Preface

'Solosieme' is a proposal for a new typology, which within the overall theme of tectonic architecture, introduces a social housing complex in the development plan of FredericiaC. Exploring the notion of tectonics, this project is encompassing both structure, a study of the dwelling through the theory of Christian Nordberg-Schulz, as well as incorporating the human scale through a high degree of detailing.

The project is developed by Lone Brøndum Jørgensen and Maja Daugaard Klausen as a master thesis on the 10th semester Architecture M. Sc., at the Department of Architecture and Design and Media Technology at Aalborg University.

The report is the result of the project development including program, ideation containing detailing, presentation, recapitulation and an appendix.

Abstract
English

Informed by the contemporary discussion on how elderly are being treated in the society, as well as the fact that the demography is changing rapidly, resulting in an increasing group of people over 60 years, this master thesis is concerned with this group of people. Thus, we are proposing a new typology, which can accommodate a social way of living together, however, not compromising the fundamentals of privacy and contemplation.

The social housing complex of approximately 3000m^2 is a part of the development plan of FredericiaC between the Little Belt and the existing city center of Fredericia, a progress extending over the next 20 years. FredericiaC presents a strong vision of an active and diversified neighborhood, which complies with a central focus of the thesis, to study, understand and thus incorporate the notion of dwelling, which explores the urban scale as well as the house and institution.

The diversified usage of private house and social institution is met through the means of dividing these modes, however intensively working with the transitions and relations, to encourage the movement between. This key focus is implemented and solved by the means of a folding wall, forming both the houses, the institution and the transition to the urban space.

Striving to obtain an outcome which fuses both architecture and engineering, the approach to the project is based on a tectonic understanding, thus is the wall both structural and furnishing, why it contains both measurable and the unmeasurable. The wall has the potential of defining social centers within the institution, containing functions as the kitchen, as well as addressing the human scale, in terms of its level of detailing and the possibility to occupy it as furniture.

Synopsis
Dansk

Præget af den aktuelle diskussion om, hvordan ældre bliver behandlet i samfundet, samt det faktum, at demografien ændrer sig hurtigt, hvilket resulterer i en stigende gruppe af mennesker over 60 år, har gjort at dette speciale beskæftiger sig med netop denne målgruppe. Derfor foreslås en ny typologi i dette afgangs projekt, som kan rumme en social måde at leve sammen på, der dog ikke går på kompromis med de grundlæggende behov for fordybelse og privatlivets fred.

Det sociale boligkompleks på ca. 3000m^2 er en del af en udviklingsplan for FredericiaC, der ligger mellem Lillebælt og den eksisterende bymidte Fredericia, en proces der strækker sig over de næste 20 år. FredericiaC præsenterer en stærk vision for et aktivt og varieret kvarter, hvilket er i overensstemmelse med et centralt fokus for projektet, at studere, forstå og dermed indarbejde begrebet hjemlighed, der udforsker den urbane skala, samt huset og institutionen.

Den diversificerede brug af det private hus og den sociale institution er opfyldt i form af at adskille disse tilstande, men gennem intensivt arbejde med overgange og relationer, fremmes overgangene mellem dem. Dette hovedfokus er implementeret og løst ved hjælp af en foldende væg, der former både huset, institutionen og overgangen til byrummet.

I bestræbelse på at få et ingeniør arkitektonisk resultat, er tilgangen til projektet baseret på en tektonisk forståelse og dermed er væggen både strukturel og møblering, hvorfor den indeholder både det målbare og det umålelige.

Væggen har dermed potentiale til at definere de sociale centre i institutionen, indeholde funktioner såsom køkken, samt henvende sig til den menneskelige skala, i form af dens niveau af detaljering og muligheden for at indtage den som et møbel.

PROJECT TITLE
Solinsieme [alone - together]

THEME
Tectonic Architecture

4st SEMESTER M.Sc. PROJECT
Aalborg University
Department of Architecture, Design & Media Technology
Specialisation in Architecture

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Content

1.1 Motivation

Completing our engineering architect education at Architecture and Design at AAU, and in that relation writing our master thesis, it has been essential to us, to reflect on our comprehension of architecture. Amongst this, how architecture has the potential to influence human beings and what is required of an engineering architect. This ongoing search has led us to appreciate the architectural practice as a multidisciplinary field, which requires the ability to grasp and balance many inherent, but also contradictory aspects. This multidisciplinary nature of architecture was originally expressed by the Roman engineering architect Vitruvius, in '*The Ten Books on Architecture*' as such: *"The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgment that all work done by the other arts is put to test"* (Vitruvius, 1914, p. 5).

In a more contemporary understanding, architecture plays an immense influence on everyday life, why the significance of the accumulated knowledge of architects and the possible effect of architecture, is described by architect Simon Unwin in '*Analysing Architecture';" Architecture has the potential to establish and influence relationships, elicit emotional responses, even to affect how we behave and who we think we are."* (Simon Unwin, 2003, p. 3)

Further, during our education, we have been introduced to two main fields of study, sustainability and tectonics, which have laid basis for our various projects. But since we construe sustainability as being a converging aspect of tectonics and both being invariable while addressing architecture, we chose to adopt a tectonic approach. Additional, by delving into the work of architect and Professor Kenneth Frampton, who in his book '*Studies in Tectonic Culture*' states that the etymology of the word "*tekton*", being the builder or carpenter, eventually led to the significance of an engineering architect or the "*architekton*", makes us understand the initial definition of tectonics. Similar, through Frampton's interpretation of the tectonic position of several architects and thereby also the different outcome of their works, this further confirms us, that tectonics is an approach which can be applied in all architecture (Frampton, 1995).

Thus to us, the above obligate, but much more provides opportunity for us as architects to immerse into aspects of life. This could be family-life, the habits of foreign societies or a certain age group, as well as understanding a given context, its capabilities, limitations, and its genius loci.

Further, the discipline of responding to the possibilities of the future, and the potentials of societal development, demands courage, why it is important to be visionary.

This is why a tectonic approach and an investigation on the notion of dwelling, informed by a future societal influence, form the basis of this thesis, which aims to propose a new typology, by introducing a social housing complex, with both social and private atmospheres.

Why tectonics?
As described above, to us, tectonics is an approach to architecture, which is fully achieved by getting both the measurable and immeasurable incorporated in a complete work. In our understanding the measurable

includes the structure and construction, whilst the immeasurable represents the soft values of architecture. Among other, this could be the framing of a good view, the good seating spot and the flow of the building or the atmosphere. Aspects that all relate to the human body.

We find this tectonic approach important to incorporate in a building process, because it is essential to us, as engineering architects, to obtain a comprehensive outcome.

Why dwelling?
"When dwelling is accomplished, our wish for belonging and participation is fulfilled" (Nordberg-Schulz, 1985, p. 7). From this we understand that the primary purpose of architecture should be the ability to *dwell*, thus meant that this should be achieved in all architecture. Therefore our master thesis is based on studies on the notion of dwelling, to elaborate our architectural knowledge on this matter.

The concept of dwelling, in this thesis, is concerned with three levels of dwelling; the urban space, the institution and the house (Nordberg-Schulz, 1985). This also complies with our knowledge on the societal development of the future, where people are moving into the cities and thereby living closer together (Kjeld Kjeldsen, 2009). In this way dwelling becomes both the participation in the *institution* and *urban space,* but also the intimacy of the private *house*. This interests us, the sensitive scale of the private house, because it relates directly to the body and reflects the personal identity and the life, in which we participate.

Why elderly?
The demographics of most of the industrialized countries are in a progress of change, where the extent of elderly people over 60 years is increasing. People are getting older than earlier, more active and less reliant on help in their third age, which influence the way they are living and dwelling. Furthermore many elderly are living alone, especially the women, who are having a longer life expectancy (Detail Konzept, 2012).

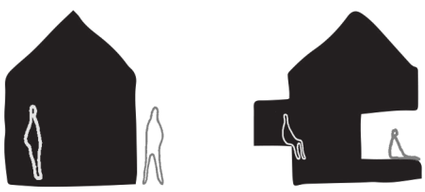
This raises the issue of how we as architects create dwellings, which are adapted to the new way of living for elderly, so that it meets the needs and expectations of living and dwelling in the later stages of our lives (Detail Konzept, 2012).

Knowing that many elderly are living alone, this leads us to the second level of dwelling; the institution, where people of common values come to an agreement to live together (Nordberg-Schulz, 1985). As the institution is also an influencing part of the urban space, together with the elderly being more active, this further confirms us that elderly would benefit from living in the city, as part of a participating and active lifestyle.

Hence we ask; how does one, through a tectonic approach, define and create a new typology. A typology, which encompasses both social and private atmospheres for elderly to dwell in and how is a relation between the different levels of dwelling achieved?

Relation inside - out

Relation outside - in



Ill. 1.1

Relation inside - out and outside - in

The relation between the house, the institution and the urban space

1.2 Introduction

By addressing the tendency of the current architectural practice and how it often prioritize the balance between the measurable and the immeasurable, one could question, whether this assessment provides a tectonic approach to architecture.

Commonly, attention is paid to the measurable means, as a result of e.g. regulations, time pressure and insufficient economy. But by approaching architecture in this way, we fail to retain the narrative of the sensuous scale, hence the soft values of architectural practice is neglected, thus making it impossible to obtain the notion of dwelling.

Hence, in the achievement of a fulfilling life, the built environment should, through employment of the immeasurable means, accommodate a high degree of detailing to be able to address the human scale.

Accordingly, homes for the third age of life, ought to be much more than a place, where maintenance and mobility in- and outside the house, are the generating factors. It should be a place, which is carefully detailed, so one is able to dwell and is encouraged to keep living an active and participating life; a place for both encounters and refuge.

Hence, the institution we propose should aim to gather and enhance social encounters. To achieve this social gathering point, the place should convey the sense of belonging albeit make room for diversity. It should also be the link between the urban space and the house and emphasize the sense of connection.

Further the aspects of intimacy, construction and context are introduced through a tectonic approach. Hence interplay between the technical and poetic dimensions, between the urban space, the institution and the house is to be achieved.

Project brief

The project is based on *'1.1 Motivation'*, thus proposing a home for the third age within the urban development project; FredericiaC. The 20ha development project, which is located between the historical center of Fredericia and the waterfront facing the Little Belt, is an ongoing process expanding during the next 20-25 years.

The urban plan is based on a competition written in 2011 by a consortium of the Municipality of Fredericia and Realdania By. The intentions are to develop a unique, exciting and vibrant new district with recreational spaces, attractive housing, jobs, shopping and a rich cultural life. Hence, stressing why this development plan is appropriate for this project. The competition of the development plan was won by KCAP Architects and Planners. The current development plan is refined by FredericiaC, who have been taken point of departure in the proposal from KCAP Architects and Planners, but also draws in elements from the top three contestants.

The plan ties FredericiaC together with the present city center, and by using green and blue infrastructure, the quay is extended through the implementation of channels, thus connecting to the waterfront. The plan gives possibilities for activities that can catalyze the future life in FredericiaC, stressing the vision of the development; *"Courage to desire"* (FredericiaC, 2010).

Within the proposed plan of FredericiaC, the building plot of this project has been chosen on the background of the size and the different types of atmospheres which are found adjacent to the site. The diversity, of the surrounding building sites and urban areas, supports the studies on relations between the institution and the urban space.

1.3 Tectonic approach

Driven by a critical and curious approach of designing a home for the third age, it is important to develop a methodology to the study. Working with a tectonic approach an equilibrium of the immeasurable and measurable aspects, to be able to encompass the competencies of engineering architect, is to be obtained. This balance involves defining sub points, which together achieves a tectonic outcome.

This multifaceted field of an engineering architect and the importance of being able to manage this, is also described by architect Louis Kahn; *"Architecture stands between ourselves and the world. If we define ourselves and the world as measurable, our architecture will be measurable and without Spirit, but if we allow ourselves to be open to the meeting of the measurable and the immeasurable, our architecture can become a celebration of that meeting and the abode of the Spirit"* -John Lobell's writing on the architecture of Louis Kahn (Lobell, 2000 p.3).

The sub points of the tectonic approach are elaborated in the following, which should help us, through various media to come up with a tectonic design proposal.

Dwelling

To develop our architectural knowledge on the notion of dwelling, the concept of dwelling is studied through the theories of architect and Professor Christian Norberg-Schulz. His theory is based on an interrelationship between levels, modes and aspects, which he states must be fulfilled, to be able to dwell.

Analysing architecture

To identify relevant architectural means, according to our project, case studies of existing architectural works are carried out. The method used, is that of Simon Unwin, explained in his book *'Analysing Architecture'*, in which he propose that understanding what other architects have done, helps us to understand our own work, hence making us aware of different decisions and priorities to be made (Unwin, 2010). His method of analyzing involves several analytical points, from which we select the appropriate for our case studies. The cases are selected in relation to Norberg-Schulz' levels of dwelling; house, institution and urban space, which are described in *'1.4 Dwelling'*.

Senior life

Knowledge, of the future users of our home, is achieved through readings on the elderly of the future. Information has primarily been found in statistics and in *'Ældre Sagens fremtidsstudie'* as well as other relevant releases from the same publisher.

Additionally the study of Knudstrup and Møller, on design program and well-being in assisted living facilities, is used for knowledge on the current state of designing for seniors in Denmark. From this combined knowledge, we create personas with different scenarios to further understand the future tenant. Further to clarify the functions of such institution

and the possibilities of a senior housing project with social relations, a case study of such is undertaken.

The context

The contextual analysis includes an understanding of the site, through relevant studies involving microclimate and mappings. The study will clarify through quantitative and qualitative perspectives, the opportunities and challenges of the site.

Ideation

The ideation include the design process of the project, hence in iteration the process is documented, including; development of the new typology through typology studies, selection an definition of functions in the different levels, implementation of the structure and the concept of the folding wall including detailing, as well as studies on daylight together with development of the façade.

1.4 Dwelling

In the following, attention is drawn to the notion of dwelling and the relationship with place. The intention of exploring dwelling is based on our statement that the common denominator of comprehensive architecture is the ability to dwell. Hence, in the following, we study how one dwells - alone, together and in a larger context, where the city is the stage. Thus, this knowledge enable us to propose a new typology, which ensures the ability to dwell for elderly, along with amplifying social encounters, however still ensures privacy.

Our study is based on the theory of Norberg-Schulz, expressed in '*The Concept of Dwelling*'. This is chosen because of his interpretation of dwelling, in which he does not only look into the home, but rather the whole world, for one to dwell in. This also complies with our standpoint on dwelling; being the intimacy of the house and the participation in the institution and urban space. According to Norberg-Schulz the notion of dwelling means more than to be sheltered by a roof and have a certain amount of square meters. His understanding of dwelling is described through four levels of dwelling, their related modes as well as two aspects of dwelling.

More specific he addresses the total *environment* as consisting of four architectural levels; *settlement*, *urban space*, *institution* and *house* in which four related modes; *natural*, *collective*, *public* and *private,* take place.

Following describes the architectural levels and their related modes.
+ The first architectural level is the settlement, which has to be understood in relation to its given natural surroundings, since it is the place we decide to settle down. The settlement is therefore a place where people develop, use and discover the natural environment and hence it is the stage for the natural dwelling mode to take place (Norberg-Schulz, 1985). In the landscape, the settlement is clearly visible with defined edges and its horizontal and vertical rhythms are decisive in the way it is perceived (Dr. A. van Nes, 2012).

+ The urban space is a place for discovery, where one can experience the richness and possibilities of the world. It is also a place of encounters, where people come together in their diversities. Hence collective, in the sense of gathering and assembly, is the mode that characterizes and takes place in the urban space.

+ Within the world of possibilities, choices are made and patterns of agreements are established. This creates a more structured kind of togetherness, hence a public mode of dwelling, which takes place in the institution, where values and beliefs are united.

+ Finally one has to have a piece of the world, where choices are made by one self. Thus this mode of dwelling is called private. The stage for private dwelling is the house, where one can refuge to define one´s own identity and digest the impressions of the world.

As described above, Norberg-Schulz also draws in two aspects of dwelling, as he says; *"…dwelling consists in orientation and identification"* (Norberg-Schulz 1985, p. 7). The general structure of dwelling is made up by these two aspects; thus they are the common denominator of the four modes of dwelling.

+ Identification involves the understanding and respect of a place with all its characteristics, limitations and possibilities, hence to obtain an identity of life, we have to be open to our immediate surroundings (Dr. A. van Nes, 2012). *"Although the world is immediately given, it has to be interpreted to be understood, and although man is part of the world, he has to concretize his belonging to feel at home"* (Norberg-Schulz, 1985, p. 20).

