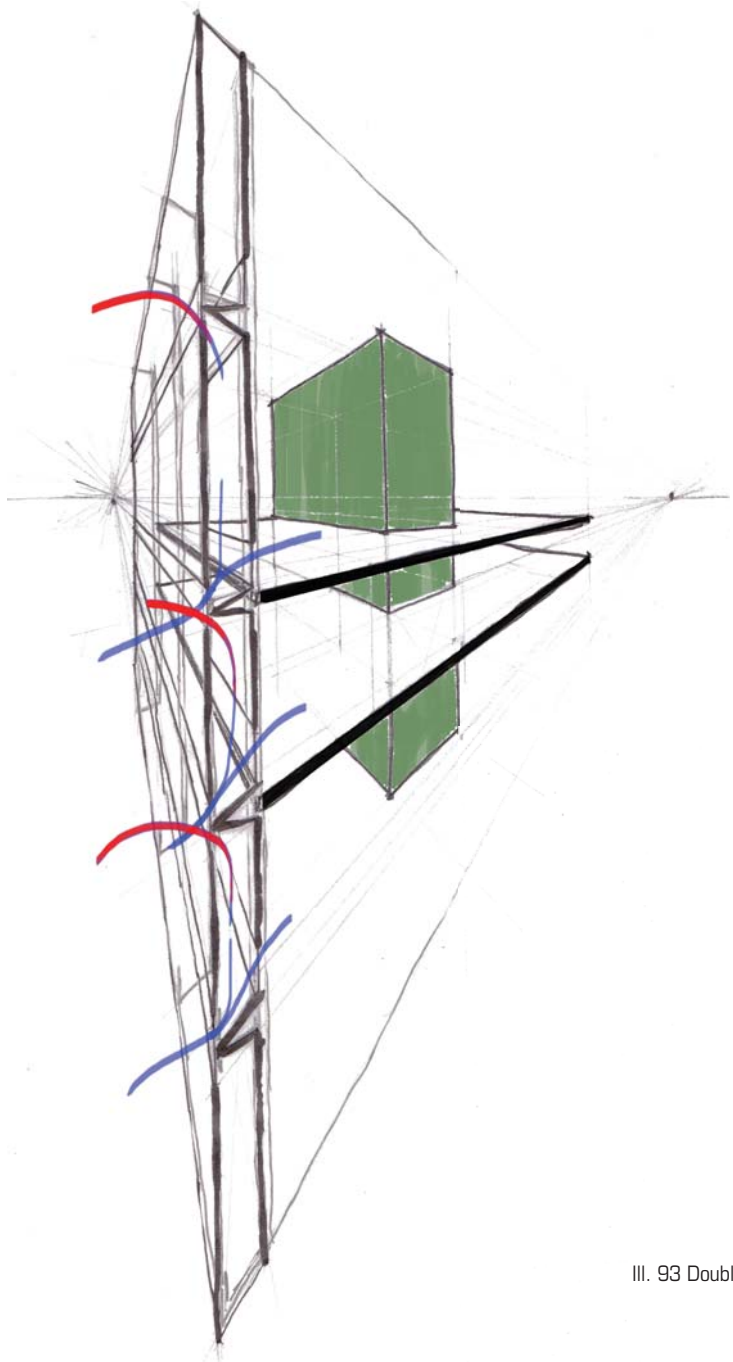


Double Facade

The technical challenges in designing the new Carlsberg Brand and Experience Centre have been numerous and varied. Of these the most challenging has been the creation of the double façade. Because of the importance of this element, not only to the indoor climatic qualities and energy consumption, but also the expression of the building, it was critical that the design of this in particular received special attention. This proved to be quite a challenge for several difference reasons. Firstly the physics involved with determining the airflow through double facades are so complicated that accurate simulations are borderline impossible. This is mainly due to the impact the relationship between local conditions, dimensions and construction technique has on the performance of the façade. This results in a situation where the successful implementation of a double façade in one location does not mean that a similar solution will work somewhere else. Because of this the available literature is scarce and usually only deals in generalizations and simplification of the topic. Most of the reliable information on this topic comes from various test building where the environment and geometry is well defined. From these, as well as observations of successful real world implementations, certain standards have been defined for double façade construction in Denmark. The double façade in this project has gone through several iterations based on information extracted primarily from a study made by the Swedish Lund University. (H. Poirazis, 2004) The most important factor in the airflow through the façade has been kept constant through the iterations, this being the depth of the ventilated air gap. The change in the iterations was mainly to the construction method and materials used. The chosen depth of the façades air gap is 40cm this value was given as a guideline when creating double facades of less than five stories in Denmark and based on imperial observations. Initially the façade was constructed as stacks, a single layer of glass in the exterior and double layer in the interior. This configuration was capable of providing the air change rates required, but lacked the u-value needed. Through multiple iterations this was changed to the current design, where the method is change to box construction with double layer glass on the exterior and triple on the interior. This solved the problem with the u-value and the change of construction method will still provide adequate air change rates.

Ventilation Strategy

The atrium along with the double facade serves as the main conductors for the natural ventilation strategy in the building. This is complemented by a VAV controlled ventilation system that takes over in the colder months where natural ventilation isn't feasible to use because of the heat losses associated with it. This system incorporates a heat recovery system that allows the ventilation system to also supply a majority of the heating required in the building. The double façade accelerates the airflow in the individual stories by a combination of single story stack ventilation along with thermal buoyancy, this allows for an adequate air change rate throughout the summer. The individual rooms use cross ventilation to ventilate from the double façade out into the atrium, where the stack effect of the high room will ventilate the air out through the skylight window. During winter the double façade is closed off to increase its thermal insulation. Along with aesthetic considerations the centralized placement of the technical room also optimizes the mechanical ventilation system by reducing the length of the ventilation pipes.



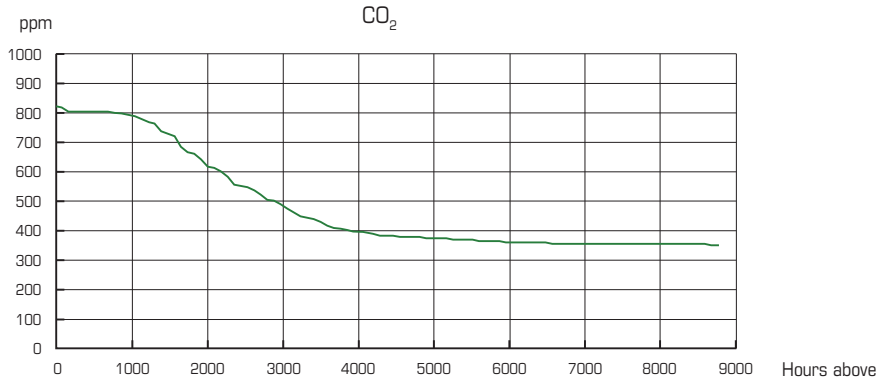
Ill. 93 Double facade

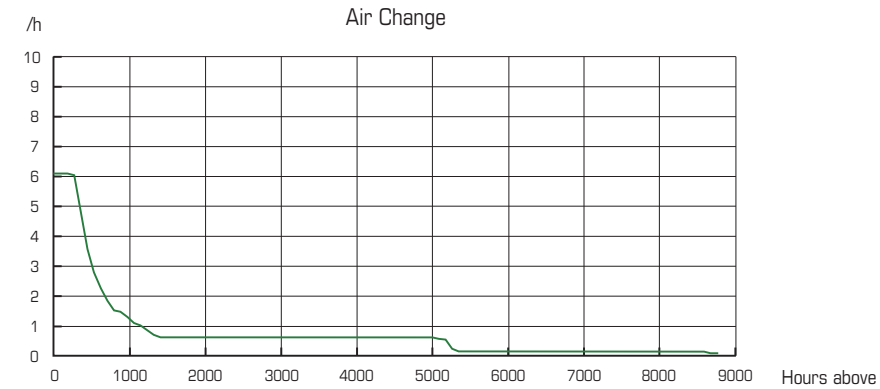
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum/Mean
tOp mean	21,2	21,5	21,9	22,5	21,9	22,4	22,6	22,6	22,0	22,1	21,5	21,2	22,0
Airchange /h	0,4	0,5	0,5	0,6	0,7	1,2	1,5	1,4	0,6	0,5	0,4	0,4	0,7
Co2 ppm	504,2	499,5	487,5	471,3	517,2	499,5	423,1	434,6	488,8	487,1	501,6	498,3	480,2
Hours > 26	0	0	0	7	1	12	16	17	2	0	0	0	55
Hours > 27	0	0	0	0	0	6	5	9	1	0	0	0	21
Hours < 20	0	0	0	0	0	0	0	0	0	0	0	0	0

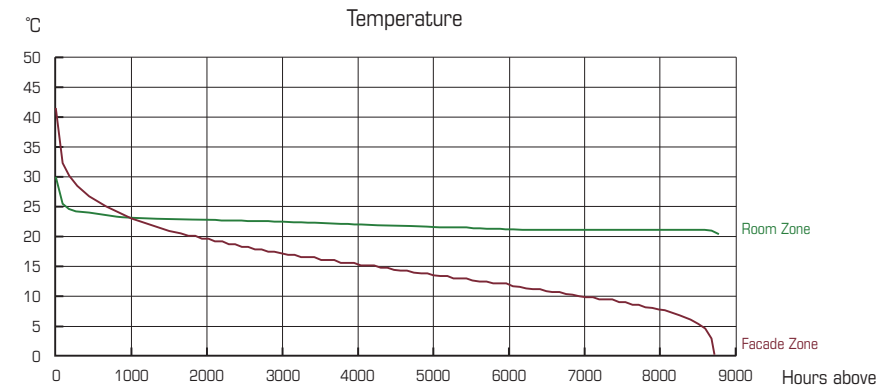
Indoor climate

In order to ensure a good indoor climate in the building without excessive power usage, simulation and optimization of this aspect were carried out in BSim. The double façade again complicated this process because BSim was not designed to handle this type of construction. Because of this limitation in the software available, some assumptions had to be made in order to get realistic results. These assumptions were based partly on information from our BSim teacher and partly on information gathered from literature. Because of the complexity of these studies and the varied nature of the building, only the most critical room was modeled and tested to optimize the indoor climate. The room chosen is the south facing office on the 2nd floor of the building. This room was chose because it is heavily shaded throughout the year and its sheltered location limits the effectiveness of natural ventilation.

Studying the results from these tests helped optimize the natural and mechanical ventilation in the office, regarding thermal and sensory indoor climate as well as CO2 levels. The following shows the most important results from the final test, additional information can be found in appendix 2.







Energy

The goal from the outset of the project was to create an offsite Net-Zero Energy building. The energy will here be produced by a pair of 4mW offshore windmills scheduled to be constructed to provide the energy needs of the entire Carlsberg Valby site in conjunction with the realization of the Entasis master plan. In order to achieve this goal and limit the amount of renewable energy the building will consume it has been optimized in order consume as little energy as possible, with the goal of meeting the 2020 energy frame. The building will utilize district heating to supplement the heat recovery system in the ventilation in order provide the heating needs of the building. The building envelope is creates with as low u-values as possible to limit the losses, in this regard the double façade with its combined five layers of glass provides a very low u-value while still retaining transparency. Despite the high glazing percentage of the building it has been designed to not require any mechanical cooling. This is in no small part due to the double façades ability to optimize the natural ventilation in the building, by providing a high potential air change. Illustration XX shows the key numbers from the BE10 energy calculation, additional information can be found in appendix 3.

Key Numbers, kWh/m^2 year

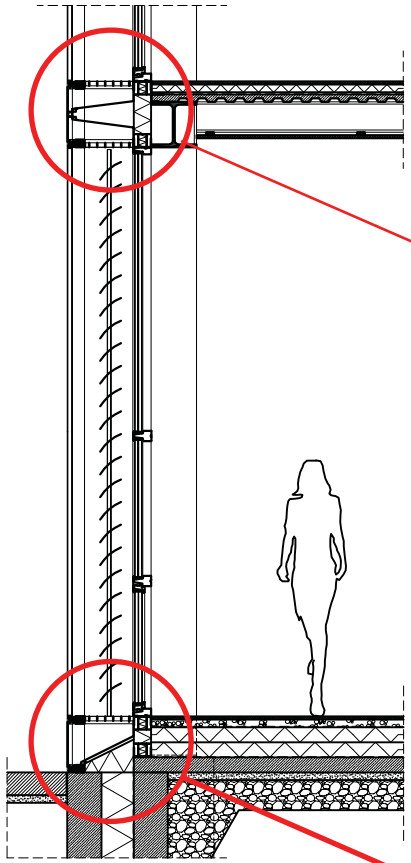
Contribution to energy requirement		Net requirement	
Heat	6,2	Room heating	0,9
Electricity for operation of building	8,4	Doestic Hot	5,3
Excessive in rooms	0,0	Cooling	0,0