+ Whilst identification is about things and place, as is orientation that, which binds

these things and places together in relationships and in an understanding of their connection. To be able to orientate and thereby obtain a coherence of a spatial order, we act according to centers and paths which together form a domain.

Elaborating on these, the center is found within all levels and is the place, where significant actions in life take place; *"…the settlement thus forms a center of arrival in the landscape, the square a center of meeting within the settlement, the institution a center of explanation in the built fabric, and the house a center of personal life"* (Norberg-Schulz, 1985, p. 22).

The path is inevitable in relation to the center, because the center define a place where one makes arrival or departure on paths from the center. Paths are, as well as centers, present within all levels, where the paths represent an orientation and a choice of direction. Together the centers and paths comprise networks, which become domains, functioning as places in which potential actions can take place.

Through the studies of dwelling, according to the theorist Norberg-Schulz, it has become evident to us that, to make it possible to rejoice the pleasure of dwelling, all levels, modes and aspects must be comprised in an interrelationship. This stresses the importance of the context chosen for this project, being the inner city, where it is essential that the architecture embodies the relation between the different modes described above. This is also stated by Norberg-Schulz: *"The urban house, however, forms part of a social context, and therefore has to adapt more directly to its neighbors. The sub-urban dwelling on the contrary, remains free from this restriction"* (Norberg-Schulz, 1985, p. 96).

Similar, as we have grasped the importance of the interrelationship of the levels, modes and aspects, we must also put ourselves critical of it. By delving further into the theory, it is also clear to us that Norberg-Schulz concentrates mainly on an overall analysis of the various levels and their associated modes. But he barely addresses the relationships between them, and in general how to achieve them. Following up on this, the theory laid the foundation for understanding the basic features of it, in order to examine and obtain the relationships between them.

Consequently, we are seeking to use this theory, by working with the relations between the levels and their related modes. As the settlement is given in the development plan of FredericiaC and thereby also sets the preconditions for the urban space, with its activities and visions, the focus will be on the relations between house, institution and urban space.

Working with this, the architecture should allow for visual interaction across the levels, in that way allowing for visibility from house to urban space, but to obtain social life, physically the residents have to go through the institution. Further to emphasize these relations, we must address the aspects of the theory; hence through a study of the context, identification should be introduced by understanding the place and the things given there. Similar for the institution and house, different values should be applied to achieve identification for the residents. The aspect of orientation should be accomplished on all levels by creating centers which gathers people and paths which guides, however still evoke other purposes. Together they should generate domains.

To further explore the notion of dwelling through actual examples, case studies are carried out in the following section. The three cases have been chosen according to their level of *house, institution and urban space*.

CASES
ANALYSING ARCHITECTURE

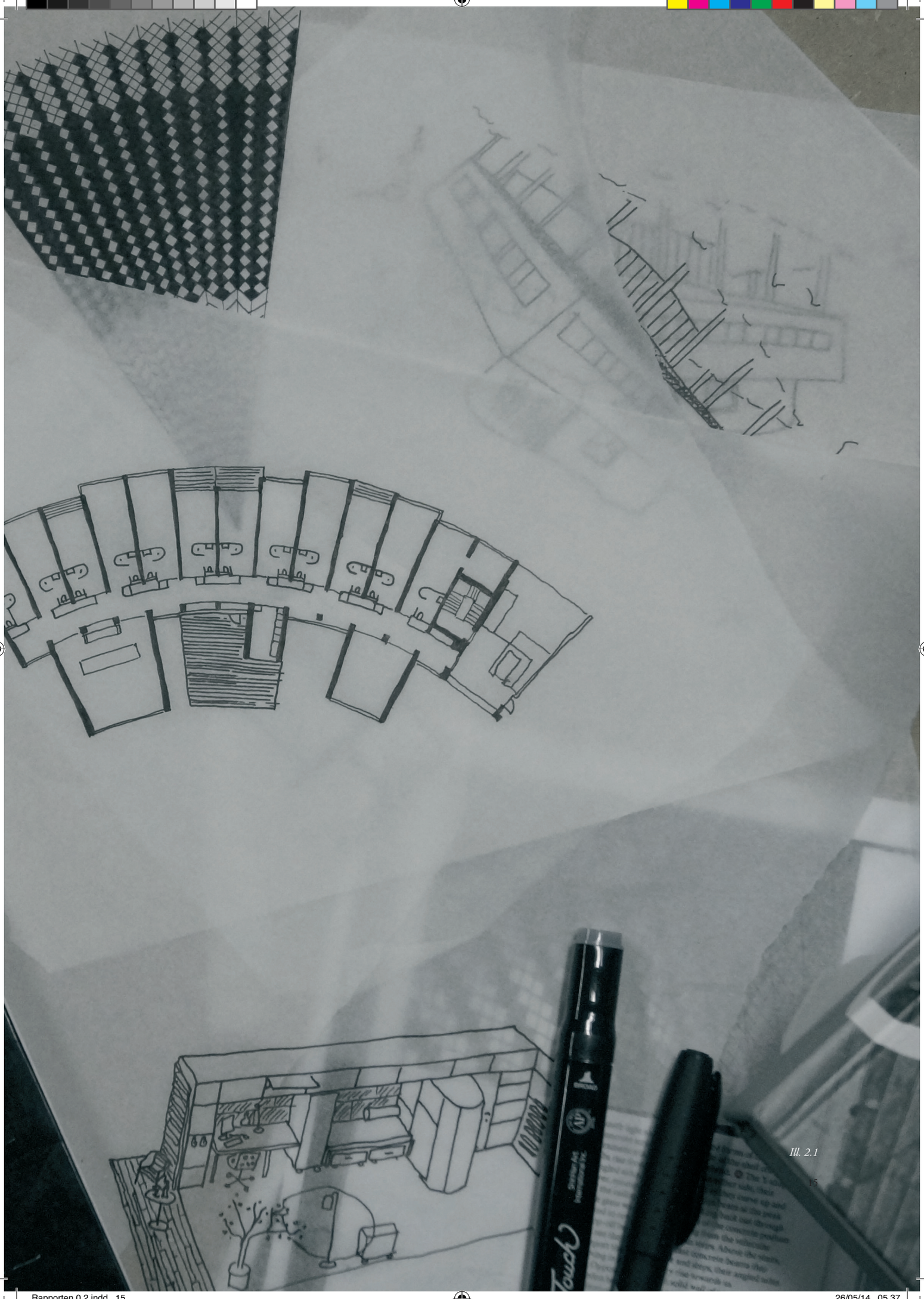
Chapter 2
PAGE 16-31

In the following section the approach, to how case studies are analyzed, is explained followed by three case studies that explore Villa Savoye, Tietgen Dormitory and Sydney Opera House.

Villa Savoye by Le Corbusier is chosen for its architectural level of the house and its exploration of movement and experience through the house.

Tietgen Dormitory by Lundgaard & Tranberg Architects is chosen for its architectural level of the institution and its ability to ensure privacy along with social encounters.

Sydney Opera House, by Jørn Utzon, is chosen for its architectural level of the urban space and its ability to fuse with the environment of the harbor, though still stand as a landmark.



Ill. 2.1

2.1 Case approach

"How does one learn to understand architecture through cases?"

By immersing into examples, by means of case studies, an understanding of these is obtained and thereby enabling us to deduce the means, which comprise them. Simon Unwin describes this, as understanding a common language, to enable one to use the tools used by others, who already understand architecture. Further he elaborates on this; *"To move from passive to active, spectator to performer – from being a person who appreciates, enjoys, criticizes, listens to, lives in, purchases, laughs at – (even at the level of a connoisseur) to one who creates, is exciting but difficult"* (Unwin, 2009, p. 17).

To understand more views on methodologies of analyzing, Lise Bek, who is an art historian, is considered. Bek focuses on what distinguishes art and architecture, as being the function; hence she focuses on space and the experience of architecture, using the room as the subject of analysis. According to Bek, if one should to be able to do a thorough case study, large amounts of data must be collected, before one can begin to analyze, using her five analyzing aspects. In this way, Bek stresses that knowledge of a case study must come from archival work and excessive readings. On the basis of her own analyzing method, she questions how many perspectives it takes, to make a deep analysis of a case. Further she emphasizes that she believes it is important to understand the purpose and objective of the analysis, in order to derive the relevant aspects of her analysis, instead of using all of them all, if they do not contribute to the objective of the analysis. (Bek, Oxvig, 1997)

Unwin, on the other hand, has through his three books, increasingly developed his analyzing method from being notes and observations, to fully giving examples on the usages of the developed method (Hvejsel, 2010). His method, opposed to the one of Bek, is concerned with breaking the analyzed work apart and thereby come to understand the means of which they are comprised to be able to assimilate them (Unwin, 2003). The method by which Unwin addresses his analyzed works, is through drawings as he states; *"You cannot understand architecture merely by looking at photographs. You cannot understand architecture by only reading words (...) The only way to understand architecture is through the media used in its creation – drawing"* (Unwin, 2010, p. 3).

On the basis of the previous section *'1.4 Dwelling'*, the three cases are analyzed using the method of Unwin described in his book *'Analysing Architecture'*, however, we have chosen to interpret the method in two ways.

Firstly, we believe, in contrast to Unwin, that photos are very useful for us, especially when we have not experienced the work, which we analyze. Photos help us to understand the atmosphere of the work and the materials applied. Nevertheless, we also understand

to appreciate drawing as media to analyze. A drawing manages to involve us more in the study, by which both remembrance and understanding of the work, especially its proportions, the relation of space, structural principles and details, is generated. On this basis, we choose to use a combination of both drawings and pictures in our analysis.

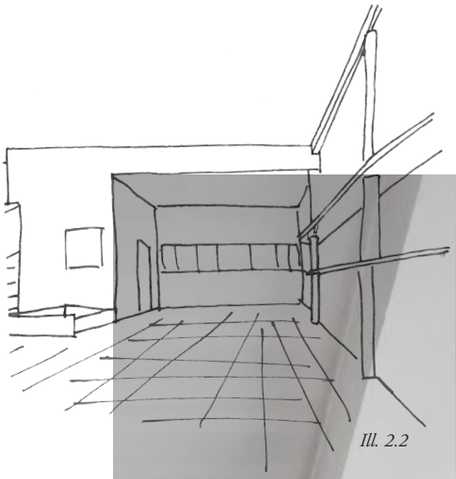
Secondly, we are somewhat critical towards Unwin's method, as he does not select certain analysis points and furthermore he does not sum up on the measures, which he finds in his analysis. In contrast, we are going to select specific analysis points for our chosen case studies. Likewise we are going to conclude on each case study, which enable us to obtain a gathering of measurements, to emphasize and to extract principles of how it is achieved.

Thus, to gather these measurements, the case studies are comprised of an introduction, the realm of the case and four identical analysis points from Unwin's method, which are;

'Identification of place'
'Basic elements and ideal geometry'
'Modifying elements'
'Architecture making frames'

Using the same analysis points to them all, allow us to focus on the same aspects and to compare them. Opposed to this, we have also chosen a specific analysis point for each case, to be able to look into what particular constitute each one, these are;

'Stratification' in Villa Savoye
'Social geometry' in Tietgen Dormitory
'Using things that are there' in Sydney Opera House



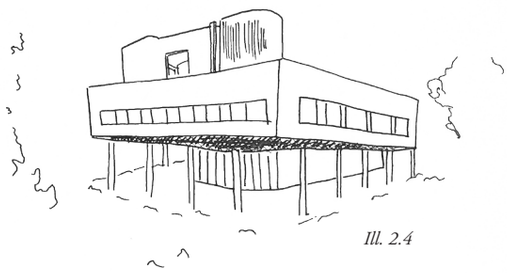
Ill. 2.2

Ill. 2.3

2.2 Villa Savoye

Villa Savoye
82, Rue de Villiers
Poissy, France

Architects	*Le Corbusier*
Completion	*1929*



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In 1921, Le Corbusier designed Villa Savoye; a country retreat in Poissy, on the outskirts of Paris, France. Today the villa is a state property of the France and function as a national monument, open for visitors (Centre Des Monuments Nationaux, 2014).

Realm
One of the quandaries in architecture is gracefully highlighted in Le Corbusier's Villa Savoye; the relationship to the topography of the place. Should architecture emphasize the place or should the place emphasize architecture? To Le Corbusier, in contrast to Frank Lloyd Wright´s Fallingwater, the attitude lays in making a place appear by transcending and raising the building above the context. Wright´s Fallingwater on the other hand, emphasizes the context by exploiting what is already there, and relates to it (Unwin, 2010).

Identification of place
Situated on the top of a gentle hill, the place is identified as a machine for living and even from a distance, the trees embrace the site and attest to a place of a home. The villa stands like a Greek temple in its temenos lifted above the ground on pilotis rising for the sky (Unwin, 2010). The irregularity and verticality of the nature stand as a contrast to the pure geometric forms, as does the dominating horizontal lines of the window band in the façade of the first floor. The nature is framed through the window band which opens up to the nature, whilst embracing the human body in movement.

Basic elements and ideal geometry
The villa is designed on the basis of pure geometry, mathematic formulas such as the Golden Rectangle and Le Corbusier´s five elements of architecture. The structural system is visual on the ground floor, where the pilotis are arranged in a grid of five times five. The entrance is drawn back from the edge of the pilotis and designed according to the movement of an arriving car. The first floor consists of a sharp edged quadrat in plan, which is carried by the pilotis. On the roof top a folded wall create shelter and stands in contrast to its geometric base.
Villa Savoye is thoroughly designed through Le Corbusier's five elements:
+ Pilotis – freestanding columns are used for the structural system of the building and to elevate the piano nobile from the ground.

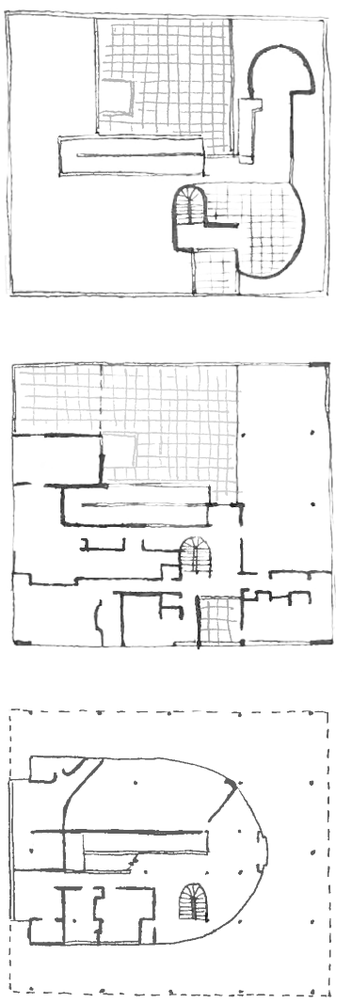
+ Roof garden – a flat roof to be utilized for a domestic purpose.

+ The free ground plan – with the absence of supporting walls as structural system, the house can be designed with a free utilization.

+ The horizontal window – because of the free façade, it is possible to establish horizontal windows in the entire length of the façade to make the rooms equally lit.

+ The free façade – the façade becomes free because it is separated from the structural system.
(Fazio, Moffett and Wodehouse, 2008)

Modifying elements
The important modifying principals for Le Corbusier were daylight and time. The emergence of daylight is enhanced by means of



Ill. 2.5

movement through the house. Its intensity progresses throughout the movement of the house, hence the light guides one. By entering under the building mass, the daylight is dim, but moving on to the first floor, guided by the daylight and the ramp, the daylight is more intense, streaming through the horizontal windows and the inner courtyard. Concluding the movement, one is guided further up on the rooftop, where the sky performs the act of a roof.

The movement in the house is not intended from front to back, but from the ground to roof enhancing an exploration of it. This is achieved by a main axis, represented in the ramp; a center, in which the movement relates to. Various routes from around the axis enhance the felling of time and movement, but one is constantly drawn to the main axis (Unwin, 2010).

Architecture as making frames

The edifice frames the landscape in which it is situated, but further it also frames views within the building itself. This is obtained through the means of the courtyard and open plan that allows many views through the building. A hierarchy in the views is framed by the center of the ramp and the paths, which in a movement guides one around the house. The house also frames the human body through detailing, as applied in the bathroom where a bench interprets the form of the body, implying it is a place to lie.

Stratification

Vertical hierarchical levels are visual both in the expression of the exterior and the division of the interior. The exterior can be compared to the order of the ancient temples, along with the three-parted order of renaissance palazzos, which also reflect the separation of the interior. The verticality expresses a division and a line of tension between the main activities, the noble activities and further up, the relation to or representation of the heaven. Hence the organization of space and levels can be related to the renaissance architect and architectural writer Andrea Palladio, who also expressed these different states of being, in his edifice Villa Rotunda (Unwin, 2010).

Conclusion

The construction of Villa Savoye is visual on the ground floor, where it also creates a relation to the landscape. Already before entering the house, one is neatly guided because the wall follows ones movement by folding around and finally becomes the entrance space. Further when entering, a transition to the intimacy of a house is created by movement and organization. This movement and organization is achieved through the ramp that guides around and up, thus becoming a central axe.

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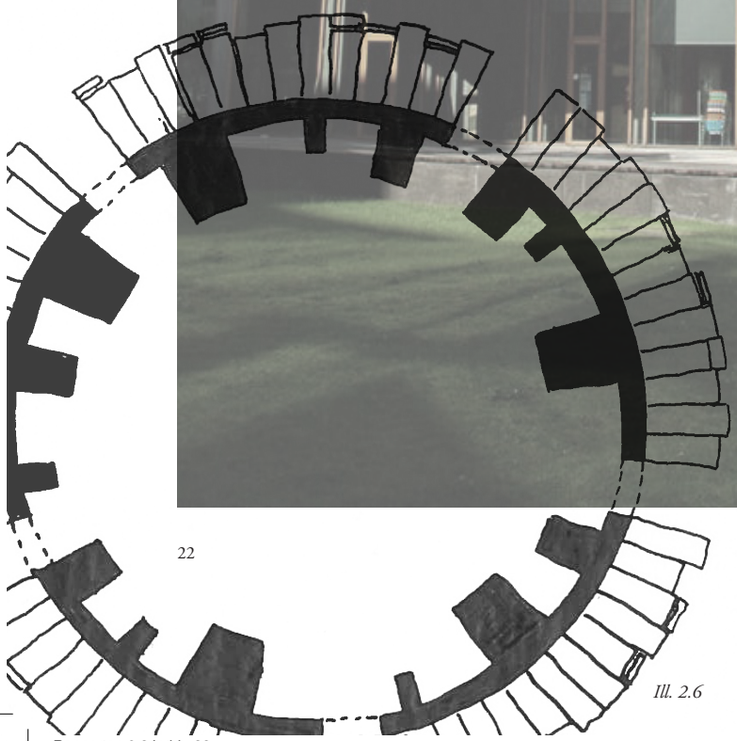

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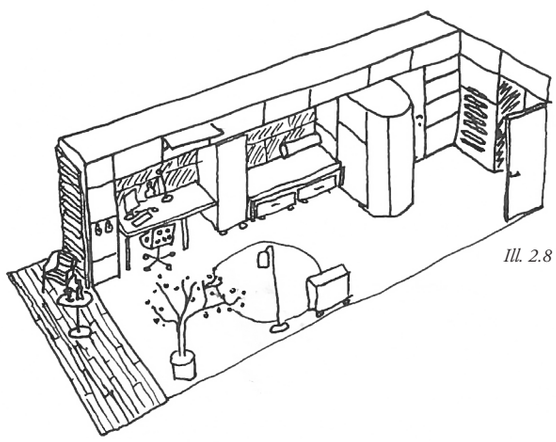
2.3 Tietgen Dormitory

Tietgen Dormitory
Rued Langgaards Vej 10
Ørestad, Copenhagen

Architects	*Lundgaard & Tranberg Arkitekt firma*
Completion	*2006*
Effective floor area	*26828 m2*
No. /Size of apartments	*360/26-45m2*
No. of inhabitants	*390*
Age structure	*Student*



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In 2006 Tietgen Dormitory was completed in the new established Ørestaden close to Copenhagen. It is designed by Lundgaard and Tranberg Architects and built for Nordea Danmark-Fonden. The foundation wanted a dormitory with focus on social encounters, solidarity though still ensuring privacy and the possibility to study.

Realm
The initial idea behind a traditional dormitory was to create a place to live in solidarity while studying; however solidarity is today no longer a main focus in dormitories. Contrary to this tendency, the Nordea Foundation still perceives solidarity as the most important idea in a dormitory and therefore whished for this to be expressed through the building layout (Stensgaard, 2007).

The dormitory is placed in Ørestaden, because of the close distance to the universities and the possibility for public transportation. Most activities in this area are located within the public buildings why the relation to the urban space is lost. This has led to a deserted district, where people move through quickly from A to B. Thus, the dormitory is also located there, to bring activities to the district (Stensgaard, 2007).

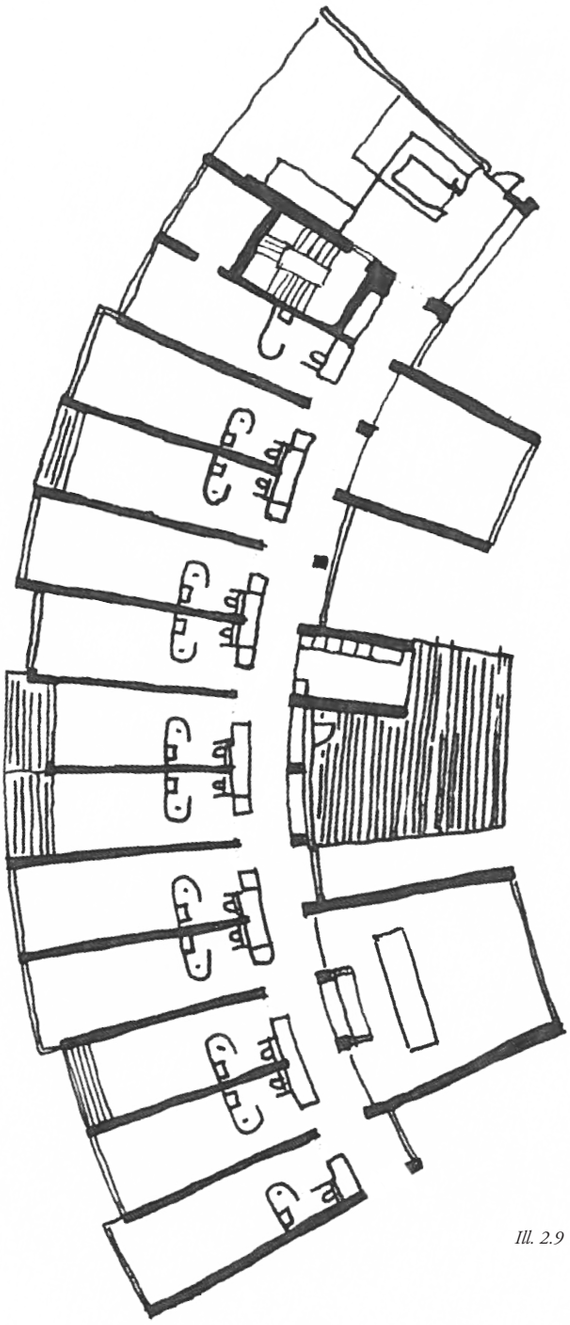
The economy was not a focus point for the architects, as the intention of Nordea Danmark-Fonden was to give an honored building, designed to live in a community, which should last for centuries.

Identification of place
The dormitory ventures to dissociate with the uniform formal setting of the other buildings in the area. The contrast, through the modified geometric form of the circle, creates an identification of place and it is clear from a distance what kind of place this is: a place for gathering and belonging.

Basic elements and ideal geometry
The initial form of the building is a geometric circle, which as a symbol describes solidarity as it clearly defines a center and encloses around it. The circle permits a continuous path, which allows an organization of the social facilities towards the common central courtyard. The individual spaces are arranged in the periphery of the circle, looking toward the outside. The individual rooms are expanded in different extents towards outside, whereas the common rooms on the inside are formed by multiple cantilevered boxes, thus defining space, in, over and under them. To structural achieve these cantilevered boxes, with a depth of up to eight meters, they are one, two or three modules deep. The construction method, of the protruding modules is the same, as when building balanced cantilevered bridges. The protruding modules are hung and casted to one another, hereafter clamped together with cables (Stensgaard, 2007).

The composition, of the two simple vocabularies of the rigorous circle and the cantilevered rectangle boxes, gives character to the building and courtyard. Additionally, the cantilevered boxes are downplaying the formality of the geometric circle, thus helping to bring down the scale.

Modifying elements
Contributed by the light that stream through the glass façade, the corridors are character-



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ized by the contrast of openness and enclosure. Although the opposite wall is enclosed, the cladding of birch plywood softens the perception of it. The texture and warmness of the wood symbolizes the more private spaces behind the wall and to further obtain a sensuous identification and belonging, the cladded wall is ornamented with a graphical pattern (Stensgaard, 2007). The cladded wall continues into the private room, creating an entire piece of furniture along one side of the room. The furnished wall holds the bathroom, storage and a movable room divider, which creates multiple possibilities of personalization and a sense of belonging.

The use of oak and Tombak as exterior material, fractured into smaller panels, gives the building a natural unifying texture and adds warmth to the building. The fractured panels give the façade a varied expression and breaks down the scale.

Architecture as making frames

Architecture can frame views and much more, but the noblest purpose of architecture is perhaps to frame life (Unwin 2009). From within the building, views are framing life in- and outside the building. The circular form and the inward position of the common spaces, makes it possible to see what is going on in the other common spaces; hence social life and relationships are framed through the views. The building thereby offers frames within a frame, because the exterior form of the circle also frames a sense of gathering. When entering the circle, a contrast to the larger scale of gathering and community appears, and a sense of belonging is framed through the modified cantilevered elements.

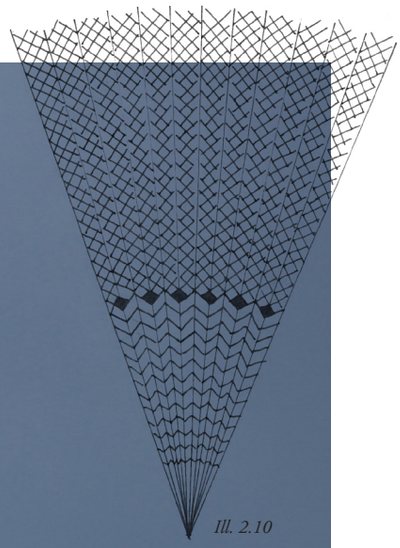
Geometry of being, social geometry

The building demonstrates a strong harmony between life and form, as the circle represents the plan of people gathering. No paths have dead ends; they all lead to the common rooms as the centers and gathering points of the building. The building thus recognizes and establishes a social circle.

Within the building it appears, as if it was constructed of two circles; an inner and an outer. The inner represents this sense of gathering, whereas the outer creates a place where it is possible to retreat and digest life. Belonging, gathering and privacy are acts needed for one to be social and the opposite.

Conclusion

Tietgen Dormitory is a place for social encounters, expressed through its architectural form of the circle, creating a place that embraces and frames the views to social life. The way a circle encloses space, it defines a clear center, but also a backside. This backside shields the building off from the urban space and enhances no relation. The building provides a balance between the individual private spaces of the houses and the common collective spaces in the institution through a graduation; hence it is possible to be gathered at different levels. The narrative of the enhanced social focus in the close-knit building is also reflected in the structural construction of the building. The large cantilevered boxes symbolize a strong construction, and referring to their social potential, they reflect the important interplay between measurable and immeasurable means.



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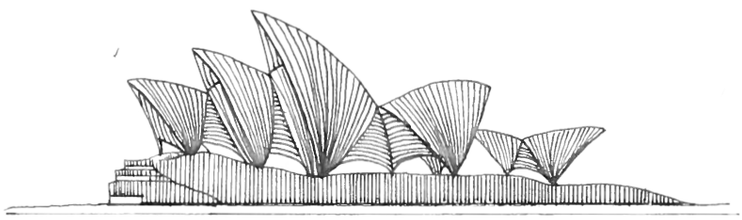
2.4 Sydney Opera House

Sydney Opera House
Bennelong Point
Sydney, Australia

Architects *Jørn Utzon*
Completion *1973*



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In 1955 an international design competition, to design an opera house for Sydney, was published. The proposal by architect Jørn Utzon was later announced as winner and the Sydney Opera House was completed in 1973. Utzon was chosen winner because of his ability to recognize the potential of the impressive site in Sydney Harbor and further the ability to create a building that also functions as an urban sculpture (Sydney Opera House, 2014).

Realm
The term techné was interpreted by the ancient Greeks as constructing with honesty. The construction should appear as what it is, symbolizing a constructive comprehension (Norberg-Schulz, 2004), identical with the philosophy of Utzon, who treated structure and construction expressively (Frampton, K., 1995).

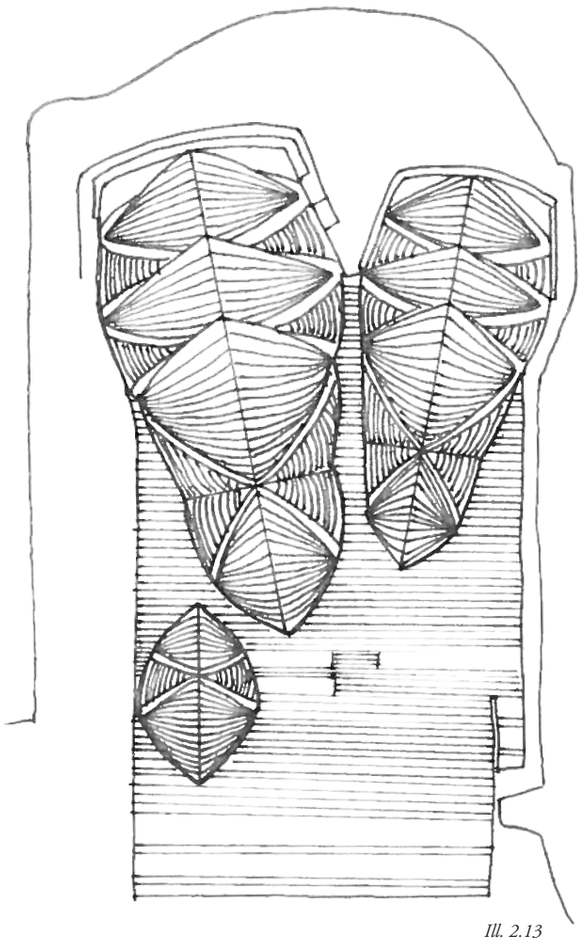
The construction of Sydney Opera House is manifested as a vision, rather than the results of calculations. A vision, which is interpreted through constructive comprehension and real size muck ups (Norberg-Schulz, 2004).

Identification of place
From afar, attention is immediately drawn to the sculptural roof of the Sydney Opera House, which rests on a large plateau on the peninsula, Bennelong Point in Sydney Harbor. Immediately a place is identified, because of the contrast and interplay, between the glistening light colored freestanding sculptural building of the Sydney Opera House and the adjacent squared brick-structured buildings.

Basic elements and ideal geometry
Utzon expresses that, a clear geometry is necessary, when working with such complexity: "Initially, no definite geometry for the shells had been established, but, as work progressed, the shells were developed according to a spherical geometry and we suddenly had a common denominator, the same spherical surface to deal with, with a similar curvature throughout" (Utzon, 2002, p. 16).

This made it possible to construct the roof with the principle of additive architecture, where varied repetitions creates a unity. The shells are sub-divided into concrete rib segments that are pre-cast and raised as ridged beams (Sydney Opera House, 2014). The forces of the structure are elegantly expressed through the pre-cast rib ceiling, which segments also structure the ceiling spans in the plateau (Utzon, 2002).

Modifying elements
The composition of the plateau and the sculptural roof emphasizes the character of the two by the white tone of the roof, against the dark plateau as well as the dark water of the Harbor. The division of the two is further perceived in the separation of functions, as the heavy mass of the plateau contains all the functions for preparing the performances and the sculptural light roof contains the stages. The quality of the white roof and its tiles is, that it catches and mirrors the varied lights of the sky throughout day and night, thereby accentuating the mood of the place.



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Architecture as making frames

Utzon frames the place and creates an affiliation, by recognizing the ground as the ground and the sky as the sky, thus creating a space in between where life can be lived (Norberg-Schulz, 2004). Thereby the edifice contains potentials of framing, as it recognizes and enhances the qualities of the place, thereby framing its location, while at the same time framing the people residing on, or near the building.

Using things that are there

The urban space continues as a fluid transition and becomes part of the building plateau and vice-versa. Further the plateau sets a reference to Utzon's transcultural intention, referring to the temples in Yucatan Mexico, which taught him about the relation between place and architecture. The intention of the plateau is to follow the movement of the terrain and to emphasize the place and ground by arising it (Norberg-Schulz, 2004). The plateau creates as public place both in it and on top of it, where it can be used as a town square and outdoor auditorium. By not being symmetrical the plateau, like a landscape, encourages movement and discovery (Utzon, 2002).