Energy frame Buildings 2020

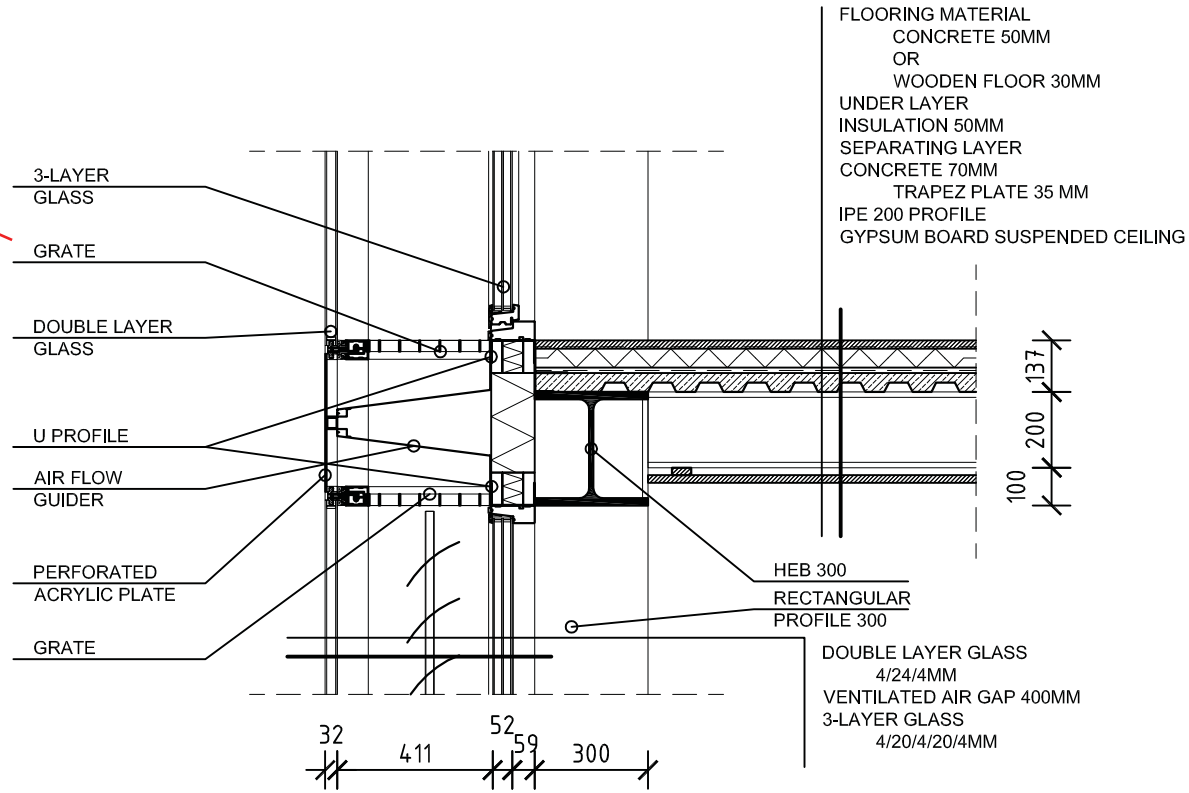
Without supplement	Supplement for special conditions	Total energy frame
25,0	0,0	25,0
Total energy requirement		18,8

Details

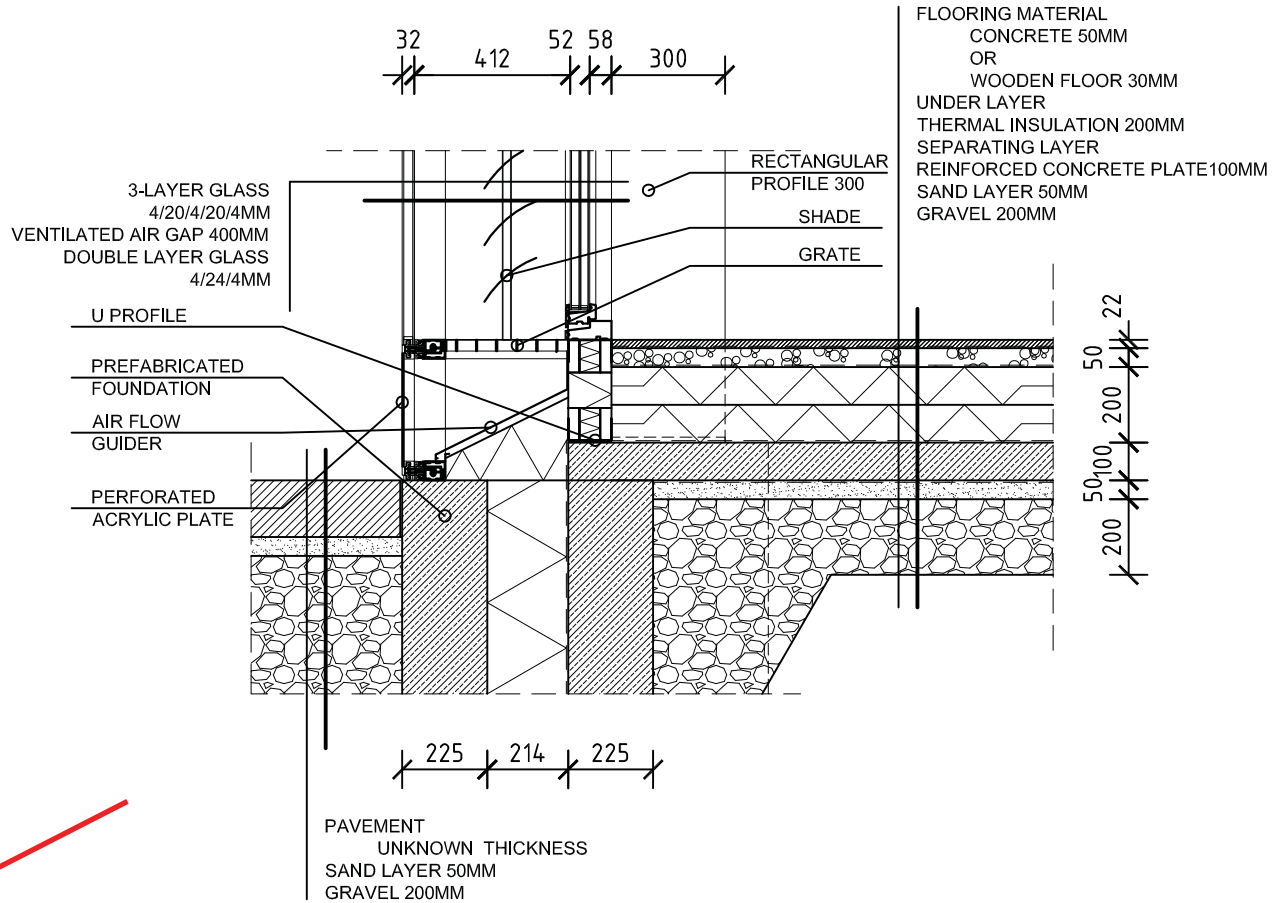
Because of the significance of the double facade for the design of the new Carlsberg Brand and Experience Centre, the suggested design of this element is presented on this spread. Additional details can be found in appendix 1.



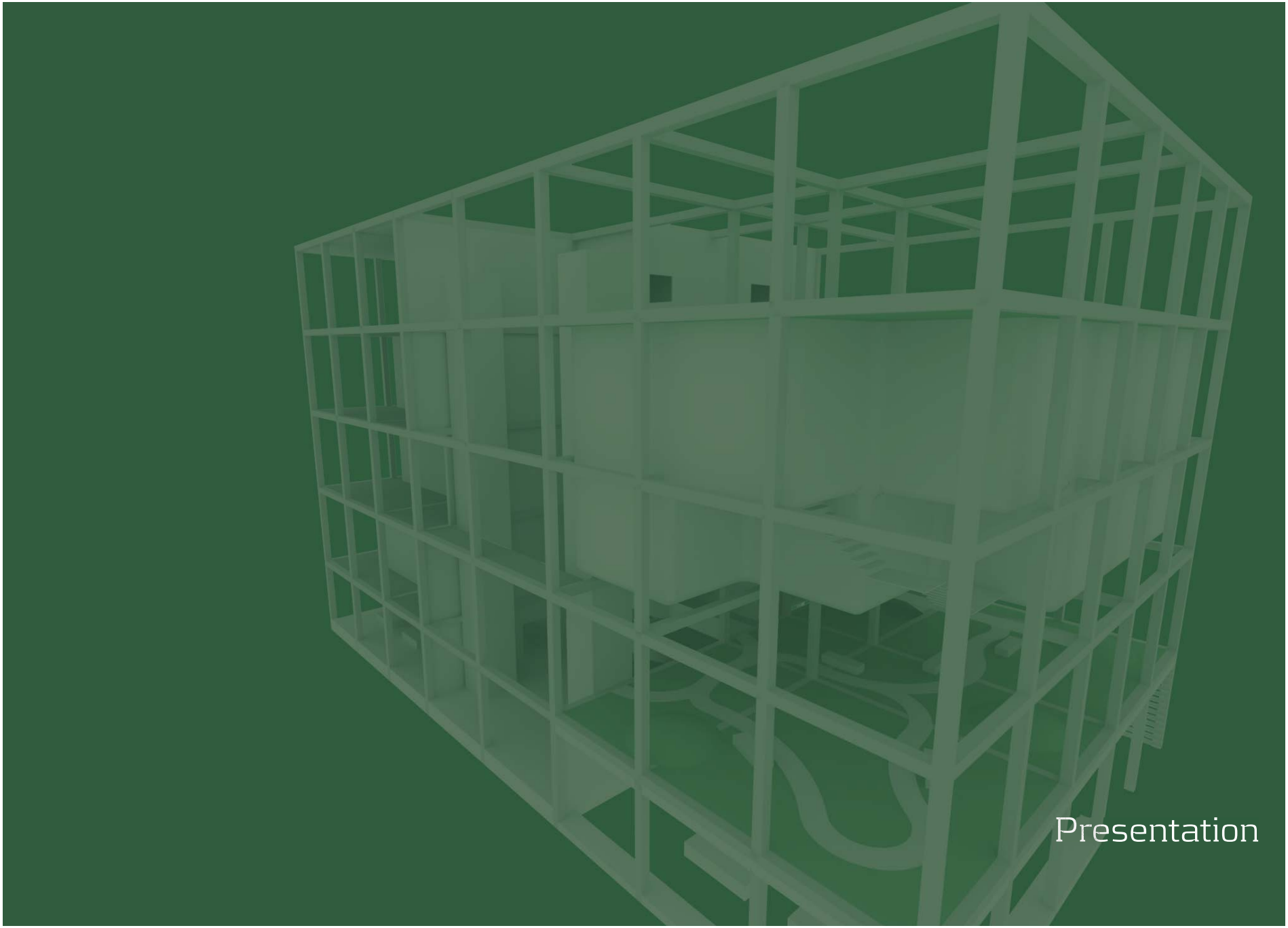
Ill. 94 Detail overview



Ill. 95 Top detail



Ill. 96 Bottom detail



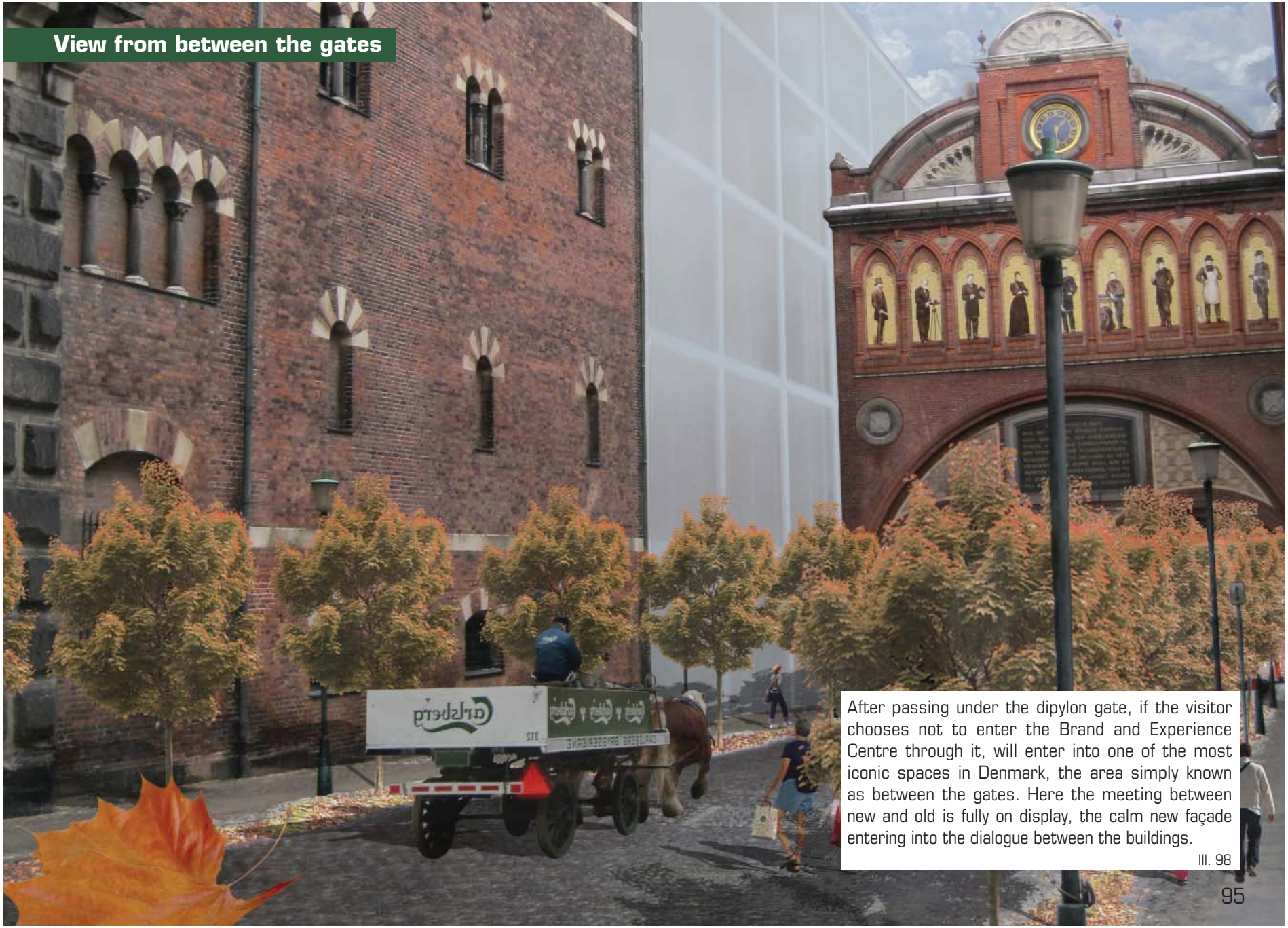
Presentation

Arrival from Ny Carlsberg Vej

When first entering the area most visitors, like today, will come from Ny Carlsberg Vej. Here they will be met with their first glimpse at the Carlsberg Brand and Experience Centre that stands framing the dipylon gate together with the historic 2nd expansion to the Ny Carslberg Breweries.