Conclusion

Sydney Opera House is not just a place where musical performances are created and showcased, but also an extension of the urban space. This creates an affiliation to the area, providing a place to stay and for activities of various kinds to take place. The organic shape of the landscape alters to the geometrical shapes of stairs, which folds and becomes the volume of the plateau. Finally as a crown on top, is the spectacular architectural engineering achievement of the shells.

SENIOR LIFE
SENIORS: PRESENT - FUTURE

Chapter 3
PAGE 32-39

In the following section the current situation for elderly is studied. This is carried out, to get an idea of the present stage of accommodation possibilities and in general living conditions for elderly.

The research of Mary Ann Knudstrup et. al. is studied, although they are aimed at an older segment, who are reliant on the nursing homes of the healthcare sector. However they give a good starting point of understanding the present situation. To exemplify accommodation initiatives that are arising within the chosen age group, of 55 +, an interview with Senior Bo Fredericia is carried out, demonstrating how a new course might be, thus stressing the incentive for the motivation of the project.

Further to study a representative example of such institution Can Travi, a housing complex in Barcelona for citizens of the age of 65+, is studied. Additionally, by looking at the extrapolations and thereby the future prospects of the changing demography, we are getting to know the possible users of the social housing complex of this thesis. Concluding on the section, this enables us, to withdraw some key points for further treatment of the project.

3.1 The life of a senior today

Looking at the current stage of studies on living conditions for elderly, it is obvious to look at the research done by Mary Ann Knudstrup et. al. in collaboration with the Ministry of Welfare, who have set measures of how seniors ought to live. The research is aimed specifically at the physical conditions in nursing homes, which typically accommodate people over 70-80 years (Knudstrup, Møller, 2008). In this relation, it should be mentioned that this research is therefore not aimed at the age group worked with in this thesis, thereby stressing the lack of actual studies within this specific age group of 55+. As for location of a nursing home the research propose proximity of shopping possibilities, service functions and public transportation and further mainly addresses the functional and practical level within the nursing home, and thus proposes a basis. Consequently, in relation to the theory of Norberg-Schulz and the ability to dwell, together and alone, we see a need to build on these studies, by implementing the immeasurable and soft values of architecture. Nevertheless, to generally sum up on the research that has been done, the recurrent theme is physical well-being, which cannot be channeled onto an unambiguous housing type.

With the knowledge that this is still fairly new research and that the implementation hereof is limited to one nursing home - Fremtidens Plejehjem Nørresundby, this further confirms us, that this is a field which require attention to be able to rethink the way we as society treat elderly today. Currently we often put away our elderly in a nursing home and let others care for the ones, who have been taken care of us our whole life. Alternatively they can move into a senior housing project, where social relations are at a minimum, and contact with the world is reduced to infrequent visits of relatives, or a walk to the grocery store. They live isolated inside their own homes, maybe they have lost their partner and therefore have the prospect of living like this, alone with their memories, grief and thoughts for the rest of their days.

How do we get beyond this? To imagine that families are going to take care of their relatives, as it was custom earlier, is a thought which is not realistic. The main reason why older people are placed in nursing homes or senior housing projects, is often the need for extra help, or a home that accommodates special physical needs, and thus this becomes the main focus of these homes.

Then again looking at the future generation of elderly people, most remain independent until an advanced age and even continue to live an active life. Additionally, despite our long life expectancy, there will be a growing tendency that we will continue to develop and be middle-aged to the end. Thus, future generations will break the stereotype of older people and will be individuals with strength and will, if the appropriate environment permits it (Ældre Sagen, 2007). This is further stressed by manager of senior home Can Travi; Marta Lodo Caraballo;

"A lot of them are so healthy and independent that they don't want to go into an old-people's home. They want a dwelling, without barriers, that they can manage on their own – and one they can afford" (Detail Konzept, 2012, p. 953).

This leads us to what is involved here, is not just a question of accommodating special physical needs, but rather, amongst other, of a good social network. Contact with family members, friends, neighbors and an active relation to the city is key as well as ensuring homes with the ability to dwell in.

Our position on this is also supported by a tendency, which is emerging in Fredericia. Boligkontoret Fredericia, jointly with the voluntary organization Senior Bo Fredericia, has developed a housing project with the goal to provide social homes for seniors in Fredericia, all situated in a central location. As one of the first social houses are going to be situated in the development plan of FredericiaC, and because of our similar ideas, an interview with founder of Senior Bo Fredericia, Edvin Steiness has been carried out. Following is a short excerpt of the interview;

"Our senior homes are NOT nursing homes, but homes that are available for older people. On top of that with a community 'catalog' and, not least, a common position and views on, for example, maintenance and quality that the residents themselves decide and writes in the individual house rules" (Steiness, 2014)

"A senior community is NOT a commune where people share almost everything, and in turn cooks for the others and eat in large dining rooms" (Steiness, 2014)

Additionally this initiative also goes hand-in-hand with the slogan of the municipality on housing for seniors; *"longest possible in your own life"* (Gregersen, 2013, p. 3), which further stresses the support and incentive on working with dwellings for this age group.

As the abovementioned initiatives are barely realized, but nevertheless in order to study the possibilities of public uses and social relationships within a senior housing complex, we have had to look beyond the borders of Denmark, where this type of dwelling is more prominent.

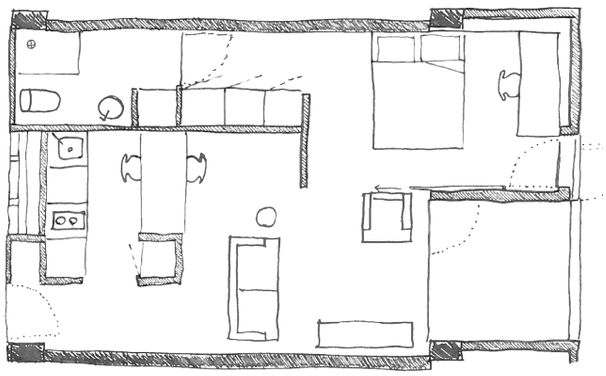
In our search for a suitable project, our interest first was drawn to the award winning WOZOCO of MVRDV, which we were introduced to in the early semesters, especially on the 4th semester, where we visited the building on our study trip to Holland. The interest in WOZOCO was due to the fact that it, in a distinctive typology, conveys housing for elderly at the age of 55+. Further it proposes a solution for building in the dense city, hence conforming to strict site regulations, whilst ensuring green areas and good daylight conditions (mvrdv.nl, 2014). But after studying the plans, it became clear to us that the edifice does not contain any common areas, beyond the park located nearby, why it was deselected as a case study.

In further search of a suitable housing project for elderly with common functions, Can Travi by GRND82 was chosen. This housing project was selected through inspiration from a concept edition of 'Detail' magazine, which exactly treat the subject 'Housing for Seniors' including the theme of living together. The study should beside the above mentioned, clarify the functions of such institution, as this master thesis is not based on a competition, however must still include representative functions.

3.2 Senior housing

Can Travi Senior Housing
Carrer de Can Travi 30b
E-08035 Barcelona

Architects	*GRND82, Barcelona*
Completion date	*1/2009*
Effective floor area	*7682m2*
No. /Size of apartments	*81/45m2*
No. of inhabitants	*90*
Age structure	*65 +*



Ill. 3.1

Can Travi is located in the Northwestern outskirts of Barcelona in Spain. Next to the complex, a busy road is found, but as the dwellings are rising up in wings on top of a plinth structure, this is not perceived (Detail Konzept, 2012). The façade of the building is characterized by the checkerboard pattern of the terraces, which is a result of the units alternating from floor to floor.

The dwelling

The first encounter is the kitchen, then the living room and as a fluent transition to this, the terrace. As each dwelling, of 45m2, is solved as an open layout plan, creating the longest diagonals possible, the entire space is perceived upon entering. Only a sliding door provides the possibility to close off to the more intimate zone of the dwelling, containing bathroom, bedroom and a connecting area with wardrobe. This rather small open layout plan ensures clarity, which is important in relation to maximize the sense of spaciousness, but also in terms of manageable maintenance.

This is also stressed by the manager of Can Travi; Marta Lodo Caraballo *"The fact that the flats are small is ultimately to the advantage of the elderly people who live here. Although we provide help with cleaning, basically they have to do everything themselves, and that's much easier with a small dwelling"* (Detail Konzept, 2012, p. 953).

Considering the climate of Barcelona, the terraces are the key living space during the majority of the year. This is also due to their direction, which allows the residents to enjoy a good view of Barcelona and the sea beyond. Each resident makes the space of the terrace their own, why they condense the life inhabiting them, and thereby reflect the activities of the users to the surroundings. Although the terraces are directed towards the city and the sea, the position of the large plinth structure in front creates a distance to the urban space, preventing the residents to easily watch the life of the street. The orientations of the building wings and the clear front and back on the other hand, ensure a high degree of energy saving, both in regards to good daylight conditions, as well as the indoor environment.

Functions

Can Travi is not only divided in two because of the building volumes of the plinth and the wings, but also the functions within, are divided in these. The wings contain, as mentioned above, the dwellings, small administrative premises and a community space for the residents. Marta Lodo Caraballo explains; *"Another popular feature is the community space. Residents have contact with each other there when they come down to use the computer, to read, or to play dominos or bingo. This room is the social 'heart' of the building, in use every day."* The fact that there is only one community space for the residents is quite questionable. One room gathers the residents, but on the other hand, this does not permit any diverse activities, the possibility to gather in smaller groups or the need for solitude, though still in proximity to other people. Another concern about gathering and community feeling is that, there is no outdoor common area for the residents, forcing them to use their own terraces, where they instead could have had the pleasure of each other's company.

Opposed to the function of the wings, the plinth contains public uses. These uses are of different character such as teaching spaces, activity spaces, and a lecture hall. This composition of public uses serves to integrate the center into the neighborhood (Detail Konzept, 2012). The idea behind this public building is of benefit for the neighborhood, but since there is no direct correlation with the homes above, these functions could just as well be located in a completely different place.

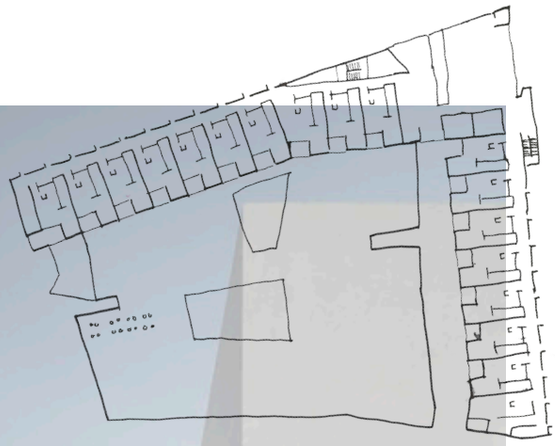
Because of the design of the building, as a partial basement floor, outdoor spaces are placed on strategic locations, to act as light wells. The layout is designed, placing as many activity rooms as possible adjacent to the light wells and thus benefiting from daylight. Further the indirect light ensures more comfortable indoor environment, compared to a direct glazing summer sun.

Flow and relations

The main entrance to the dwellings is placed on the back of the building, opposite to the public part which offers access direct from the main street. From the main entrance, one has access to the dwellings along corridors, which run in a straight line along the back of the dwellings. In the intersection of these the community space, accessible for all residents, is found. Also an artificial light well is used as a means of separating the community space and the entrance hall, though still allowing for visual interactions. The layout of the plan, with the strong backside, containing only the indifferent straight corridors, does not encourage for any encounters or stays, rather on the contrary, they provide a disinclination to go out there, nor down the hall to the common room.

The independent public center has a more unstructured layout, where the functions, as mentioned before, are placed according to the light wells to optimize the lighting conditions. An access way to the dwellings does not exist which, though in the same building, stresses the separation of the two.

Although Can Travi demonstrates some potential, we have also been made aware of the importance, through the layout of the building, to encourage residents to be social and further to provide them with the opportunity to gather in smaller groups to allow for different interest and activity levels.



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3.3 The future senior citizens

To understand the future seniors and thereby the prospect residents of this proposal, studies have been made on this segment according to statistical data and extrapolations.

Future seniors are a significantly different composition of people, than those we see today. Their educational level, and hence also the income level, will be better than the elderly today. Also their health condition and life expectancy will be improved, especially because of the advanced technology, which means that there will be fewer rundown people, because of their working conditions.

Another change is the tendency to live alone. Many people are happily living like this for many years while still being in the labor market. But when they retire they do not thrive with it anymore, because they do not have well-defined roles and activities of daily living. Hence many dream of a home with stepwise transitions to a community outside and to be together with other people, however still living in a private home.

According to 'Ældre Sagen', people with the age of 50+ typically live in detached houses. This has been steadily increasing since 1990's, where families were able to afford their own house and provide their children access to free greenery. But after these children have left home, many of the parents are now in a different scenario and are considering moving.

This also supports the trend over the past years that people moving with the age of 50+ is increasing. The reason is often because they want a smaller home, more forward-looking and practical accommodation or just a cheaper mortgage (Ældre Sagen, 2007).

The following scenarios should provide insight herein.
Mr. and Mrs. Andersen (62 and 65 years, both teachers) are living in a single-family house. Their children have left home some years ago and the garden and house now take too much of their time. Time they would rather like to spend on their hobbies instead. They both like winter bathing and kayaking and in general other recreational activities on the water, why they would like to live a little closer to these opportunities.

Mrs. Hansen (66 years, retired administrative employee) lives in a townhouse that really suits her well in size, but she feels lonely there. She is very into her herb garden which she has cultivated herself in her small garden behind the house. During wintertime she enjoys to be creative with sewing and such.

Mr. Jensen (58 years, creative director) lives alone in a single-family house, since his wife died recently. The children have left home and the house is now too big to live in alone. It takes too much of him to keep both the large house and the garden. He very much enjoys the nature and fishing, as well as he is a movie enthusiast.

Mr. and Mrs. Schmidt (64 and 65 years, former farmer and housewife) live on a farm far from the city but they are no longer farming. Their children live in the city and they spend much of their time with their grandchildren, who they like to take to cultural events happening in the city. They also appreciate to cook a good meal, preferably with organic or homegrown commodities.

3.4 Seniors: present - future

Concluding on the studies in *'3 Senior life'* we have come to understand the present state of senior homes and the current research on this subject. Even if many of the listed measurements derived from the research of Knudstrup et. al. can be transferred to this project and thereby implemented, the research did not propose any examples of implementation of immeasurable values of architecture. It should further be made clear, that the research is aimed at a different user group. Their user group have different care requirements, thus accessibility has a degree of emphasis that we do not need in this project. However, we must also take into account that the residents are supposed to live without impediments in this home for many years, why we will consider the general accessibility.

Further the study on the future seniors, through the knowledge of Ældre Sagen, we have learned to understand the new context of the elderly in the future, how they have lived and how they will live. This helps to understand the needs and preferences of this group of people.

Our meeting with Edvin Steiness from Senior Bo Fredericia confirmed us the incentive for this new type of dwelling. Although Senior Bo Fredericia has many good intentions, it is also clear to us that their ideas are not innovative to the same extend as we want it for this project. We sense that their homes will be a small step in the right direction, but that the sense of community is more a label they put on their homes. We justify this, as we see no clear relation between their homes and the institution, or that is, the institution does not really exist, as their common room is just a separate room as we know it from many housing associations. In this way the encouragement to use it, is not enhanced.

Similar was discovered by studying Can Travi. Though we realized the potentials of a common room within a housing complex, we also discovered some unexploited social potentials. By creating a social heart of the complex, it emphasizes the sense of belonging and further encourages gatherings and social activities. However, the placement of the common room is questionable, as there is no relation, visual or direct to this room, hence there is no spatial encouragement to use it. The main reason for this is the long corridors, guiding directly to this center of the complex, but then again not spatially evoking any other purposes.

Concluding on this, also with regards to the study on the notion of dwelling, the important themes in achieving a home for elderly includes; enhancing the social potential of living in an institution, thereby including easy access to spatial possibilities for gathering. Further, as described by Knudstrup et. al, the proximity of shopping possibilities, service functions and public transportation is essential for the location of the institution. Why, in connection with our investigation on enhancing relationship between house, institution and urban space, the possibilities of the context is investigated in the following section.

THE CONTEXT
FREDERICIAC

Chapter 4
PAGE 40-47

On the background of the development plan of FredericiaC, the following section studies the context, to create an awareness of the place, in which the project is located. The studies deal with the realm of the place, its conditions and activities. Both the larger picture of the whole city, a zoom-in on the chosen building plot along with its immediate surroundings are studied.