Ill. 97

View from between the gates



After passing under the dipylon gate, if the visitor chooses not to enter the Brand and Experience Centre through it, will enter into one of the most iconic spaces in Denmark, the area simply known as between the gates. Here the meeting between new and old is fully on display, the calm new façade entering into the dialogue between the buildings.

Ill. 98

Bag Elefanterne

To the North of the Brand and Experience Centre lies the public plaza known as “Bag Elefanterne”, Behind the Elephants, this once closed off space will join the building in a symbiotic relationship, both elements helping to define the space.

Ill. 99

Inside atrium

Transitioning from the small space under the Dipylon gate into the great atrium marks the first of the many experiences the building has to offer the visitor. Surrounded by everything Carlsberg the visitor is free to proceed where they wish.

Ill. 100

Office space

The office spaces on the 2nd and 3rd floor mark the other side of the Brand and Experience Centre, the day to day administration of the Carlsberg Valby site. This space overlooks the atrium space and represents a modern approach to office design, with ample relaxation and meeting facilities.

Ill. 101

2nd floor garden

The sub-tropical garden placed on the 1st floor with its contemporary exhibition cloud, providing both light and shade, gives the visitor a unique opportunity to experience how far Carlsberg's influence has spread, bringing in plants and trees from Carlsberg predominant foreign markets. This space also serves as the entrance and exit for the auditorium, giving the visitor a break before or after a lecture or concert.

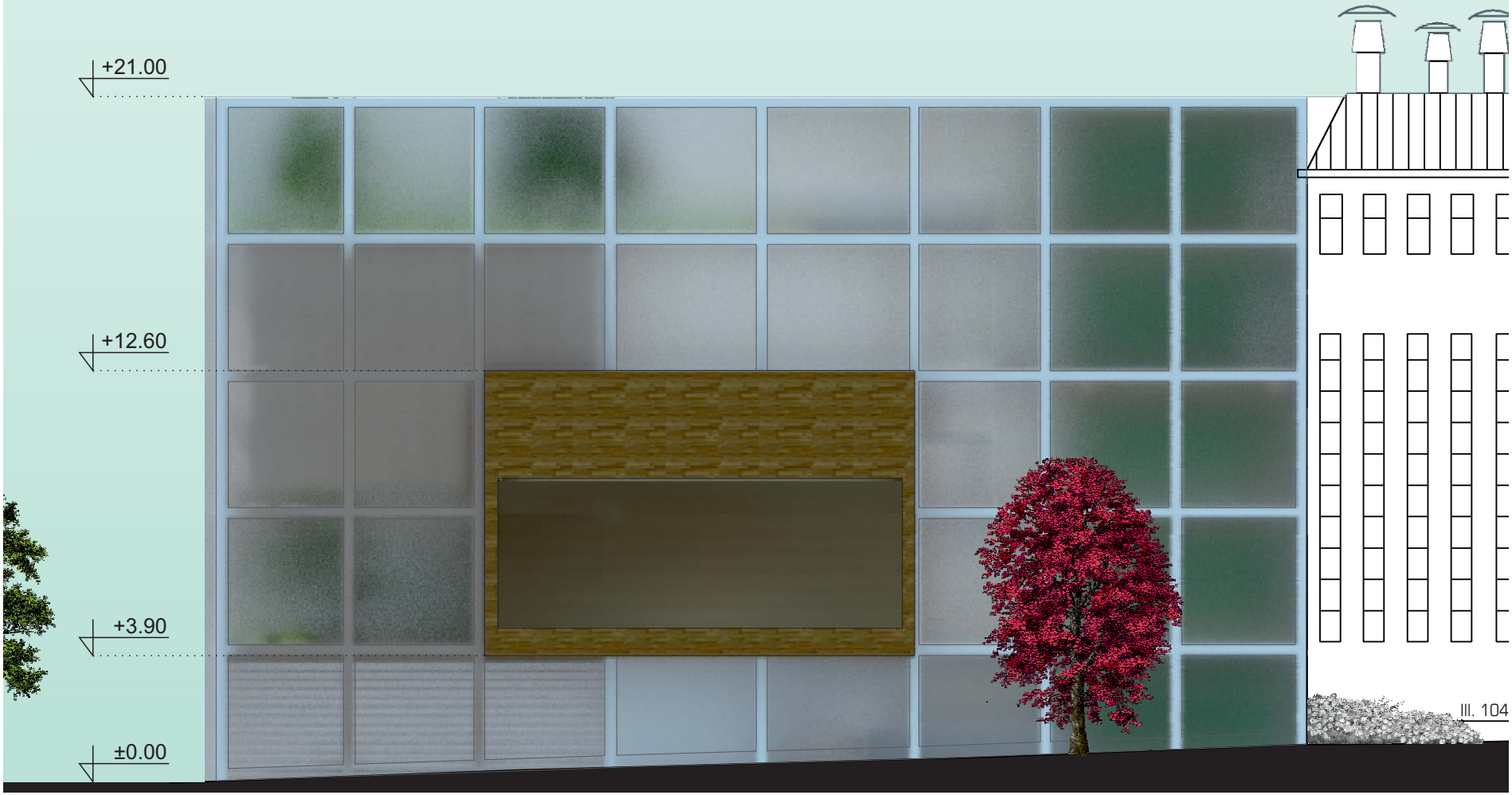
Ill. 102

Restaurant to garden

The building is capped off with the restaurant and hops garden. The restaurant provides a nice end to a day of visiting the Carlsberg Valby site, with its calm setting and remarkable view out between the gates to the south and out towards Copenhagen and its spires to the North and West. The hops garden provides a pleasant backdrop for this as wells as providing peaceful spaces within its mazelike hops curtains.

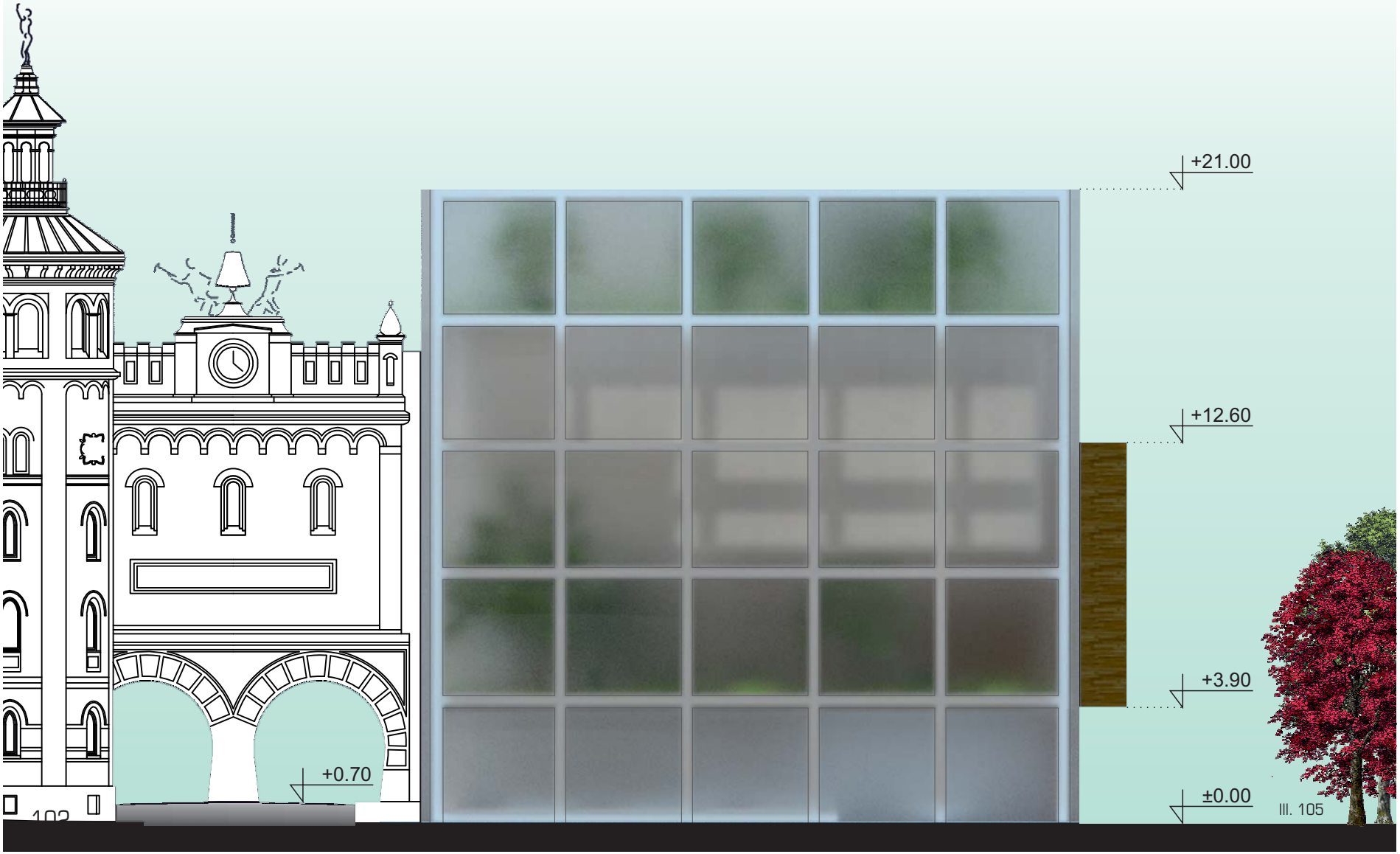
Ill. 103

Facade North 1:200

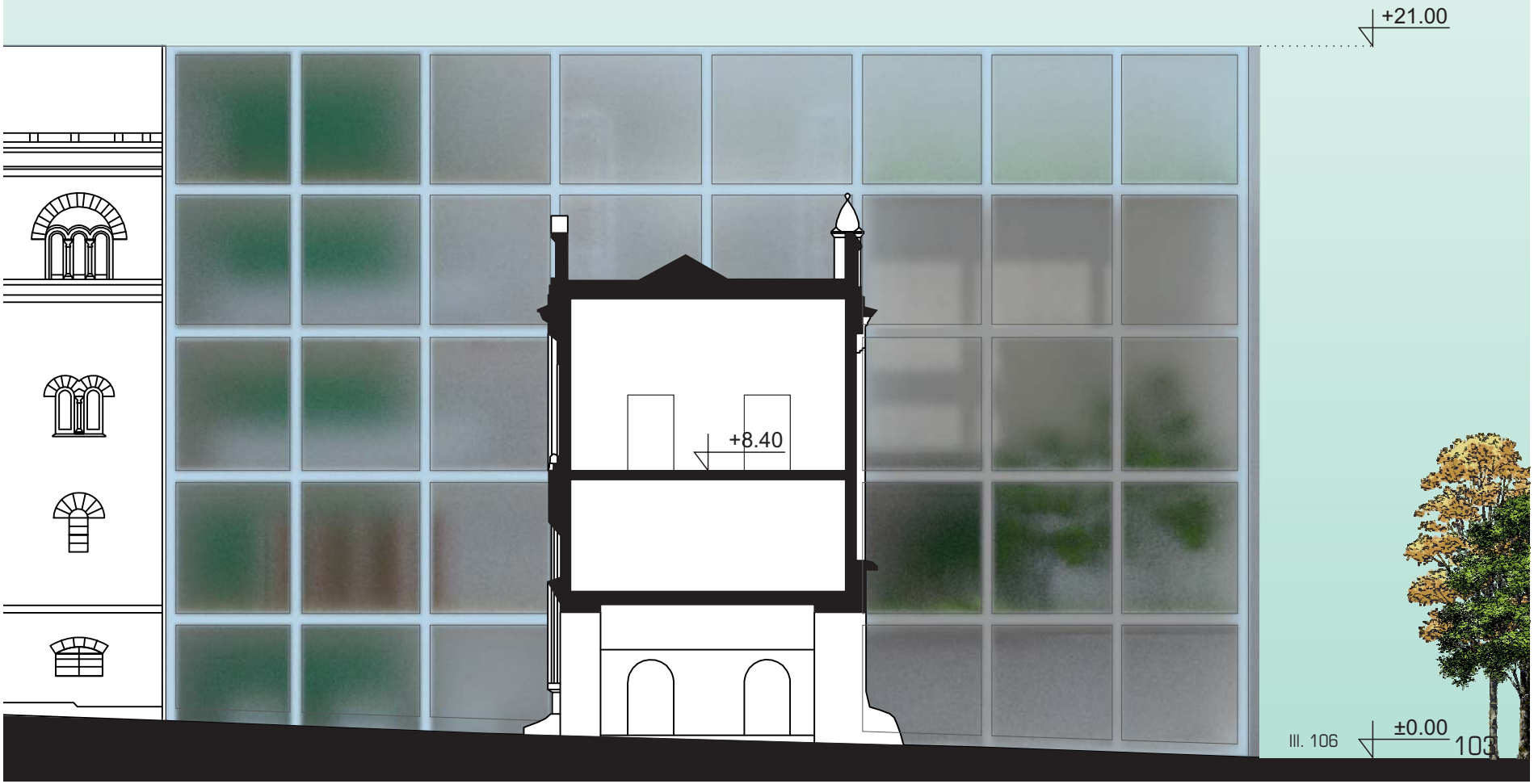


Ill. 104

Facades East 1:200



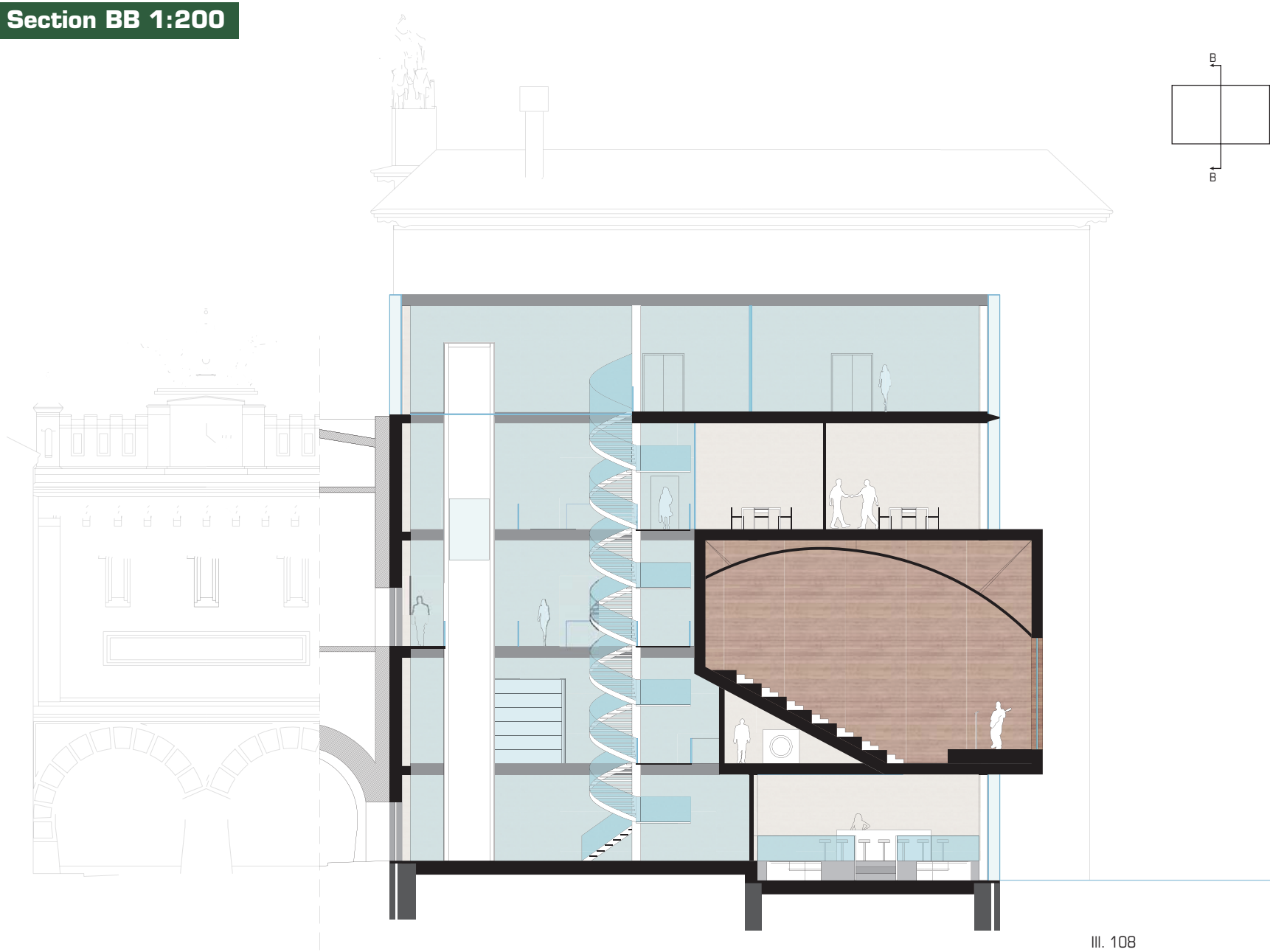
Facades South 1:200



Section AA 1:200

Ill. 107

Section BB 1:200



Ill. 108

Ground floor plan 1:200

Ill. 109

1st floor plan 1:200

Ill. 110

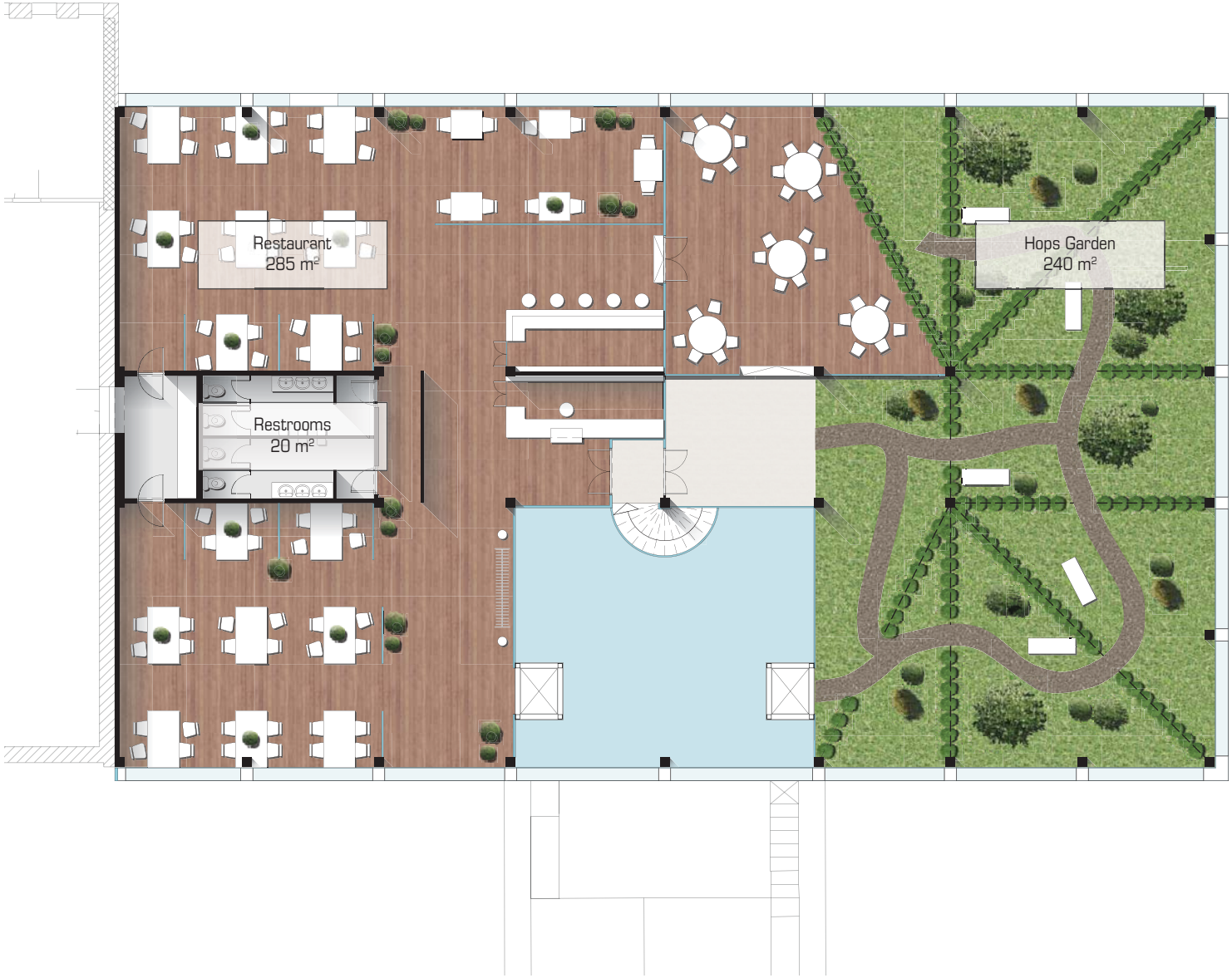
2nd floor plan 1:200

III. 111

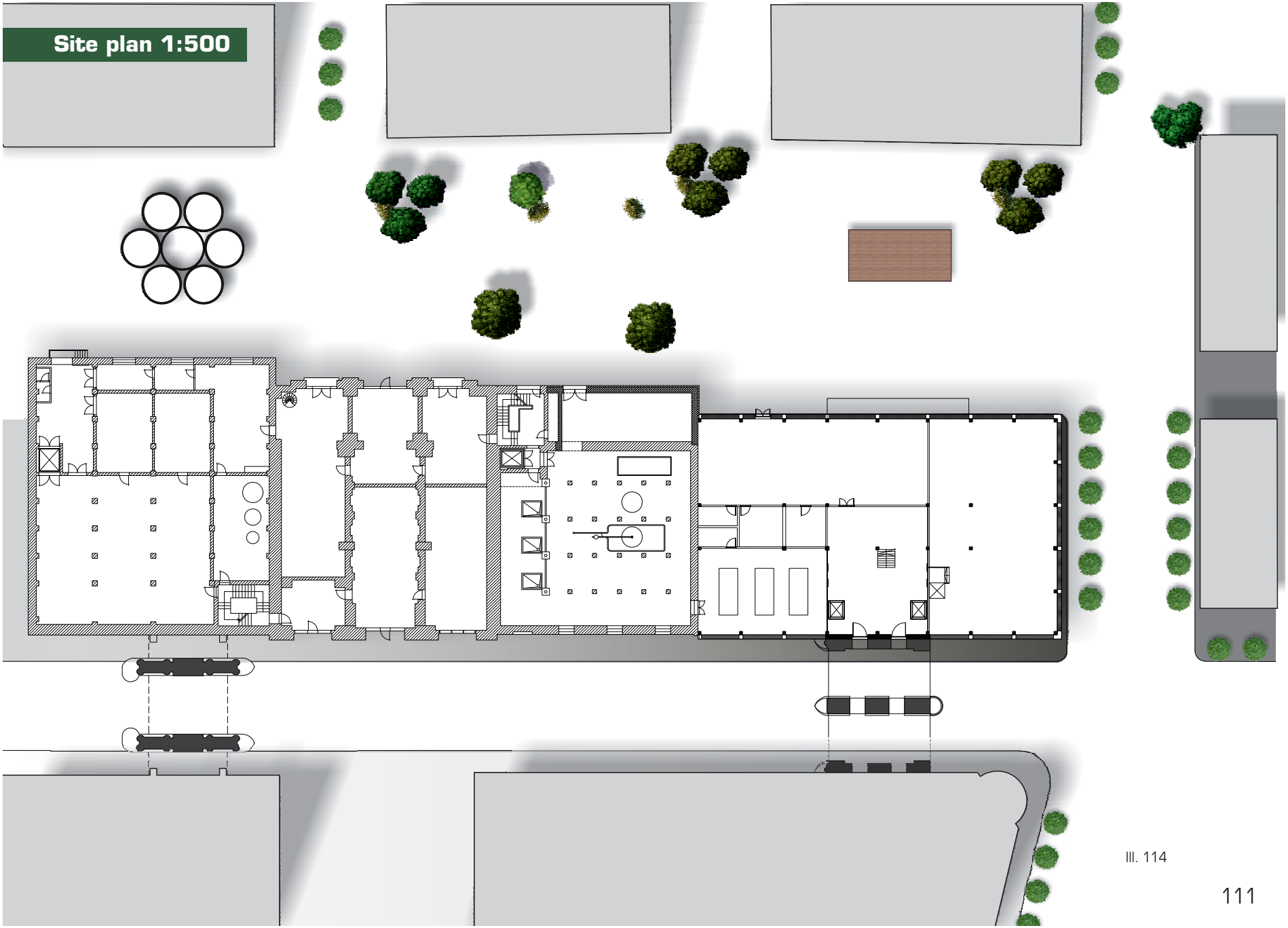
3rd floor plan 1:200

III. 112

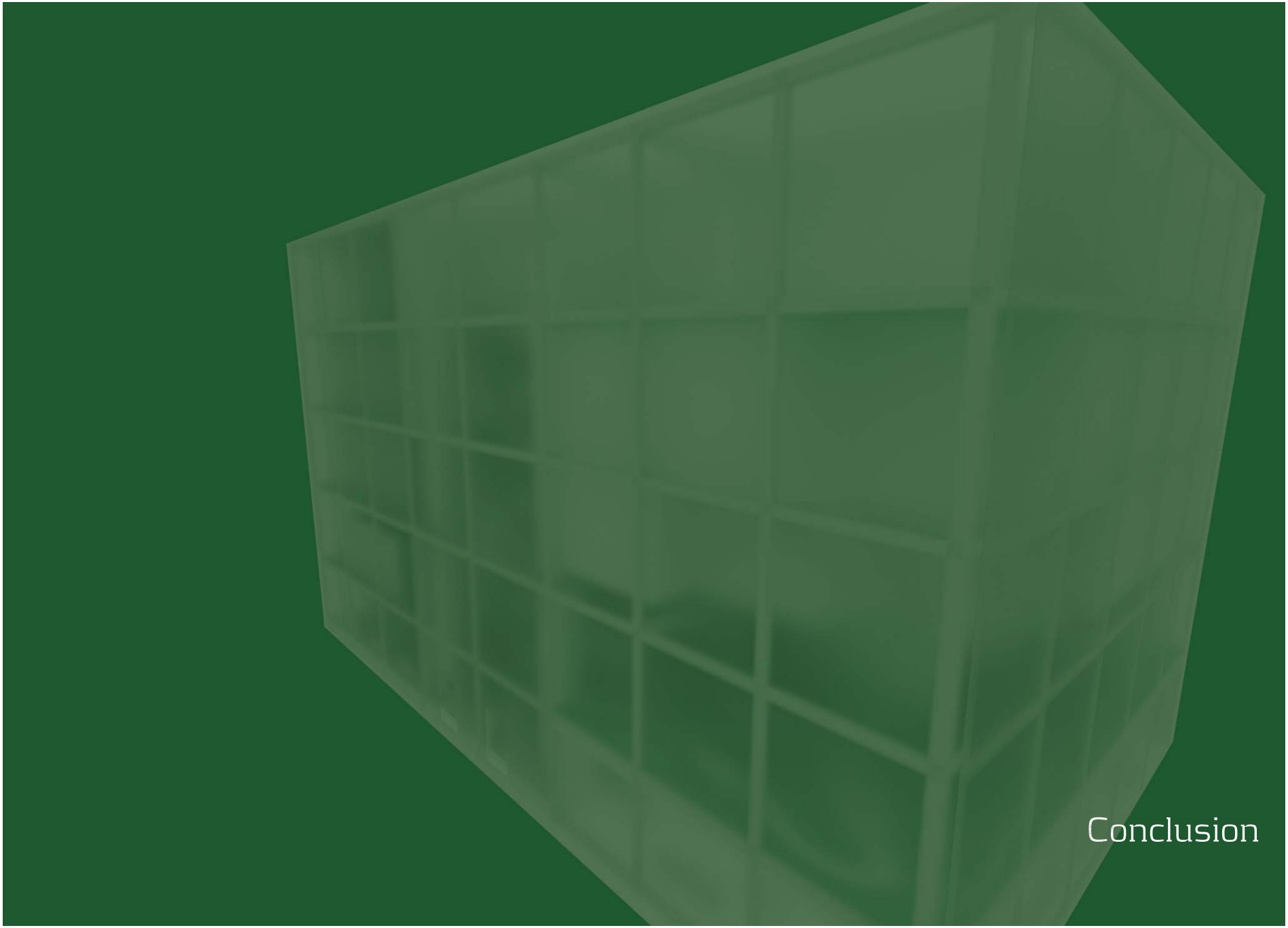
4th floor plan 1:200



Ill. 113



Ill. 114



Conclusion

Conclusion

In designing the new Carlsberg Brand and Experience Centre we have created a building that represents the inherent duality of the design problem laid out by the Carlsberg Group. Acting in a context of such deep importance for Danish culture at large, and additionally designing not only a building but an attraction presented a difficult problem. How to create a building that at the same time is calm and respectful to the context and wild and engaging to function as an attraction for the area. An obvious solution to this predicament could be to create a contrast to the existing, something so far removed from the context as possible. This approach did not appeal to us as it circumvents one of the most interesting aspects of the design task, walking the thin line between too similar and too different. The design suggested in this project walks that line, it is clearly different from the historic buildings but it contains various references to it. The façade, while calm and respectful to the context, hints at what lies within. Where the dynamic interior aims to peak the visitors curiosity, encouraging them to explore what the building has to offer. The floating forms, mix of materials and natural elements of the interior creates an environment rich with different experiences. The structural system with its rhythmical and geometric grid provides a contrast to these, thereby enhancing their dynamic appearance. The glue that binds all these elements and gives the building a good indoor climate is the double façade. It provides shading, ventilation, thermal resistance and plays a crucial part in the appearance of the building. This makes it arguably the most important part of the design. It also represents the biggest uncertainty of the building, because of the lack of reliable tools available to calculate this, thereby creating a situation where the exact effect of this will remain unknown until the building is build or better tools are developed. The qualified estimation presented in this report points towards that it will function, but because of the estimations that had to be made in order to get useful results from the programs available, certainty in this regard is not possible.