Ill. 4.1

4.1 Context

As this thesis seeks to explore the concept of dwelling, by looking at the relation between; house, institution and urban space, this is both studied on a theoretically level as well as within the actual context, thus the context is analyzed. An understanding of the context is of important, to create identification and to make it a place, influenced by the building and vice versa.

"The existential purpose of building (architecture) is therefore to make a site become a place, that is, to uncover the meanings potentially present in the given environment" (Norberg-Schulz, 1980 p. 18).

As stated in the section *'1.4 Dwelling'*, it has been important for the project, that the immediate context is the inner city; therefore a site in FredericiaC is chosen. A further criteria for choosing this site, is its early stage of development and the vision for the neighborhood; "courage to desire", which complies perfectly with our aspiration to challenge the way elderly live (FredericiaC, 2013).

The master plan deals with both an environmental and a social sustainable approach, by building dense and ensuring diversified demographics. Thereby a vibrant daily life, with possibilities is offered, to propose a place that is minded for the future (FredericiaC, 2013). Thus the values, of the settlement of FredericiaC, impeccably comply with the modes of this thesis; private, public and collective.

Actual context

Fredericia is located on the Southeast coast of Jutland, right by the connection to Funen. The inner city has Little Belt as boundaries towards South and East and is embraced by historic ramparts towards North and West. The Southeast part of the city is an old industrial area, of approximately 20 hectares land; this is under development to create a new city center, the above-mentioned FredericiaC.

Looking at a larger scale The Triangle Region is a cooperation between eight municipalities, including Fredericia. Due to its geographical placement in the center of Denmark, Fredericia is an attractive location that offers rich possibilities and great flexibility. Further the region has the largest traffic junctions of Western Denmark, with easy connections domestic and transnational, contributing to making it the region in Denmark, with the most growth (FredericiaC, 2013).

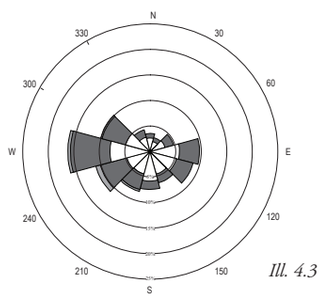
Ill. 4.2: Masterplan 1:5000

4.2 Climate

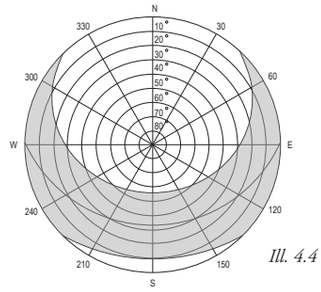
The factual climate conditions of the context are studied to gain knowledge, which is relevant for designing the building and its immediate surroundings. The following data is relevant for the indoor climate and the outdoor spaces, both regarding measurable and immeasurable aspects.
The weather in Denmark is characterized by four seasons and has a temperate climate defined by rain showers one third of the year. The warmest month is August with an average temperature of 20 degrees, while January is the coldest with 2 degrees as an average (DMI, 2014).

Sunlight
The sun path for the location and Denmark is in general characterized by a varying altitude and the azimuth angle, throughout the year. The summer has a high altitude and long days, whilst the winter has a low altitude and consequently short days (DMI, 2014).

Wind
The characteristic wind direction in Denmark is the dominating wind from the West and subsequently the Eastern wind. However, in FredericiaC, the ramparts at the Eastern boundaries will provide leeward from the wind coming in from the Little Belt.
The ridgid grid structure of the streets of Fredericia, which is continued as a layout in FredericiaC, will supposedly emphasize the wind, thus causing wind tunnels through the straight streets. However, this is compensated for in the development plan, by introducing open and attractive courtyards that encourage stays of different nature.



Ill. 4.3



Ill. 4.4

Ill. 4.5

Ill. 4.6

Ill. 4.7

Ill. 4.8

4.3 FredericiaC

The streets that enter the site from North are continued throughout the site, creating clear directions, view to the sea and further continue the renaissance structure of existing city. Across the site, a green broad contour offers a landscape of nature, and additional symbolizes the historical ramparts of the city (FredericiaC, 2013).

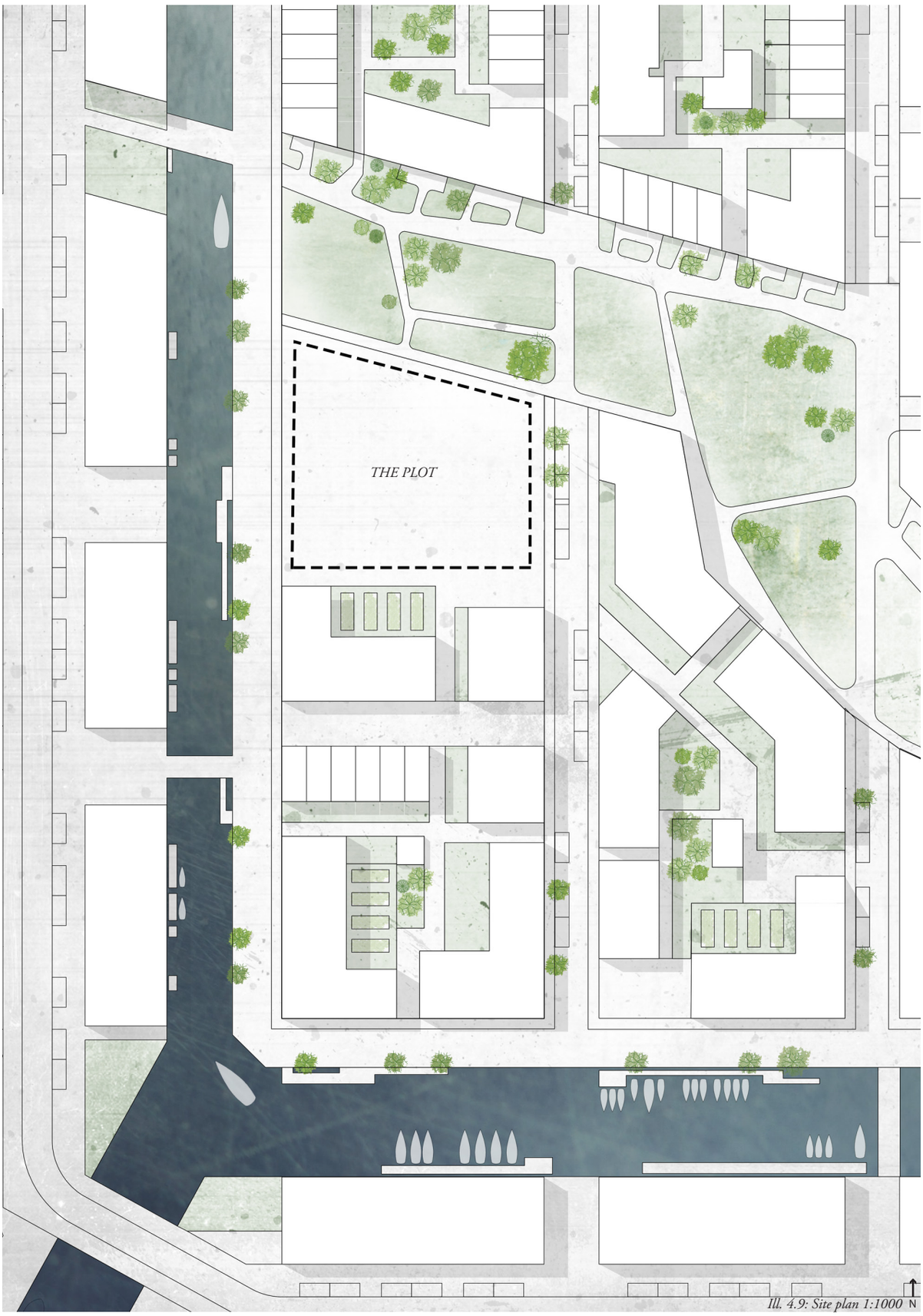
The development plan is characterized in two different neighborhoods, to create different atmospheres and intensities, furthermore ensuring a dynamic and diverse district. The Southwest corner of FredericiaC is primary commercial offices, creating a distance to the dwellings to the oil industry located there. Different institutes and cultural services are distributed around the whole area, whereas retail is gathered on the ground floor in the neighborhood located between the existing large channel and new established channel going North-South. The dominating functions are housing, which will offer 1000 new accommodations (FredericiaC, 2013).

To create easy accessibility for cars, a loop is implemented as a main street, thus insuring a hierarchy in the traffic. The loop makes it possible to have only one main street, though still covering demands for accessibility to all the neighborhoods. The secondary streets of the retail area and housing areas are laid out as promenades and shared spaces.

Grow Your City

Temporary activities are currently located on the future building site of FredericiaC, this is done to activate and enhance the qualities of the area, as well as to create encounters. Among the activities are; a skate ramp, a playground made up as different religious institutions and 'Grow Your City'. The latter should develop into a permanent activity, which can be distributed around the courtyards of FredericiaC, creating small communities, as well as a unity within the whole area.

'Grow Your City' is an urban community, for people with the desire to cultivate vegetables, flowers and herbs in a close connection with other likeminded. There are more than 700 plant boxes owned by people of all ages, along with some more boxes with herbs for the public to use (FredericiaC, 2014). 'Grow Your City' is about creating an outdoor institution for people with shared values, in this case the desire to cultivate. The vision is to create a new approach to town development, by making a community and public involvement before the buildings are built, as well as creating an awareness of sustainability (FredericiaC, 2014).



Ill. 4.9: Site plan 1:1000

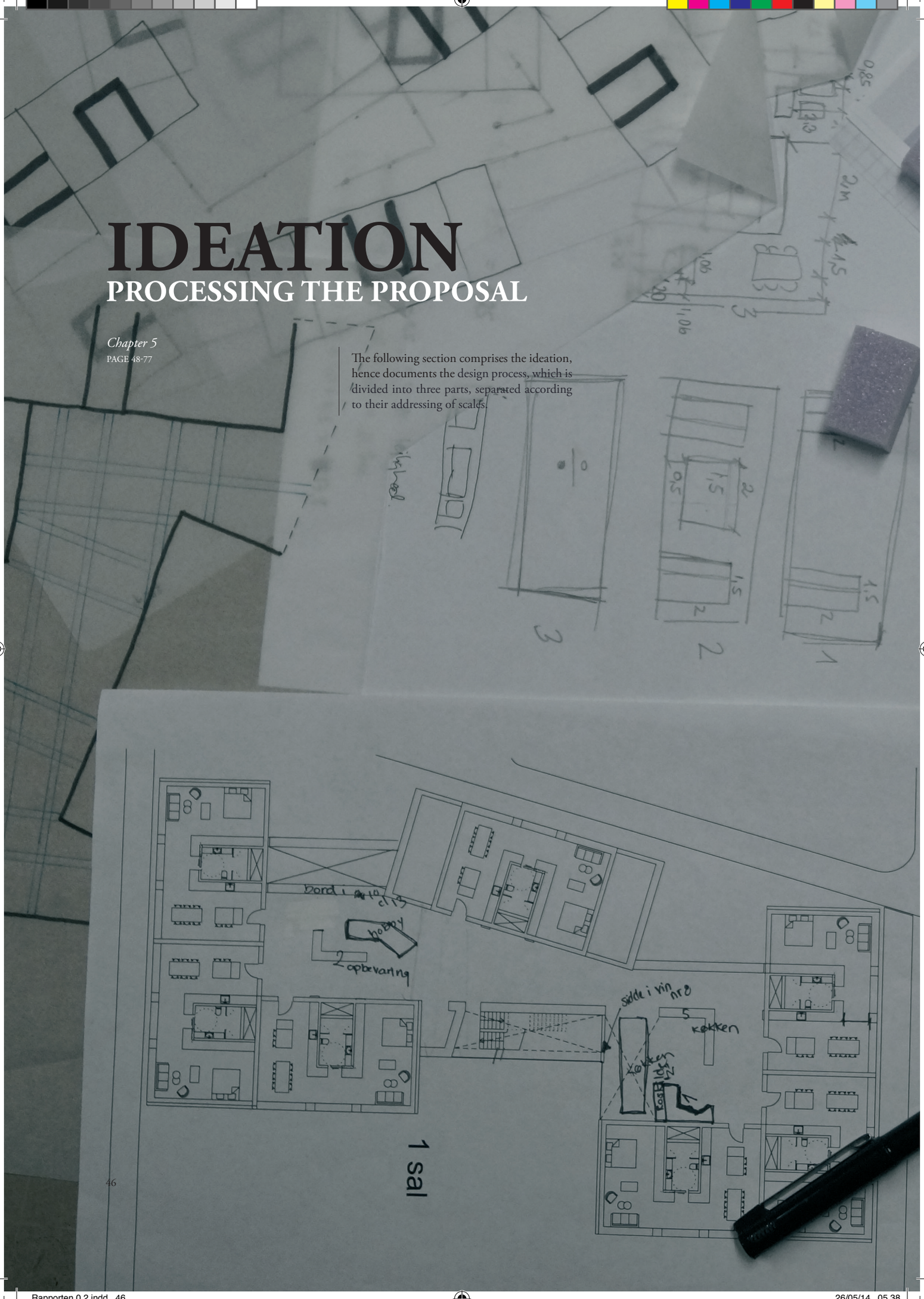
4.4 The plot

The plot, which is approximately 3000 m^2, is located in the center of the urban development plan. Currently the plot proposes four buildings that together form a block around a common courtyard. Towards East and West the block is defined by roads, as well as one of the new established channels towards East. Towards North a broad contour of nature, called 'Karolinelund' serves as the edge of the block (FredericiaC, 2013). A square is integrated into the West side of the plot, to open up the courtyard, making it a place, which is open to the public. The block has to adapt to the different atmospheres and modes in its immediate context, why the plot is chosen. Only half of the plot, towards North, is chosen as the actual building plot for this project, to ensure diversity of building types and residents within the block, in accordance with the vision of FredericiaC.

IDEATION
PROCESSING THE PROPOSAL

Chapter 5
PAGE 48-77

The following section comprises the ideation, hence documents the design process, which is divided into three parts, separated according to their addressing of scales.



Ill. 5.1

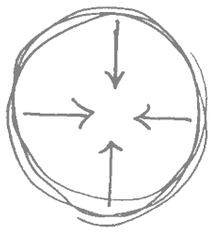
5.1 Potential of the new typology

5.1.1 The new typology

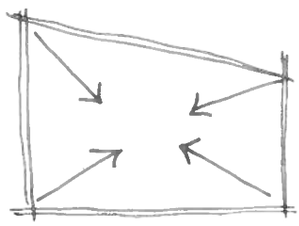
Following up on the context analysis and finally the analysis of the chosen plot, the potential of several typologies are explored. The design process is informed by the preceding studies in section; *'2.4 Sydney Opera House', '2.3 Tietgen Dormitory'* and *'4 The context'*. Tietgen Dormitory demonstrated the perfect social geometry, as a result of using the pure geometry of a circle, thus gathering the residents, even though still permitting their privacy in the outer periphery. Although this geometry seems the perfect shape for a social housing complex, we do not chose to adopt the principle of the circle, as it, as stated in the conclusion of the case, does not relate to the surroundings and adjacent buildings. However, we are inspired by the principle of bringing people together in common rooms, which everyone has equal access to. Similar we see it as a potential to create centers by locating these spaces in the middle of the institution, which at the same time ensure transitions to the more private houses on the outside.

The case study of Sydney Opera House presented how to extract the full potential of its urban terrain. The staircase that flows out into its surroundings, almost invites people to occupy it, emphasizing both the qualities of the site and the edifice. From this we feel inspired, as we aspire to meet the vision of FredericiaC; to create active and vibrant outdoor spaces, with inviting public courtyards. Additionally this complies with the desire of dissolving the transitions of the levels described in; *'1.4 Dwelling'*.

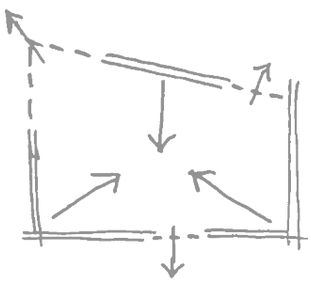
This leads to the derived points from the context analyses, which are, as mentioned above, to meet the open and inviting courtyards, as proposed in the development plan, as well as providing space for 'Grow Your City' and other public initiatives. Similar, the location of the plot sets the preconditions for the orientation of the building, together with its geometry. To follow the boarders of the plot is chosen on the background of the straight streets of the historical city center, along with the boarder of the green band, which both are important defining edges, as well as the general grid of the layout plan.