Integrating the new building directly with the existing historic buildings and using the spaces that these contain to strengthen the new buildings functions, creates a symbiotic relationship between them, they are part of the same system, the new supporting the old and vise versa.

Perspectivation

Looking forward in order to realize the building the following will have to be developed further. Firstly and most importantly the project is created on the site of an existing building, therefore research into the possibility of tearing down this building would have to be done before anything else. Additionally the integration of the preserved part of the building into the project could be strengthened if a closer cooperation with Carlsberg would be achieved. Thereby opening the possibility to alter the interior geometry of the preserved building in order to strengthen the flow and functional arrangements that are possible, this could open up the possibility of truly integrating the two buildings together. In addition to this there are several technical considerations that would have to be tested in order for the building to function. In this regard testing the effects the indoor garden would have on the indoor environment and ventilation needs of the building would need to be tested in order to ensure that this will not have a negative impact. Acoustics studies of the auditorium and further development of the reflector surface to ensure an optimal acoustic environment should be done. Daylight calculations would have to be done in order to prove that the facade will allow sufficient daylight into the rooms. In this regard the possibility of introducing natural light into the cloud might also allow for a wider variety of art installations in it. The effect of the frosted double facade on the natural daylight levels in the building will also have to be tested. Also the effectiveness of the double facade would have to be tested on the site in order to make sure that it would be effective in that specific environment.

Illustraton list

Ill56: http://c1038.r38.cf3.rackcdn.com/group1/building4662/media/Entasis_Drawing_Sustanability%20circle.jpg
Ill57-58: Own Illustration
Ill59: http://www.boiler-tubes.com/pic/Seamless-Square-Rectangulare-Steel-Tube.jpg
Ill60: http://i01.i.aliimg.com/photo/v0/212090813/curved_toughened_glass.jpg
Ill61: http://www.sxc.hu/browse.phtml?f=download&id=1353116
Ill62: http://bounteous.files.wordpress.com/2011/02/2011-01-31_1133.jpg
Ill63: http://www.sxc.hu/browse.phtml?f=download&id=483666
Ill64: Own Photo
Ill65-67: Own Illustration
Ill68-76: Own Photo
Ill77: Courtesy of Carlsberg Group
Ill78: http://www.productwiki.com/upload/images/carlsberg.jpg
Ill79: Own Photo
Ill80: Own Illustration
Ill81: Own Photo
Ill82-114: Own Illustration

Appendix
IllA1-A9: Own Illustration
IllA10: http://www.sxc.hu/photo/1363324
IllA11-A14: Own Photo

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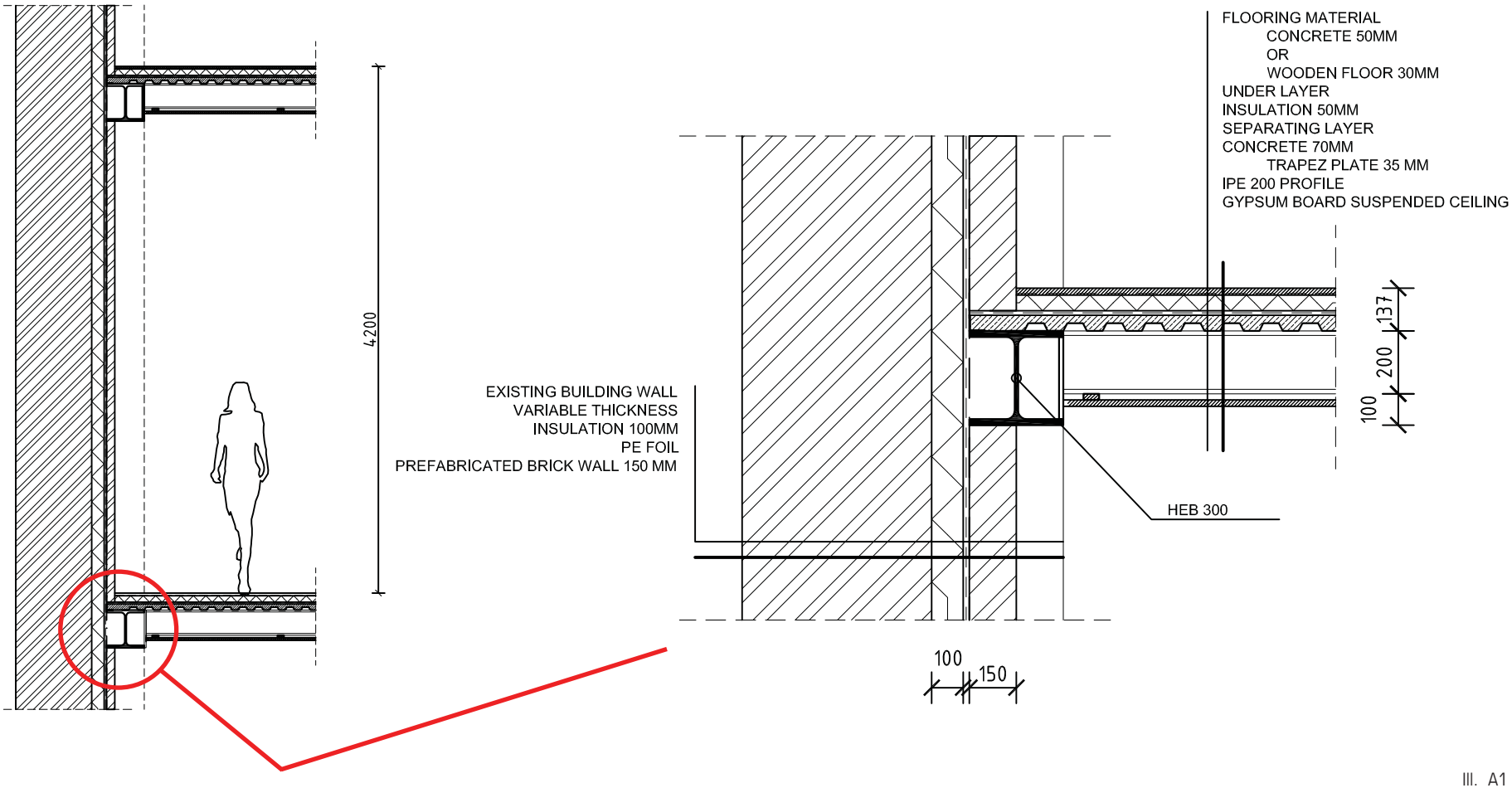
Appendix