The circle as the perfect social geometry

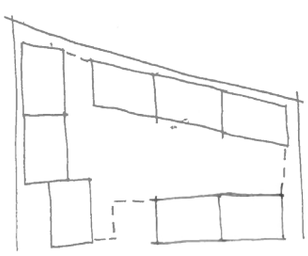


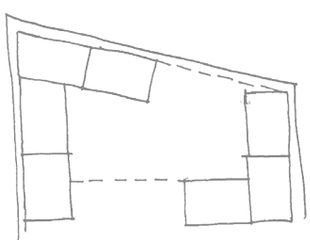
Social and recognizes the context by following the contours site.

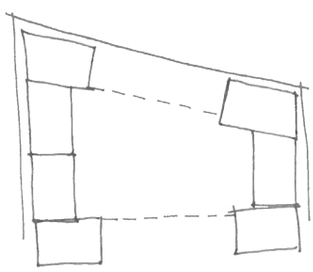


Ill. 5.2

Social and creates a relation to the context



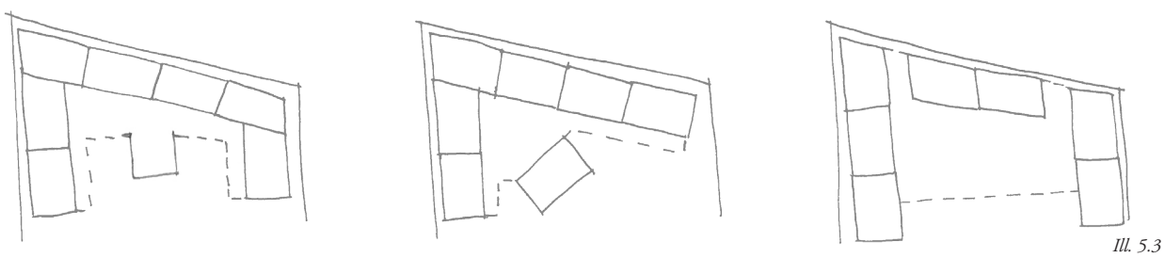




1
The potential of this organization is, that it consists of eight housing units on each floor, whereas the other proposals only include seven. Even with the additional units, there is still space for openings towards the urban space, which creates a relation to the context. However, hierarchy in the openings is missing, as the opening towards the courtyard should be the primary one, thus indicating a relationship with the other half of the block.

2
The two L-shapes embrace the space in-between them. With the openings being shifted to each side, a more defined space is obtained, enhancing the possibility to implement functions. Yet, to obtain this shape, to be able to follow the boarders of the site, the housing units would have odd corners, why the possibility of implementing identical layout plans for the houses would be impossible. This recognition though, is the case for all of the proposals.

3
The symmetry of this organization generates tranquility to the plan, but the plan consequently comes across as being divided in two. The social space in between is equally reachable from the housing units, however it lacks qualities in the sense of creating domains by the use of paths and centers. As a consequence of the large openings opposite each other, the social space is more exposed than in the second proposal, hence it could easily become a passageway.

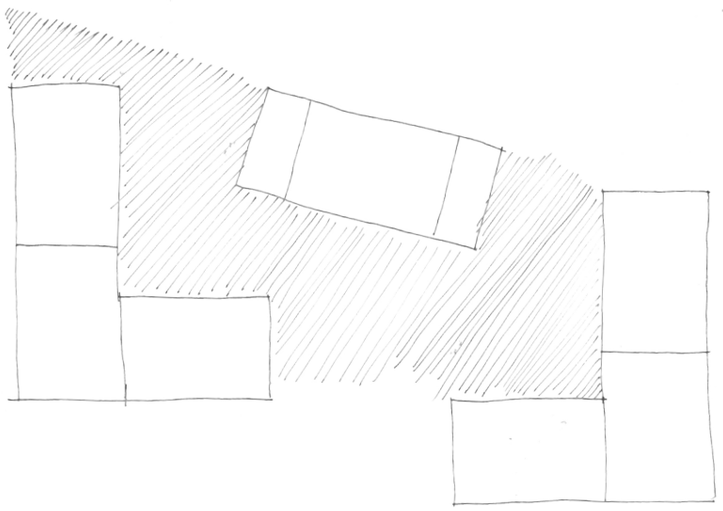


Ill. 5.3

4
Here, the housing units are arranged in a u-shape creating a boundary towards the outside urban space, but openness toward the courtyard. The space in-between is clearly distributed around one social center and the access areas, hence they becomes the most dominating. Although the social space is placed in the center of the building, the placement is unequally accessible for the housing units, which is seen as a disadvantage for the social engagement. Addressing daylight conditions, this proposal, as well as three and five, does not permit daylight from two sides in three of the seven housing units, which represents an impairment of these proposals.

5
In this proposal, the housing units attempt to create one center, hence symbolizing a social institution. This layout however neglects the units which are placed at the end of the corridors, which is a result of the attempt to follow the site and its immediate context. Further the, in comparison to the other proposals, smaller social space has difficulties in achieving good daylight conditions, as the housing unit in the middle blocks off the daylight, hence only daylight from the corridors is attained.

6
The units create a clear boundary to the streets and to the public green pathway towards North. There is a hierarchy in the relations to the urban space, with the one towards the courtyard being the primary and the two others secondary. However, the space in between is large and lacks the possibility of defining different centers and atmospheres.



Ill. 5.4

5.1.2 The chosen typology

Following up on the previous sections, it must be recognized, that the aim to follow the boundaries of the plot, because of the defining edges of the overall development plan, has consequences when considering the possibility to obtain uniform housing units. The typology studies demonstrated, as mentioned in proposal two, that all the proposals contain diverse shaping of the housing units, resulting in odd unusable corners in some of them. Further this would result in different layout plans in each house and the ability to implement prefabricated elements, as facades and partitions walls, would be impossible. Therefore, in the subsequent ideations, uniformed housing units were implemented.

In further referring to the typology studies, number two and six showed some potential. Number two, with the two L-shapes, has the potential of embracing and defining space. From proposal six the relation to the urban space and the hierarchy of the openings is extracted, to create relations to the typology. Together the ideations lead to the final organization of the housing units, including the social spaces of the institution and the relation to the urban space. The institution is placed in the middle of the housing units on all floors, thereby functioning as one continuous living space, which ensures equal accessibility for all residents.

Further the institution acts as a fluent transition to the urban space and its divided spatiality, created of paths and centers, gives the possibility to obtain different scales of social gatherings. Consequently, the institution and housing units refer to the scale of a single family house, where the private rooms are placed on the periphery making them more private, whereas the common spaces stands as open social centers. Thus, the potential of this project is found in the transition of atmospheres, along with rethinking of the social space in between, thereby creating a new typology.

5.1.3 Functions

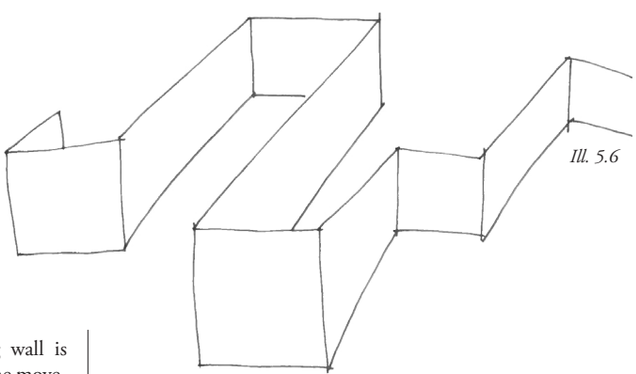
As the project aims to design a place where one dwells, according to the considerations from chapter *'1.4 Dwelling'*; a house inside an institution within an urban context is to be achieved, to obtain satisfied dwelling. Thus, to follow up on *'5.1.2 The chosen typology'*, the functions and their related atmospheres, for both the houses, the institution and the urban space, must be defined. This is achieved informed by the knowledge gathered in the preceding analyzes; the common denominators from the research of Knudstrup et.al, in *'3.1 The life of a senior today'*, along with our study of Can Travi, in *'3.2 Senior Housing'*.

Further the functions and atmospheres are considered and selected carefully based on the desire to focus on spatial potentials and enhancement of detailing, to address the initial aspiration of obtaining dwelling, through enhancement of the sensuous scale and soft values of architecture.

FUNCTION	AMOUNT	SIZE m^2
SCALE OF THE HOUSE		
Dwelling	20	65 m^2
Entrance Living space Sleeping space Bathroom		
Bay window		
SCALE OF THE INSTITUTION		
Lobby		30 m^2
Living room		
Kitchen		
Library		
Hobbyroom	2	
Guest rooms	2	32 m^2
Paths		
Technical room		65 m^2
Refuse		40 m^2
Private storage		20 x 3.5 m^2
Supplies room		3,5 m^2
SCALE OF THE URBAN SPACE		
Common porch		
Tool shed		31 m^2
Public “Grow Your City”		

LEVEL OF INTIMACY 1-5 (5 being most intimate)	FUNCTIONAL DEMANDS	SPATIAL POTENTIAL
++++	Segregation of atmospheres Flexible furniture and fittings	A place for privacy
+++	Room for visitors	
++++		
+++++		
+++++		
+++		Visual contact to the urban space
+	Overview of the entrance space Visual connection to the urban space	A space that greets the residents and guests Encourages the residents to participate in the institution.
+++	Fireplace	A place for gathering and social encounters Relaxed, informal and comfortable atmosphere A center in the institution
++	Room for all the residents Cooking facilities + festivities	A room, which simultaneously encompasses gathering of all residents
+++	Niches that provide a sheltered back Integrated shelving	A place for contemplation and inspiration, whilst being in proximity of others
++	Adaptable according to uses and needs Flexible storage space	A place where creativity can be unfold
++++	Over night stay for relatives containing sleeping and bathroom facilities	
	Easy accessibility Meet all safety requirements, such as fire regulation	The corridors shall encourage stay and movement, as well as clarity and overview
-		
-		
-		
-		
++	Located in relation to the institution, however in the garden/ courtyard	A place to be collective
++	Garden utensils storage	
+	Bonfire site Greenery boxes	Having one's own greenery box Though private, it is an integrated part of the community of FredericiaC

Ill. 5.5



Ill. 5.6

5.2 Potential of the folding wall

5.2.1 The folding wall

Informed by the section *'1.4 Dwelling'*, our tectonic approach and knowledge derived from the case studies, a common principle is extracted. Hence, the means of a *wall*, which is structural whilst furnishing and through folding in relation between the house-institution and the institution-urban space, is introduced. The general potential of the wall is addressed by a number of theorists, among them architect and theorist Gottfried Semper, who states *"The wall is the architectural element that formally represents and makes visible enclosed space as such, absolutely, without reference to secondary concepts"* (Semper, 2004; 1860 p. 247). And further *"…the wall being the visible boundary to a specific space, and the collective agreement to respect this artificial demarcation as binding and meaningful"* (Depalazes, 2008; 2005, p.186).

Hence, the concept of the folding wall is implemented as a means of solving the movement between the different levels and further to ensure, through its spatial potential, social and private spaces. Thus the wall has the potential to serve as guiding paths, as well as enclosing social centers, which together creates a network of domains, reaching from within the houses, through the institution, out into the urban space.

5.2.2 Relations

The concept of the wall and its spatial potential is developed regarding the three levels (house, institution, urban space) and the relations between them.

"Semper attributes the symbolic aspects of the creation of space to the wall" (Depalazes, 2008; 2005, p.187).

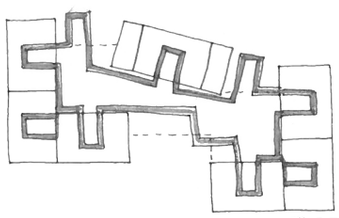
Thus, the wall is studied through various proposals, also incorporating the sense of belonging, both in the house, institution and into the urban space. As the wall should amplify a connection between the levels and give the feeling of being in one home thought-out the building, we reflect on, whether the wall should be continuous to achieve this.
This is why the initial ideations involve the wall as being continuous and thereby intervening with all the houses and the urban space. Thus by creating a direct relation between the houses, a sense of belonging is achieved through recognizability. This relation of the wall is shown on illustration 5.7, but it also reveals that the wall does not create any spatiality in the institution, which should be the purpose of the wall. A further consequence of the continuous wall is, that it becomes dominating; hence it does not create any contrast and thus loses its role as a furnishing element.

The subsequent studies of the wall as space creating, is therefore concerned with a non-physical continuous element where the recognizability should be perceived in the material and the visible presence of the wall throughout the building as seen in illustration 5.8.

Along with this study, the circulation in the institution and the houses is studied to enhance the relation between. Additional it is an aspiration to create a connection between the different floors, making the whole institution become one place. Therefore the potential of the wall, as a guiding element, is implemented into the staircase, which should function as a center where paths originate from.

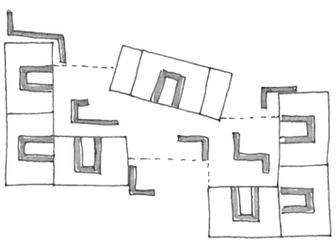
Inspired by *'2.4 Sydney Opera House'*, the building is situated on a plateau to create an awareness of the place and the building, but also to ensure privacy in the houses that are located on the ground floor. This naturally leaves a height difference from the institution to the urban space, which is bridged by the principle of folding in plan, as seen in the case study, where the relation is achieved by continuing and emphasizing the movement of the landscape.

By using a folding plan that emanates from the walls within the institution, a fluent transition is achieved through stairs and porches. In this way a strong relation to the urban space is achieved as illustrated on 5.9.
The subsequent studies will in relation to the tectonic approach, study the relation to the measurable and immeasurable.



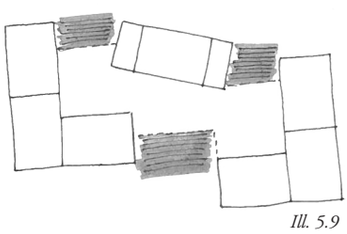
Ill. 5.7

The wall folding as a continuous element



Ill. 5.8

The wall folding and creating spatiality



Ill. 5.9

The wall folding down and into the urban space

5.2.3 Measurable and immeasurable

Working with the relations in *'1.4 Dwelling',* it became clear to us that, referring to our approach to tectonics, being; *"…an approach to architecture, which is fully achieved by getting both the measurable and immeasurable, incorporated in a complete work",* to be able to obtain a comprehensive outcome a common denominator is needed to encompass both.

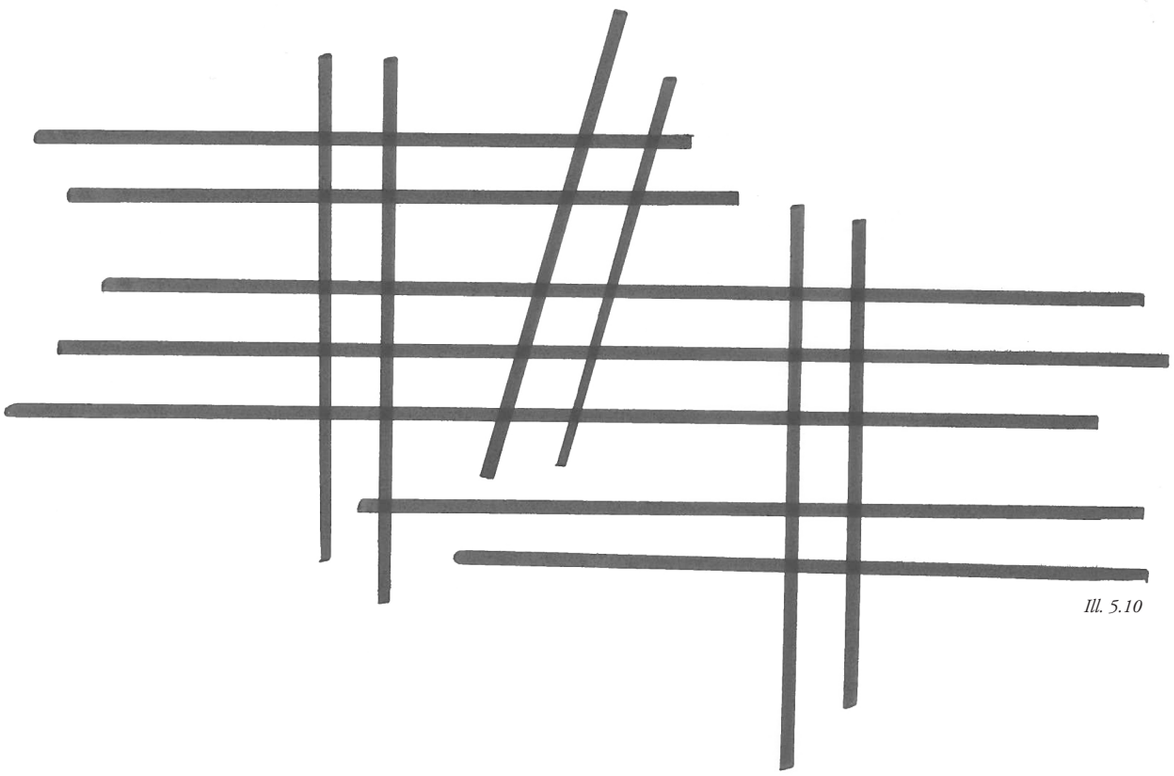
This is engaged, by studying theories on the signification of the wall by Gottfried Semper, who addresses the two, by clearly differentiating between 'die Mauer', being the loadbearing wall and 'die Wand', being the partition wall and hence stating; *"The often solid walls behind them (red. 'the true walls') were necessary for reasons that had nothing to do with the creation of space; they were needed for security, for supporting a load, for their performance, and so on"* (Semper, 1989; 1851 p.104).

Semper's attention to the characteristics of the wall emphasizes the importance he laid in enclosures and the purpose of the wall as being a spatial divider. Additional through his theory of weaving he addressed the notion of dressing the wall (Semper, 2004; 1861).

Hence addressing the 'true walls', Semper referred to hanging carpets dressing the masonry walls, as he was engaged with the initial purpose of the wall, as being the cover of the human body. The use of carpets though, was presented earlier, as carpets were hung between wooden frames, which together fulfilled both the structural purpose, as well as a spatial potential for dwellings (Hartoonian, 1994). But through technological development and improved construction capabilities, loadbearing masonry walls were introduced, with the carpets as soft dressing of the walls. Additional the carpets had several other functionalities, such as a climate barrier, as well as colorful decoration of the home (Semper, 1989; 1851).

This duality, of the potentials of the wall, is further stressed by Semper's comparison of the German words 'Wand' and 'Gewand', referring to 'wall' and 'clothing'. This comparison arose in his theory, which stated that weaving of branches led to weaving of mats and covers. Thereby the reference to weaving of textiles hence indicates the wall as being of woven material (Semper, 1989; 1851).

Semper's theory further describes that the technique of weaving was developed to that of wickerwork, which he ascribes as the original space divider, and thereby assigns the industrial art of weaving to an architectural element. The theory of comparing industrial arts with architectural elements originates



Ill. 5.10

from Semper's '*The Four Elements of Architecture*', in which he stated that ceramics, carpentry, masonry and weaving were industrial arts, which influenced the elements and means of architecture (Hartoonian, 1994).

Tectonics and the honesty of materials

In relation to the above studies of Semper, which proposes dressing of the wall, to address sensuousness in general, we cannot help to compare this theory to contemporary architecture and tectonics, in relation to honesty of materials.

As stated in the introduction contemporary works focus mainly on the honesty of construction and what is intended to be hidden behind the wall, thus the attention to the immeasurable and soft values of architecture is commonly neglected.

Thus when addressing tectonics, it seems, as the salient common denominator, is the honesty of construction, hence denoting cladding as being dishonest, also denoted by architectural historian Eduard F. Sekler as being 'a-tectonic' (Frampton, 1995). However, as stated earlier, to us tectonics should encompass both the measurable and the immeasurable, why we question the denotation of Sekler and further argue that cladding has the potential to enhance the perception of structure and thereby they complement each other. This is also stated by M. F. Hvejsel and P. H. Kirkegaard in their paper on wallpaper and tectonics as; *"…(the) principle of cladding unfolds a particular potential in awakening the sensuous and narrative dimensions of architecture that signifies our recognition of its quality"* (Hvejsel, Kirkegaard, 2013, p. 399).

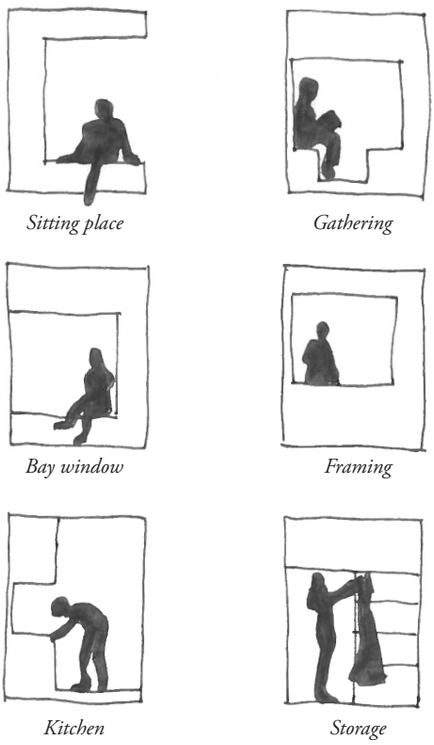
Consequently, through the tectonic approach and informed by the studies of Semper, it became evident to us, that the wall should encompass structural properties, whilst addressing the sensuous scale of human body. This is being addressed by introducing a grid, emanated from the private houses, thereby organizing the structure of the building, along with arranging the spatiality of the institution. Hence, the structure of the building is solved by arranging the loadbearing columns in the intersection-points of the grid. Thus the façade and the additional walls are freed from loadbearing properties, allowing for the ability to replace or renovate the facades in the future. As a means of creating the folding wall and spatial potentials within, wooden cladding is used. The potential of cladding will be described further in *'5.3.3 The cladding wall'*.

5.3 The potential of detailing

5.3.1 Detailing

The following will address detailing in regards to both the measurable and immeasurable. As pointed out by architect and architectural theorist Marco Frascari, an architectural detail is always defined as a joint that becomes part of the whole (Frascari, 1981). Frascari characterizes joints, either as a material joint that define a physical connection between two elements or a formal joint, which expresses the relation between spaces.

Equally, in this project, detailing has influenced both formal and material joints, which will be elaborated on through explorations on the potential of these. The potential of the structural wall explores the potential of the grid and the structure emanating from it, including calculations. Similarly, the potential of cladding is studied for its potential as addressing the human scale, as well as its acoustic capabilities. Detailing of the facade and daylighting are made parallel to investigate both daylight conditions in the house, but also how the windows influence the expression of the facade and interior of the houses, including the relation to the urban space.



Ill. 5.11

The potential of detailing the wall

5.3.2 The structural wall

In the previous section *'5.2.3 Measurable and immeasurable'* a grid is introduced to arrange the structure of the building. The following will study the potential of this grid as a means of being the structural principal of the building. The studies will be based on measurable aspects, whereas the immeasurable aspects will be studied and elaborated on in the following section *'5.3.3 The cladding wall'*.

The grid generates the possibility for a primary system of beams to be arranged according to it while subsequent a secondary system of beams can be applied to it. Together this system carries the floor slab. The primary system of beams is supported by columns, which are placed in the intersections of the grid.

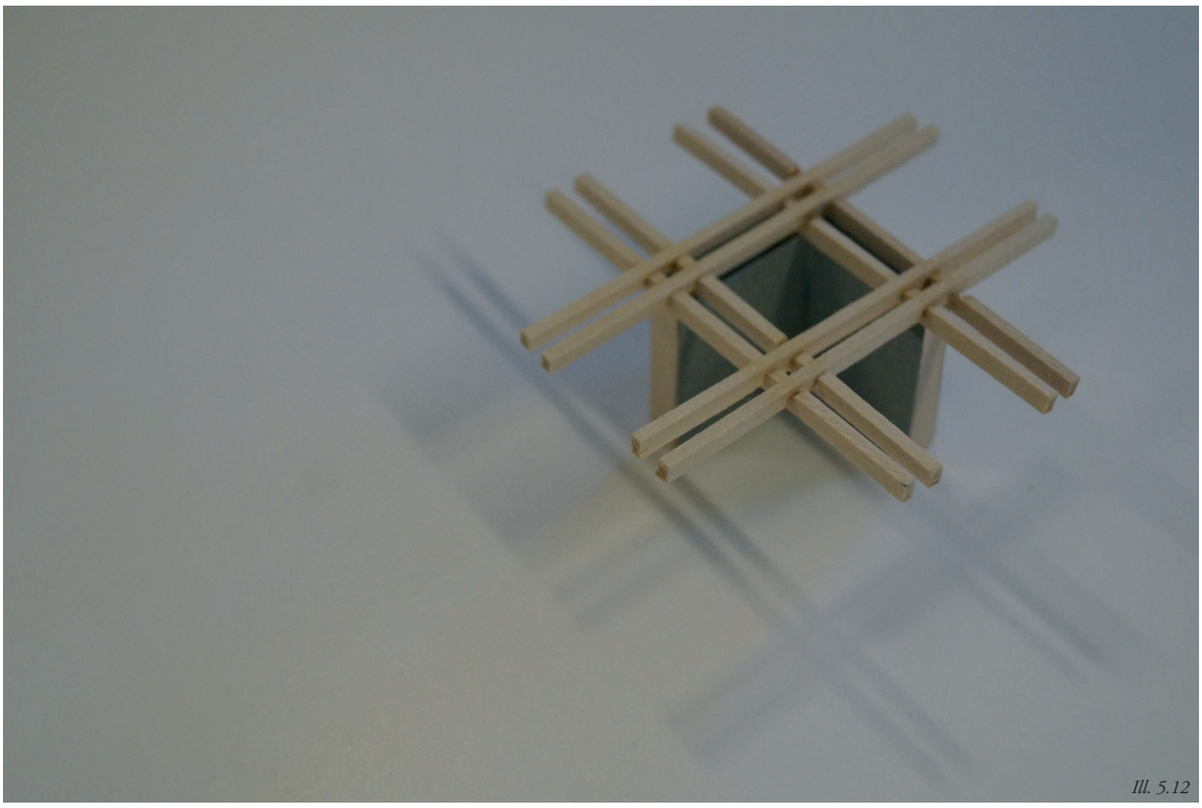
Reinforced concrete is chosen as the material for the structural system of the building for its measurable and immeasurable qualities. The measureable qualities of the reinforced concrete are, among other, the strengths of the material and its ability to function as thermal mass (Jensen, 2011). The thermal mass contributes to a stable indoor environment when it is exposed. The exposed concrete is also chosen to create a contrast to the wooden cladding and white walls.

As seen in *'8.1 Dimensioning of beam'*, the calculation of a simple supported beam spanning between two intersections of the grid, the beam is dimensioned in ultimate limit state (ULS) to have a height of 400mm and a wide of 500mm. Further calculating on the service limit state (SLS) the deflection resulted in 68mm, where 20mm is permitted, why a larger beam must be implemented. When applying the secondary system of beams and the floor slab to the structure, thereby creating a ribbed slab construction, the deck construction is undesirable high. The ribbed structure of beams create an attendance that could be a narrative of the structure, though in this case, it is too complex to understand, too dominant and creates different expressions in the houses.

As a consequence to this, the structural system is chosen to consist of a flat slab system supported by the columns to decrease the thickness of the deck construction and to avoid the dominating expression of the ribbed structure.

To verify the flat slab structure of the building, calculations are done in a combination of manual- and Robot Structural Analysis calculations. The calculated load forces in *'8.2 Loads'* are applied to a Robot Structural Analysis model, which contains the geometry of the columns and the slabs. The force on the most exposed and critical column is extracted from the Robot Structural Analysis model *'8.3 Dimensioning of column'* to determine and verify the dimensions of the columns. The columns of 400mm x 400mm are dimensioned to take forces of 3030 kN. The applied force, extracted from the Robot Structural Analysis calculations, is 1074 kN, thus verifying that the columns will hold. The Robot Structural Analysis model consists of the three decks. The basement is calculated as an individual system, with the concrete exterior walls of the plateau and the columns being load bearing.

Further calculations *'8.4 Dimensioning of beam in basement'* are done to explore the possibility of removing some columns in the basement, to be able to implement parking there. The development plan of FredericiaC proposes that each block in the housing district should include approximately 20 parking spaces. The calculations for the basement shows that columns cannot be replaced by beams, as the beams will have a height more than 1 meter. As a result of this, only five parking spaces can be implemented in the basement, which is the a requirement for a elderly housing complex with 20 houses. Further the basement is used for bicycle parking, technical installations, refuse and private storage units for the residents.



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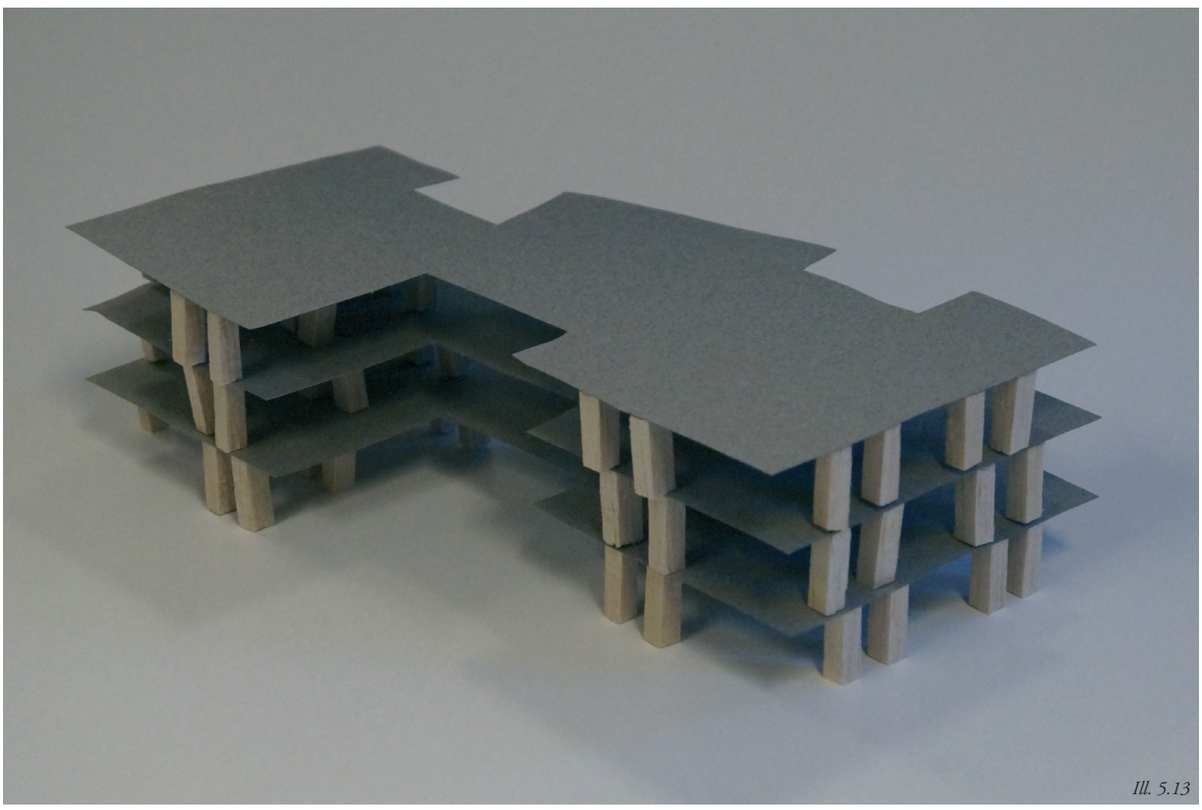