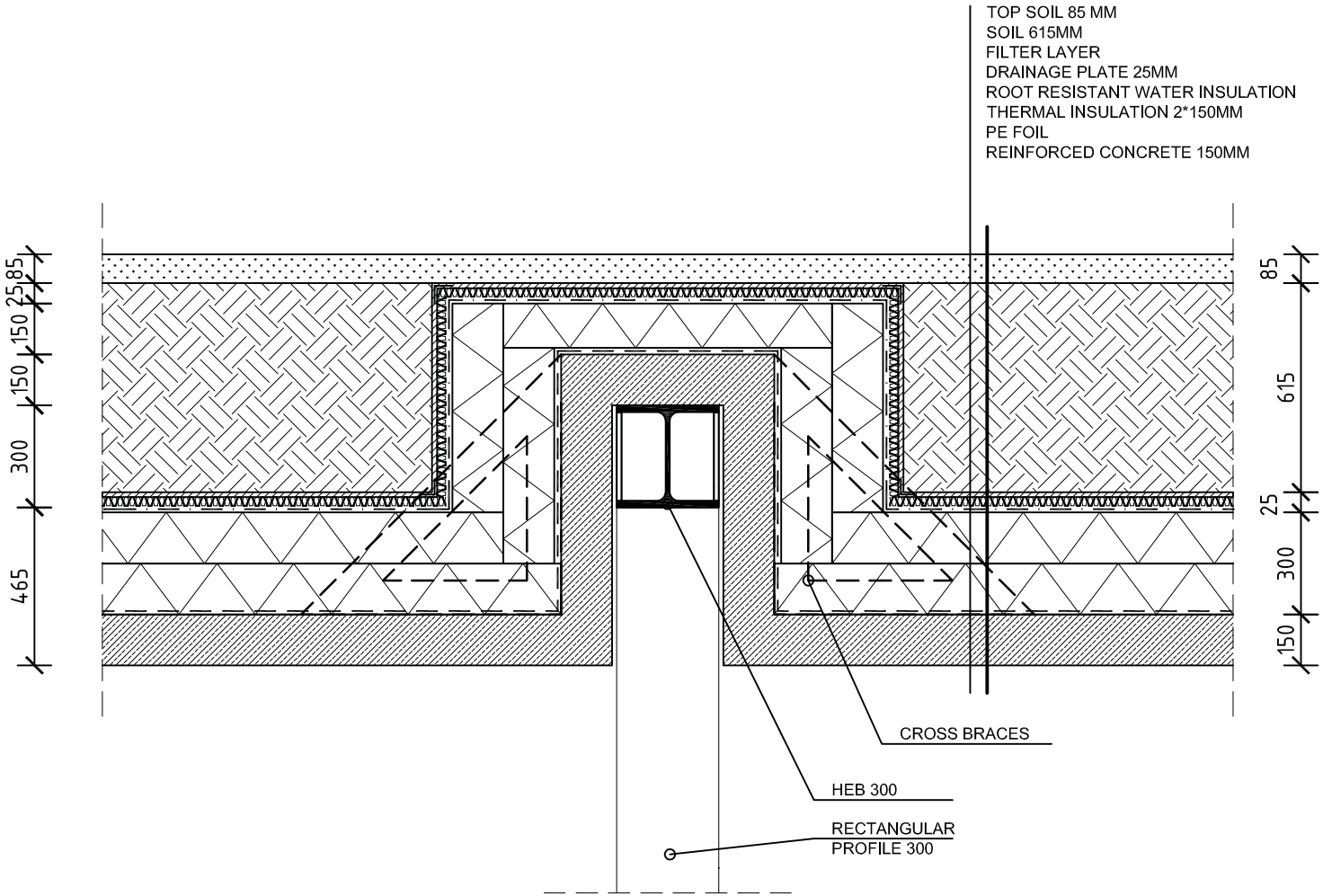
Additional details

Old building connection and floor seperation



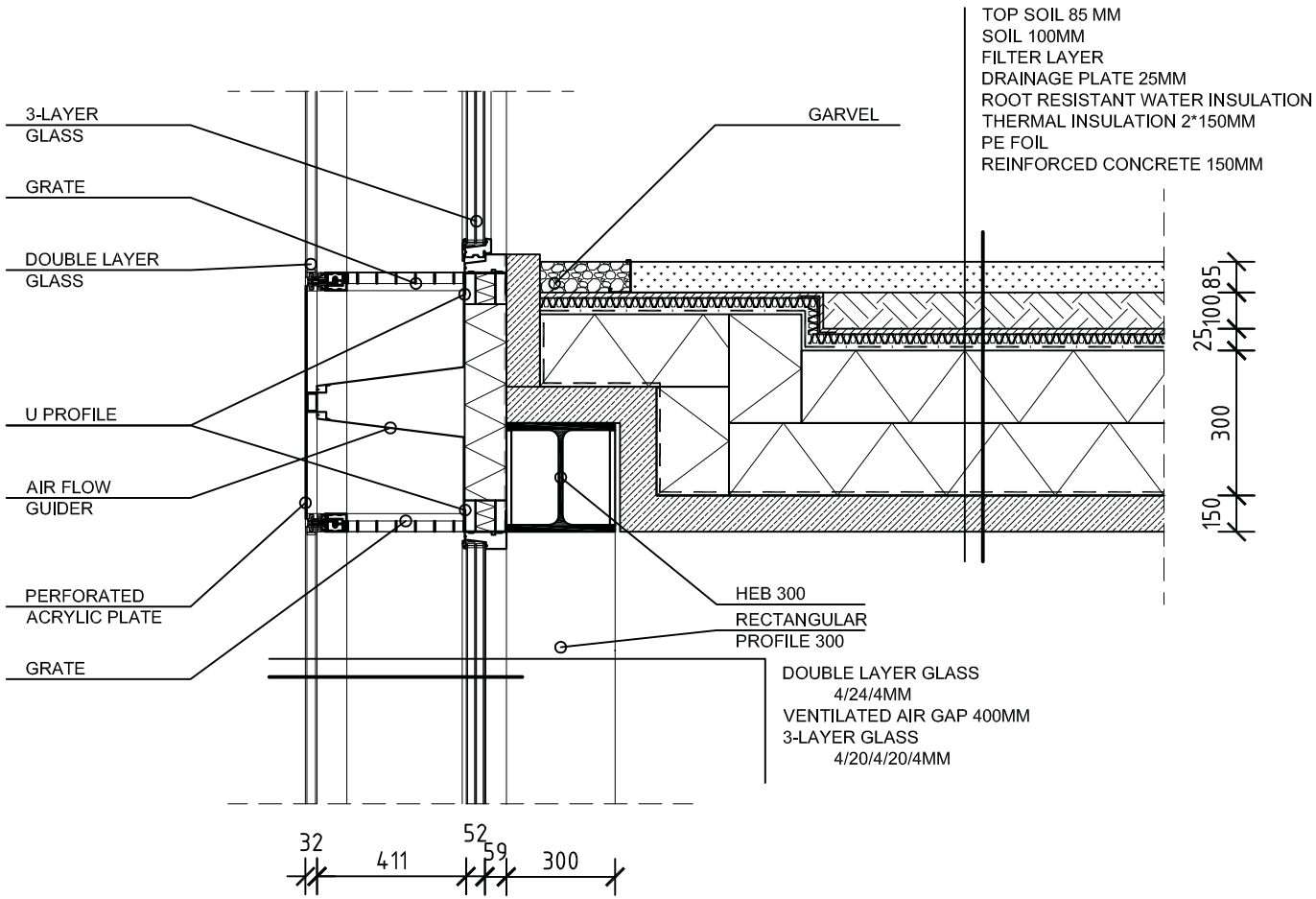
III. A1

Roof garden solution suggestion



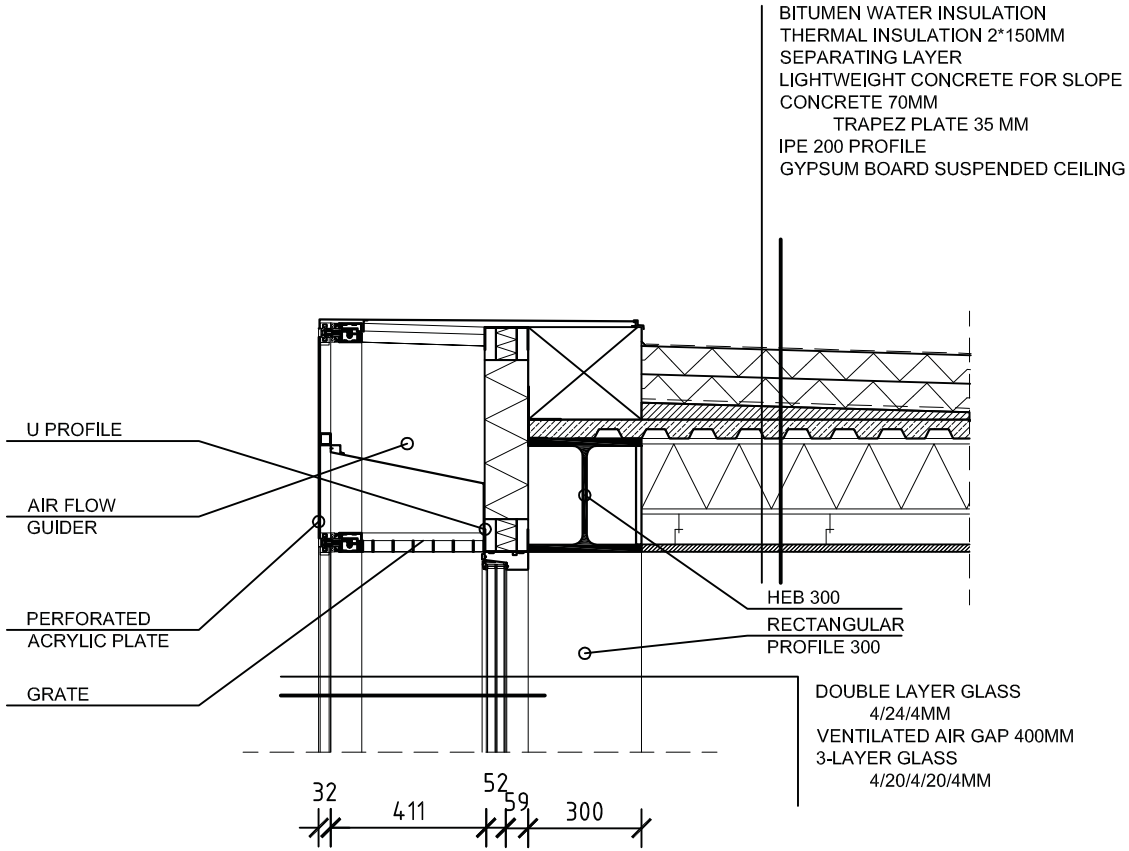
III. A2

Shallow garden suggestion

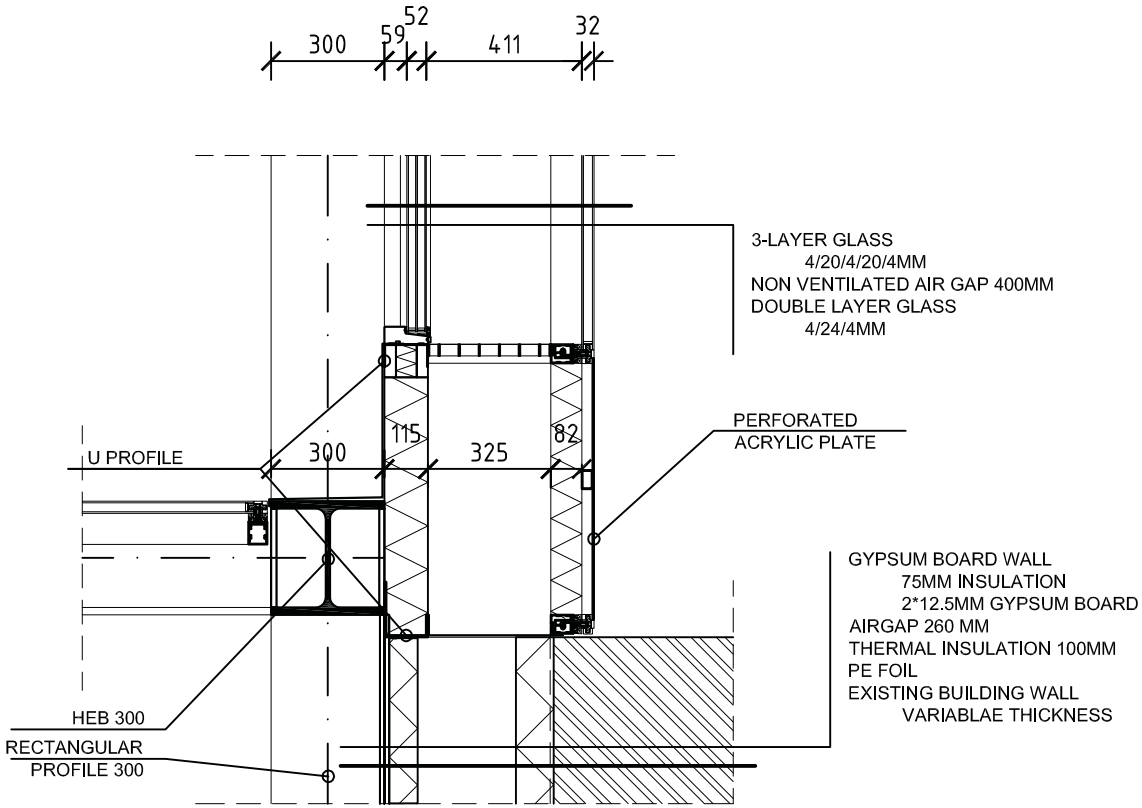


III. A3

Restaurant roof suggestion

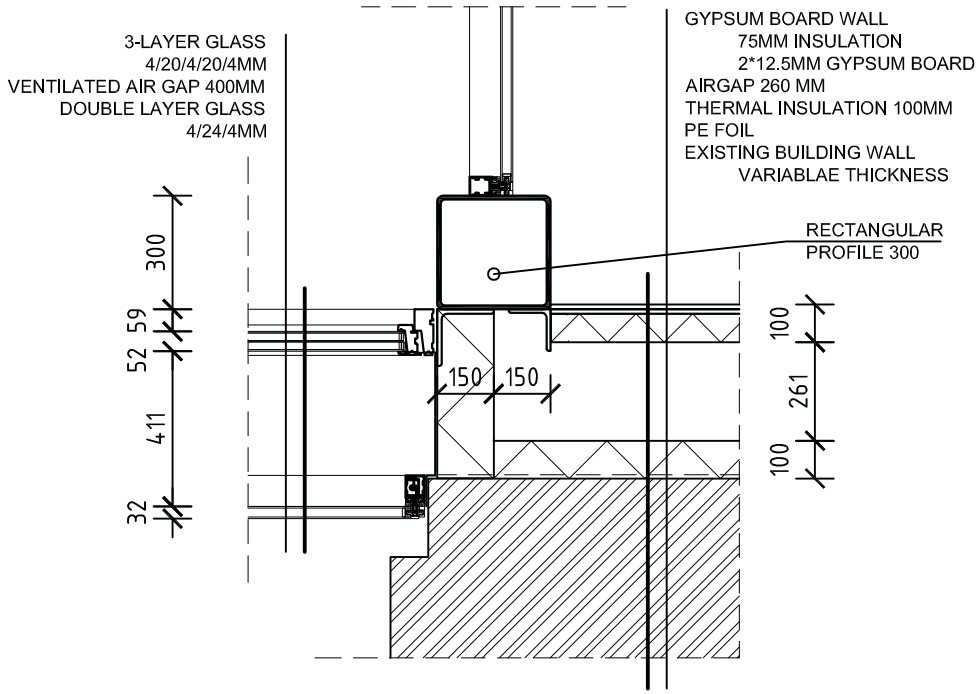


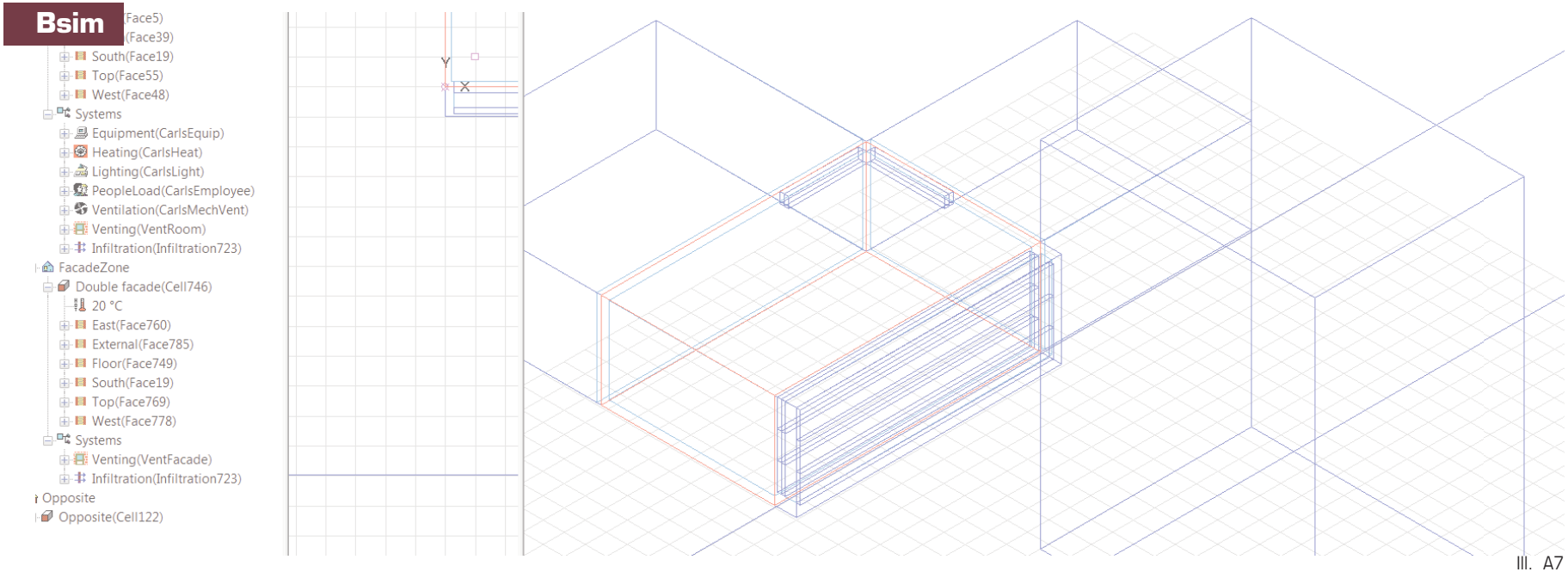
Dipylon and double facade meeting



III. A5

Dipylon gate meeting (Planar view)





Ill. A7

The following pages contain a description of the calculation conditions for the indoor climate calculation in BSim. The room chosen for this calculation is the 2nd floor office facing to the south.

Geometry

Because of the rooms rectangular floor plan it could be build in BSim without simplification. In addition to the office volume several shading volumes were placed in the simulation to give an accurate representation of the local environment.

Volumes for calculation

All but one of the faces in the office space face into the building therefore the only important surface for heat transmission is the South face connected to the double facade zone. This means only the surface material of the other faces has an impact on the calculation. These are constructed with wood in the floor and ceiling, bricks on the west face, concrete to the north and glass to the east. Venting exhaust openings are placed to the north and east near the ceiling and intake will take place through the bottom windows to the south. In addition to this volume is the double facade zone that plays a key part in the indoor climate. This volume is created as a glass box with a 40 cm air gap, triple layer glass on the interior and double on the exterior, with venting openings in the bottom and top. The shading system is integrated into this volume

Additional volumes

The dipylon gate and the building opposite are modelled to provide the correct shadow conditions in the simulation. Additionally exhaust zones are created to the north and east of the office zone.

Systems

The following systems are setup in the office and double facade zone respectively.

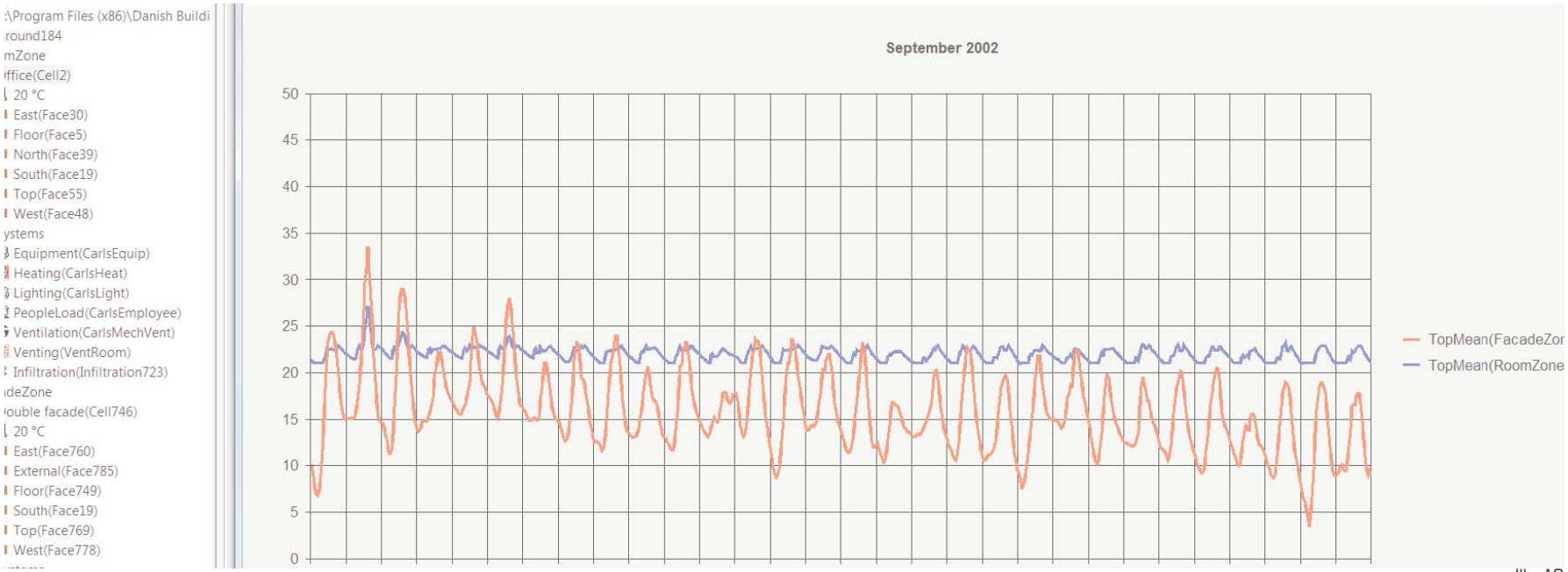
Office zone

PeopleLoad

The number of people in the office is seven and they are assumed to have a normal activity level. They are assumed to be in the office throughout the year six days a week from eight in the morning to four in the afternoon.

Equipment

The equipment load is shares the same schedule as the people load as it is assumed that the equipment will be turned off when the office is empty. The Heat Load is set to 0,3 kW and the part to air is 0,2.



III. A8

Heating
The heating system in the office will be controlled by a Heat/Cool control and is assumed to be active throughout the year. It is controlled by the temperature in the office so if the temp dips below 21 it activates to stabilize the temperature. The max power of the heating system is set to 1,5 kW.

Lighting
The lighting system is assumed to only be on when there are people in the office. It is controlled by a Light control that automatically turns off the light depending on the temperature (27 degree) and the amount of sunlight hits the glass of the facade (0,2 kW). The light level is set to 200 lux and the lighting type is fluorescent.

Ventilation
The ventilation system employed in the office is a VAV controlled system with a heat recovery system. It is setup to start two hours before the employees get to the office in order to insure that the indoor climate is optimal by the time they get in. The system is only on from October to April. The VAV system is setup to be able to vary its inlet temp from 18 to 28 and limits the CO2 level to 800 ppm. The heatrecovery unit in the system is assumed to be capable of an efficiency of 85%, and the ventilation system itself is setup for an airchange rate of five /h.

Venting
Because of limitations in the multizone model in BSim, automated natural ventilation proved impossible to calculate when working with a double facade. Therefore a manual setup of this had to be implemented in order to get realistic results. The aircchange was set to 5 /h and is assumed on always in the warmer months from May – September.

Infiltration
The infiltration is set to 0,1 /h and is on always.
Double facade zone

Venting
The venting system in the double facade is Automatic natural ventilation single sided different levels, and the max airchange is set to 50 /h. This number is based on data from empiric test. It is active in the same period as the venting in the office zone.

Infiltration
The infiltration is set to 0,1 /h and is on always.

Lighting

	Area m²	Min W/m²	Inst. W/m²	Light lux	DF %	Ctrl M,A	Fo -	Work W/m²
Service Tower	167,8	0	4	200	0,8	M	0,8	0
Offices South	253	0	4	500	0,8	M	0,8	1
Offices North	513,3	0	4	500	0,8	M	0,8	1
Exhibition Exit/Entrance	207,2	0	4	200	0,8	M	0,8	1
Brand Store	264,2	0	4	200	0,8	M	0,8	1
Atrium	119,5	0	0	200	0,8	M	0,8	0
Restaurant	271	0	4	200	0,8	M	0,8	0
Inside Garden	242	0	0	200	0,8	M	0,8	0
Contemporary Exhibition	325,6	0	4	200	0,8	M	0,8	1
Sports Bar	183,6	0	4	200	0,8	M	0,8	1
Auditorium	149,8	0	4	200	0,8	M	0,8	1
Technical Room	36	0	4	200	0,8	M	0,8	0

Ventilation

	Area m²	Fo -	qm l/s m²	n vgv -	ti °C	qn l/s m²	SEL kJ/m³	qn,s l/s m²	qn,n l/s m²
Service Tower	167,8	1	0,31	0,85	18	0	1	5,4	5,4
Offices South	253	1	0,23	0,85	18	0	1	5,4	5,4
Offices North	513,3	1	0,29	0,85	18	0	1	2,2	2,2
Exhibition Exit/Entrance	207,2	1	0,24	0,85	18	0	1	2,2	2,2
Brand Store	264,2	1	0,22	0,85	18	0	1	5,4	5,4
Atrium	119,5	1	0	0,85	18	5,4	1	5,4	5,4
Restaurant	271	1	0,25	0,85	18	0	1	5,4	5,4
Inside Garden	242	1	0,2	0,85	18	0	1	2,2	2,2
Contemporary Exhibition	325,6	1	0,25	0,85	18	0	1	0	0
Sports Bar	183,6	1	0,27	0,85	18	0	1	2,2	2,2
Auditorium	149,8	1	0,33	0,85	18	0	1	2,2	2,2
Technical Room	36	1	0,2	0,85	18	0	1	0	0

Internal Heat Loads

	Area m²	Persons m²	App. W/m²	App,Night W/m²
Service Tower	167,8	4	6	0
Offices South	253	4	6	0
Offices North	513,3	4	6	0
Exhibition Exit/Entrance	207,2	4	6	0
Brand Store	264,2	4	6	0
Atrium	119,5	4	3,5	0
Restaurant	271	4	6	0
Inside Garden	242	4	3,5	0
Contemporary Exhibition	325,6	4	6	0
Sports Bar	183,6	4	6	0
Auditorium	149,8	4	6	0
Technical Room	36	1,5	3,5	0

BE10

Building information

Because of the buildings mix of functions “other” was chosen for the building type. The heated floor area is 2733 m2 and it is rotated 9 degrees. The heat capacity of the building is set to 100 Wh/Km2, somewhere between medium light and medium heavy, because it is mostly light but features large concrete elements in the interior. The usage time is 45 hours/ week, and the heat is supplied by district heating.

Building envelope

The building envelope is constructed as 735 m2 terrain deck with a u-value of 0,08 W/m2K, and a roof with the m2 and u-value. Additionally the auditorium volumes walls that penetrate through the façade have a area of 152 m2 and a u-value of 0,15 W/m2K. The rest of the of the building envelope is the double façade and auditorium window with a total area of 1437 m2 with a u-value of 0,055 W/m2 K for the double façade and 0,52 W/m2K for the auditorium window.

Linelosses

The linelosses are devided into three categories, foundation, doors and windows and skylight. 114,58 m foundation with a loss of 0,15 W/ mK, 559,12 m doors and windows with a loss of 0,03 W/mK and 35,2 m skylight with 0,1 W/mK.

Shadow Conditions

The shading conditions for the building consist primarily of shade from the surrounding buildings to the South and East, but with full self shadow on the North façade.

Hot Water

Because of the non-residential nature of the building it only needed a water consumption of 100 l/year/ m2, the temperature remains the standard 55 °

Key numbers, kWh/m² year

Energy frame in BR 2010

Without supplement	Supplement for special conditions	Total energy frame
71,9	0,0	71,9
Total energy requirement		27,2

Energy frame low energy buildings 2015

Without supplement	Supplement for special conditions	Total energy frame
41,4	0,0	41,4
Total energy requirement		26,0

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
25,0	0,0	25,0
Total energy requirement		18,8

Contribution to energy requirement

Heat	6,2
El. for operation of bulding	8,4
Excessive in rooms	0,0

Net requirement

Room heating	0,9
Domestic hot	5,3
Cooling	0,0

Selected electricity requirements

Lighting	8,1
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	0,0
Ventilators	0,2
Pumps	0,0
Cooling	0,0
Total el. consumption	21,6

Heat loss from installations

Room heating	0,0
Domestic hot	0,0

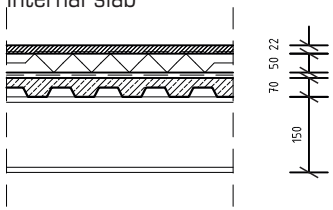
Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	0,0
Wind mills	0,0

Structural calculations

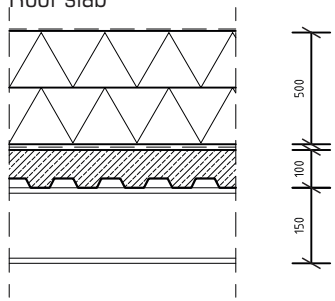
Permanent loads

Internal slab



Floor material	g= 0.484 kN/m²
Insulation	g= 0.025 kN/m²
Reinforced concrete	g= 2,0 kN/m²
Slab Element (INP 150)	g= 0.18 kN/m²
	Σ = 3.585 kN/m²
	γ = 1.2

Roof slab



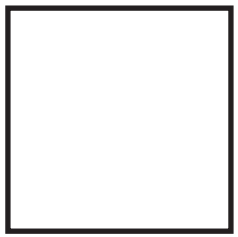
Bitumen	g= 0.05 kN/m²
Hard thermal insulation	g= 0.80 kN/m²
PE foil	g= 0.025 kN/m²
Concrete	g= 2.5 kN/m²
INP 150	g= 0.18 2.5 kN/m²
	Σ = 3.585 kN/m²
	γ = 1.2

Variable loads

Office
q =2.5 kN/m²
γ = 1.5

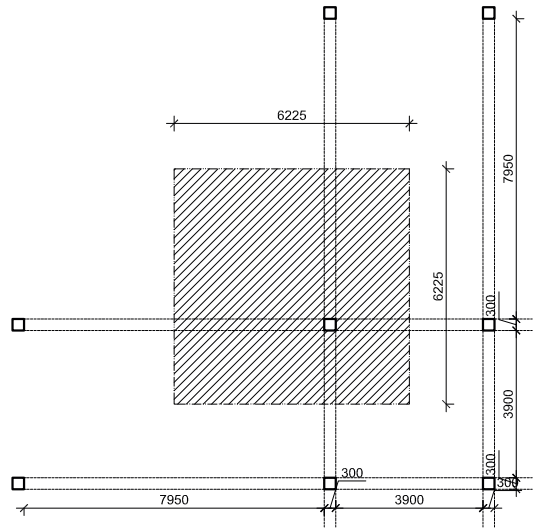
Snow load
q =0.72 kN/m²
γ = 1.5

Coloumn



Rectangualar profile 300

A = 11.5*10^3 mm²	g_c = 0.902 kN/m
A_{load} = 38.75*10^6 mm²	g_b = 0.901 kN/m
h = 21 m	g_s = 3.585 kN/m²
I = 160*10^6 mm^4	γ_g = 1.2
E = 21*10^7 kN/m²	γ_q = 1.5
Q = 2,5 kN/m²	



Loads

$G = g_s + \Sigma g_b$
G = 142.989 kN
$G_{column} = g_c * h$ = 18.94 kN

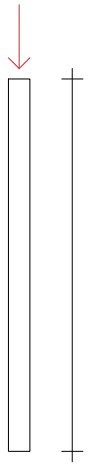
Q_{office} = 96.8765 kN
Q_{snow} = 41.85 kN

$N = A_{load} * (\gamma_g * (4G + G_r) + \gamma_{q*(4*Q_{office} + Q_{snow})} + 5 * \gamma_g * G_b + \gamma_g * G_c$
N = 1542 kN

TRE-DIM Versjon 10.0 SØYLE

TRE-KONSTRUKSJONS DIMENSJONERING

- er programmert av ingeniør Ingvar Skarvang



LAST: 1540,00 kN (Bruddlast)

Materialfaktor: 1,1

Pålitlighetsklasse: 2

TYPE SØYLE: HEA 300 S355

KNEKKLENGDE = 4,200 m om Y-akse: 115 mm

KNEKKLENGDE = 0,000 m om Z-akse: 115 mm

KNEKNING om sterk akse: (N + Mx) 45,1 % utnyttelse OK

KNEKNING om svak akse: (N + My) 60,6 % utnyttelse OK

BEREGNINGSREGLER:
NS-EN 1995 - NS-EN 1993 - NS-EN 1990 - NS-EN 1194 - NS-EN 338

TRE-DIM SØYLEBEREGNING
Dato : 26.04.2012 Tid: 09:50:49

column calculations

Registrert bruker :

HEA 300 beam (S275)

W_{pl} =1384*10^3 mm^3
I=182,6*10^6 mm^4
E=21*10^7 kN/m²
Q=2,5 kN/m²
g_b=0.901 kN/m
g_s= 3.585 kN/m²
γ_g=1.2
γ_s=1.5

Deflection

U = 1/384 *(Q+G)*l^4/(E*I)
U = 0.01601 m

U_{max} = L/400
U_{max} = 0.02375 m

U < U_{max}

$M_{1/2L}$ = 1/24* (Q+G)*l²
$M_{1/2L}$ = 108 kNm

V = ½*(Q+G)*l
V = 136.6727 kN

Load limit state

γ_3 = 0.95
γ = 1.10*γ_3 = 1.045

F_y = 275 N/mm²

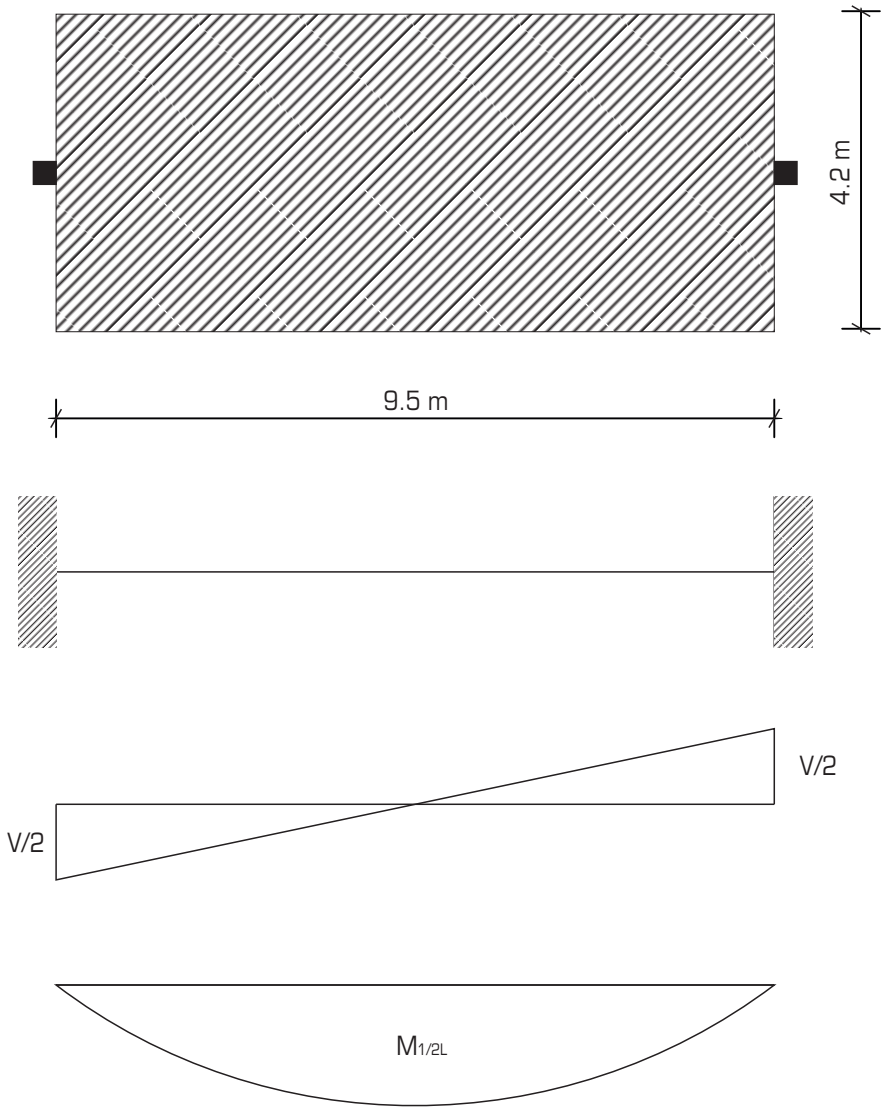
M_{limit} = W_{pl}*F_y/γ
M_{limit} = 364.2 kNm

$M_{limit} > M_{1/2L}$

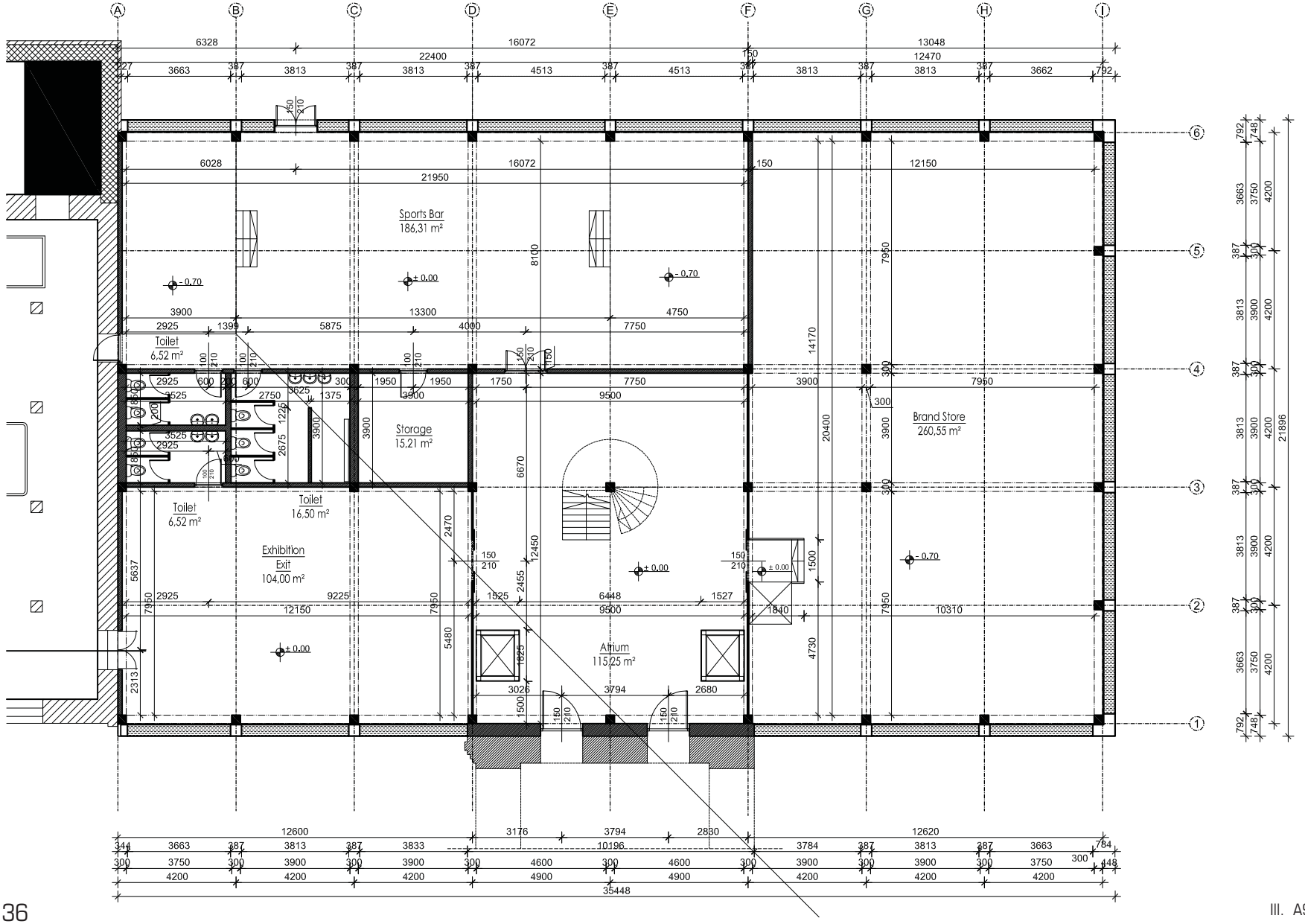
A_v = A-2b*t_f + (t_w +2r)*t_f
A_v = 3.675*10^3 mm^3

V_{limit} = A_v*Fy/(√3*γ)
V_{limit} = 558.35 kN

$V_{limit} > V$



Plan with Measurements1:200



Integration of aesthetic solar panels

Seeing as the project aims to create a net-zero energy building the use of solar panels in order to meet this is considered to be the most optimal solution to create the needed energy to reach zero. Therefore it is important to integrate these in the building so they appear as a natural part of the whole and not like a foreign element that obscures the design. In order to solve this it is important to consider this integration very early on in the design process. The very dense nature of the sites context presents a challenge when designing with solar panels, this combined with the very low angle of incidence the sun has in Denmark makes integrating solar panels in the façade challenging. Fortunately the sites East-West orientation gives a potentially large roof area that can be exploited for collecting solar energy. When integrating the solar panels consideration has to be given in the design suggestion on whether or not to match the color to the surrounding material or to contrast them. The materiality is something that cannot be changed but the color of the solar panels can be varied to fit the needs of the design without losing functionality. [J. H. Selj, 2011]

Ill. A10 Solar Panels

Case study Nordkraft

"Nordkraft used to be a power station providing power to the greater Aalborg area, but today it is transformed into a centre of excellence for the Northern Jutland Region. In the old industrial atmosphere Nordkraft today provides several activities. It is a dynamic place where culture, leisure and activity are taken to another level." [www.urban.aau.dk, 2012]

Integrating new into old

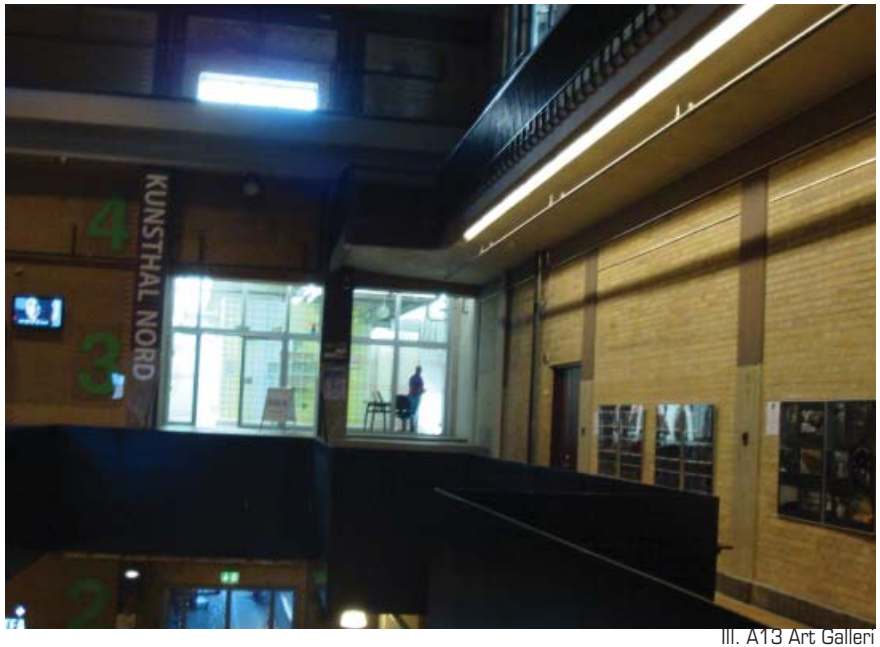
The telltale signs of the old function of Nordkraft are appearant all throughout the building. This combined with the very rough industrial style of the modern additions create a building that despite the mix of old and new feels like one whole. In respecting the existing building the new addition doesn't seem tacked on but flow naturally into the new character of the building.

Functions, layout

"In Nordkraft there are music scenes, theatre, facilities for exercise and sports, teaching, art, cafés and events." [www.urban.aau.dk, 2012] Just at the entrance an event scene takes place where they usually organize expos (university, commercial) or exhibitions. Next to this there is the Azzurra restaurant what can hold up to 60 customers at a time. Visit Aalborg also takes place in the entrance hall. Continuing towards the back of the building, Theatre Nordkraft, Skråen (music hall) and Biffen Art Cinema takes place along with Mumbai Café in a smaller hall. From the entrance, a steel stairway leads up to the third floor, where the sports facilities are taking place such as the Sports hall and a sports multipurpose hall where various activities take place as karate club, wall climbing, gym, basketball, handball courts, etc. Beside the sport facilities, Kunsthal Nord has alternate exhibitions and Aalborg University has lecture rooms on the third floor. On the fifth floor the Aalborg Kulturskole takes place and above that the upper floors provide innovative environment for 25 small businesses.

Ill. A11 The old present in the new

Ill. A12 Integration of new functions



Ill. A13 Art Galleri

Ill. A14 Nordkraft exterior