Ill. 5.13

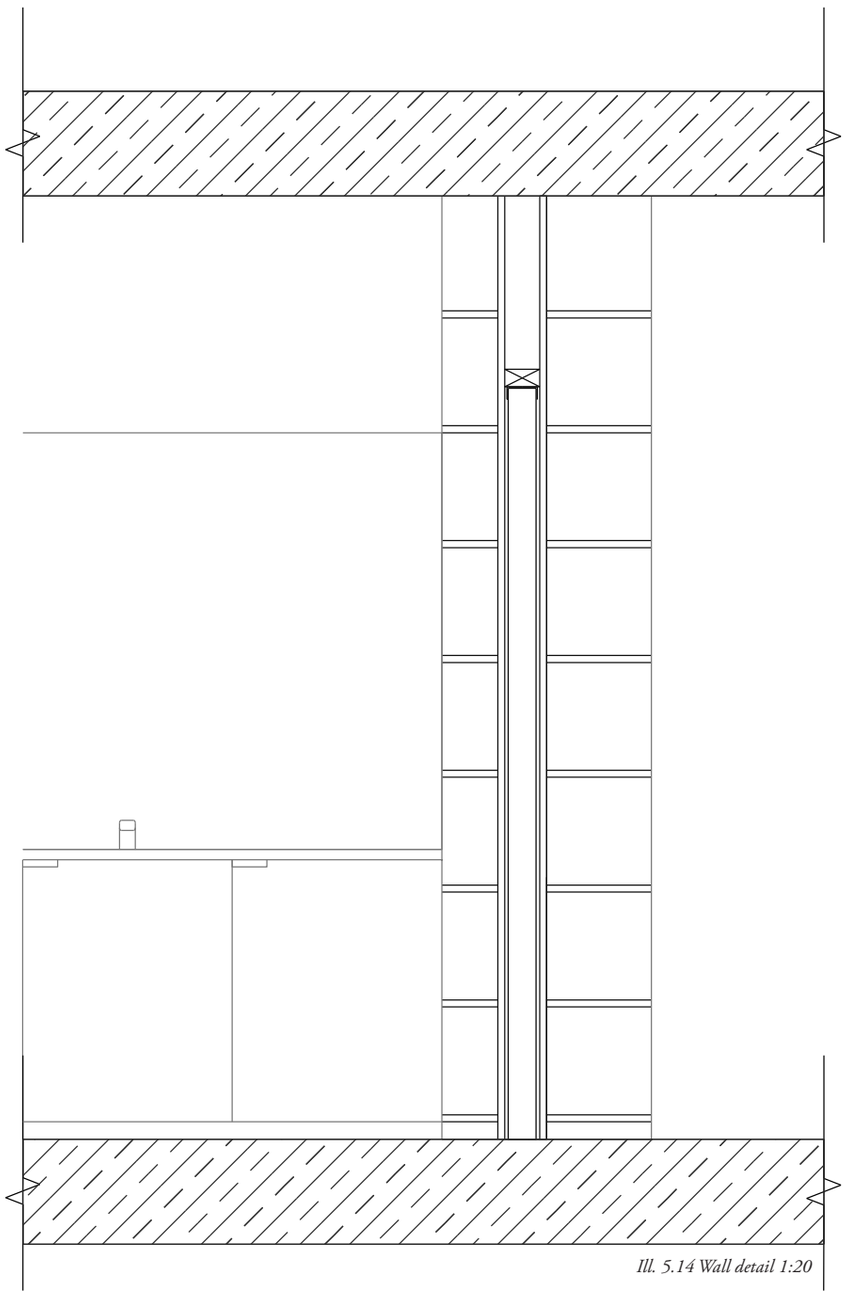
5.3.3 The cladding wall

As stated in *'5.2.3 Measurable and immeasurable'* the wall should encompass both measurable and immeasurable aspects including a high degree of detailing. This study concerns the potential of cladding and the wall in relation to addressing the human body. This study is completed simultaneously with the studies of *'5.3.2 The structural wall'*.

"However, a transition of form is possible: the masonry can be transformed into the wall. This can be achieved through cladding …" (Depalazes, 2008; 2005, p.186). This statement by Depalazes underlines the capability of the folding wall, which is created by the use of cladding between columns. Hence the wooden cladding gives texture and warmth to the surfaces, thus embraces the people occupying the walls. In that way, both a structural wall and a wall, that through its cladding, addresses sensuousness, is achieved.

As seen in the case *'2.2 Villa Savoye'* the house addresses the body according to form. Space is experienced through a bodily contact; this potential is transferred to the cladding wall, by the use of form and material. The wall is assigned functions that through their form, invite to be used and occupied. Some of the walls have functions from both sides, as seen in detail 5.14 of the bathroom wall, whereas others only from one side. Similar, the wall is a furnishing element, which can be inhabited by personalizing it through storing of personal belongings.

The cladding of the wall contains more qualities than the immeasurable i.e. the wall holds the measurable quality of balancing the acoustics. As the floors and ceilings are of concrete, the risk that there will be excessive reverberation time consists. This however can be reduced by implementation of the wooden cladding. Sound is measured in dB (decibel) and Hz (Hertz), where the loudness of human speech is approximately 50dB/1000Hz. Noise reduction coefficient is measured in NRC with no units associated. Absorption coefficients must always be chosen according to the producer of the chosen materials, but in this case, we have chosen average listed coefficients for the given material. NRC values lower than 0.2 are considered to be reflective, whereas values higher than 0.4 is considered absorptive. The absorption coefficient for smooth concrete is 0.04 for normal level of speech, why it is reflective. The wooden panels on the other hand, have an absorption coefficient of 0.79 for normal level of speech. Hence, we can assume that the wooden cladding compensate for the reflective surface of the concrete (Rossing, 2007).



Ill. 5.14 Wall detail 1:20

To utilize both sides of the cladded wall, shelves are applied on both sides, hence a relation between the rooms is achieved and further this bring the sensuous scale of the wooden cladding into the most private space; the bathroom.

5.3.4 Daylight

In the following, it is explored and described, how the means of daylight is implemented. The significance of placing a window, the inside-outside relation, as well as the importance of good daylight conditions is described.

Already when studying typologies on the plot, good daylight conditions were introduced as an argument for selecting the chosen typology. The composition, allows for daylight from two sides in all apartments except two. Eqyally, the entrance areas, with large windows, allows for daylight to stream through the institution.

To be able to implement the quality of daylight wisely, it is important to understand the variability of daylight, for instance caused by the effect of light and shadow ratio, reflections in materials, different color tones and direction. Together, this has various impacts on both perception and the use of a room, as it entails diverse atmospheres. In this way the implementation of windows entails both the measurable and immeasurable means, and thus offers the potential to obtain a tectonic outcome. This equilibrium, of the technical and poetic elements, is further stated by assistant Professor in the Department of Urbanism, Faculty of Architecture, at Delft University of Technology, Dr. A. van Nes as such;

"... inside-outside relationship also relates to windows, including their size, shape, and placement. How much light they offer the interior is one of the most important aspects of the ambience of inside" (Dr. A. van Nes, 2012).

As mentioned earlier the daylight is let in from several directions in the houses. This ensures good day light conditions throughout and thus leaves the free layout plan illuminated as seen in illustration 5.16.

Implementation of windows, in relation to depth and placement in the wall, has an impact on the daylight transmittance. Further, the window placement furthest out in the façade has the potential to act as an additional seating spot, which relates directly to the body, as if the window sash offers an embracing gesture. Additional, as seen both in the study of Can Travi in *'3.2 Senior housing'* and *'2.3 Tietgen Dormitory'*, this direct relation to the urban space frames both the person inhabiting the window, as well as the life passing by outside. This both gives extra quality to the room but also gives a livelier façade. In relation to daylight conditions, this placement of the window is also optimal, as the daylight is transmitted further into the room, as seen on illustration 5.17.

The window doors in the kitchen and the living room, additionally blurs the transition between inside and outside, which is enhanced by the possibility to open them up in their full height. Their size corresponds to both eye level when sitting, standing as well as offers a diagonal view from when lying in the bed, however they do not expose the whole bed, why privacy is still guaranteed. The latter allows, potential residents who are confined to bed, the opportunity to keep up with life outside.

Windows types and materials

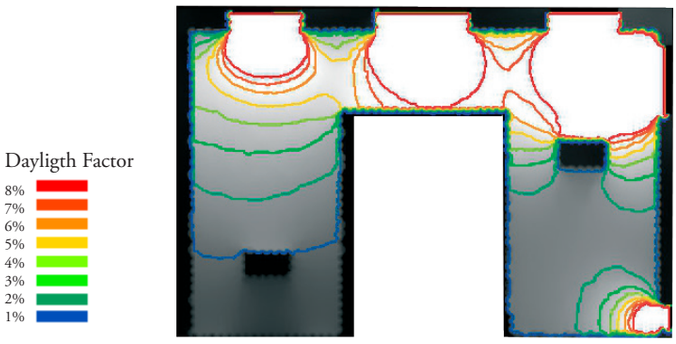
Another decisive factor when implementing windows is the choice of window type and materials. They should permit transmission of sunrays, in order to gain passive solar heat during heating season, though also prevent overheating during the non-heating season. The materials have an impact on the visual expression and the experienced transition between inside and outside, whereby choosing slender window profiles, makes it is possible to dissolve this.

The window type chosen is VELFAC Ribo wood series, which technical specifications are listed below.

• Elements of wood
• U-value: down to 0.8
• Window Selection: 48mm 3-layer
• VELFAC Ribo wood with 3-layer standard glazing meets the anticipated requirements for BR2020. (Velfac, 2014)

Daylight factor
A daylight factor of 2% is set as preferable and tests are carried out in Velux Visualiser.

The presented examples are showing worst case scenario; winter day with overcast sky. The average daylight factor is 4.2%, why it is adequate lit. In the kitchen area, were good daylight condition is desirable for preparing food, an average of 2.2% is obtained. There are no regulations on minimum daylight factor in the Danish Building Regulations for domestic housing, however a daylight factor of minimum 2%, is set as satisfactory, to reduce the use of electricity during the day.



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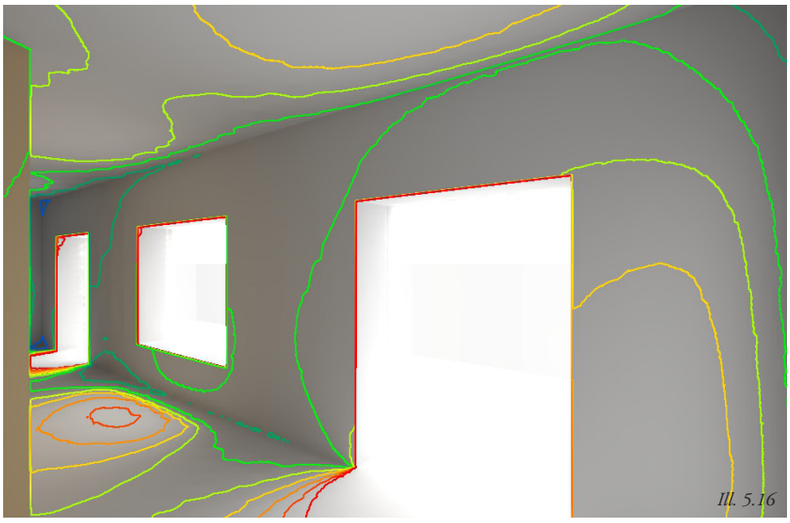

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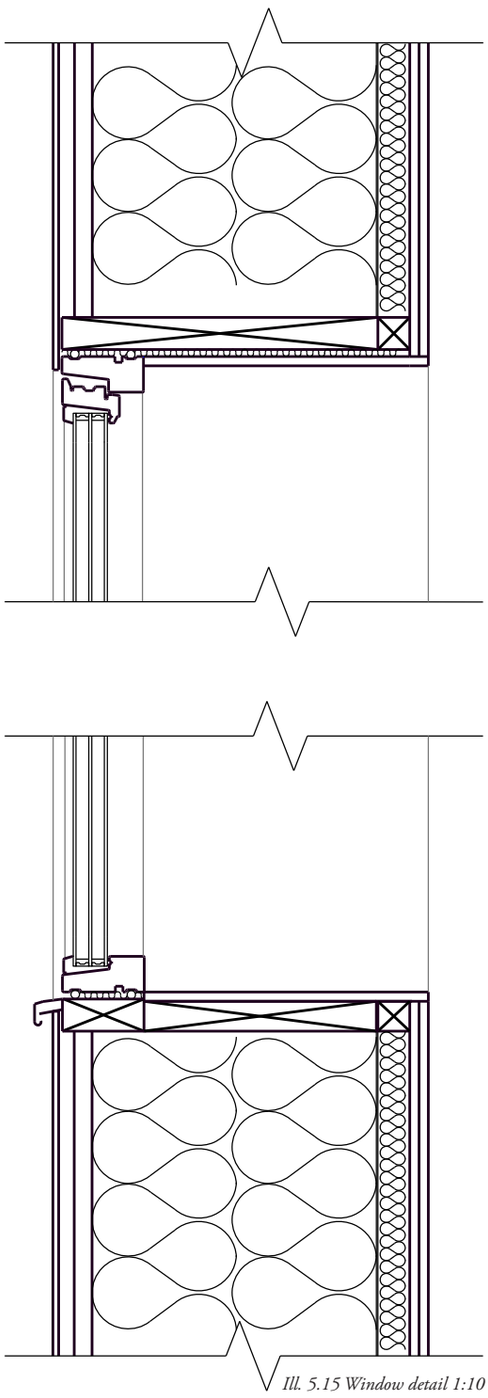


Ill. 5.15 Window detail 1:10

5.3.5 The facade

This section deals with design of the facade, in a simultaneously development of the previous section *'5.3.4 Daylight'*. However in this section, the focus is on relation between interiors and exterior.

A wall is characterized by the perforations of it, created by doors and windows. Thus, size, shapes and the amount of the perforations, define its visual expression, through openness, continuity, massiveness or lightness, and rhythm.

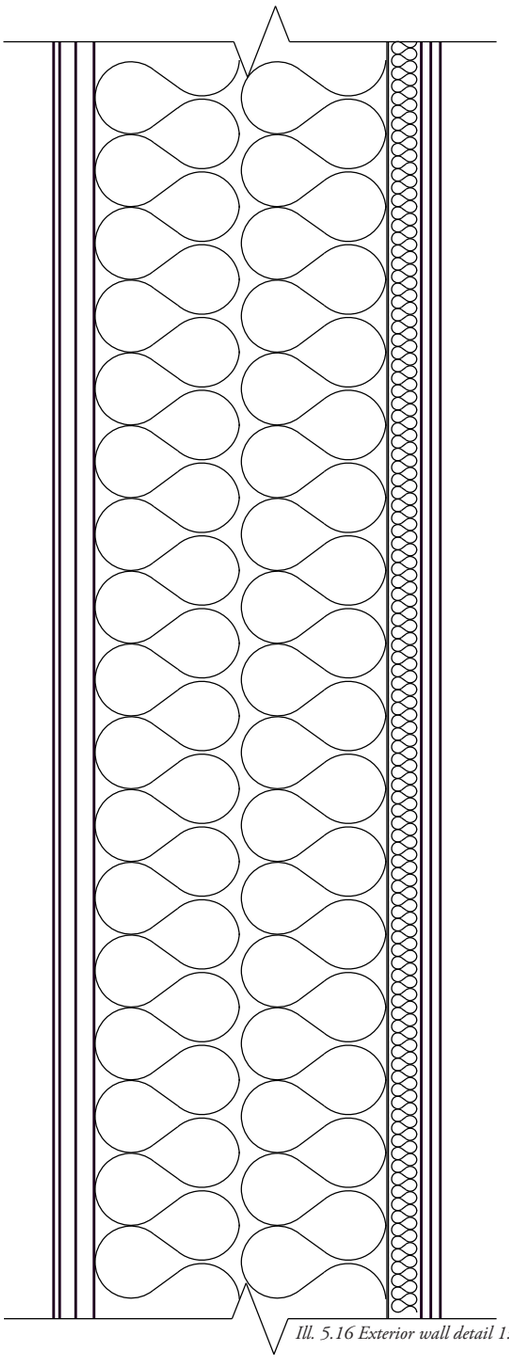
Similarly, Dr. A van Ness states: *"Norberg-Schulz gives particular attention to the wall's doors and windows, which he says play a central role in defining a building's inside-outside relationship"* (Dr. A van Ness, 2012).

As the initial vision of this thesis is to create relations between the different modes, focus is applied to the doors and windows, which is stated by Norberg-Schulz as being fundamental. In collaboration with the previous studies of light in section *'5.3.4 Daylight'* the windows in the living room and the kitchen are acting as French balconies. The balconies are breaking down the boundary of the exterior walls by enhancing a relation to the urban space by framing the life outside.

Through the choice of material and differentiation of transparency in the façade, the different functions in the building are perceived. Thus the façade communicates the potential of the typology, which embraces the combination between social and private spaces.

The façade is constructed of large glass panels where the institution is located, and the remaining façade is constructed of Cembrit fiber cement boards, which emphasize the wall as being non-loadbearing. As stated in the case study *'2.3 Tietgen Dormitory'*, the use of boards breaks down the scale of the façade. The boards chosen are Cembrit PLAN Flint, a solid grey tone, which brightens with time and have a natural color variation and tactility. The boards are strong, require minimal maintenance and each of them can be replaced, should they break or be damaged (Cembrit, 2014).

As a further dimension of the façade, wooden panels are applied, to create a contrast to it, as well as adding warmth to the building. The panels additional function as solar shading, which is assumed needed to prevent over heating during summer. The potential of the panels are also to obtain a façade with depth and a varied expression, which will vary according to season and time of day, as they are operated manually.



Ill. 5.16 Exterior wall detail 1:10

Construction of the wall from the outside in: 8mm Cembrit PLAN, 3mm Cembrit EPDM link, 22mm Supporting battens, 25mm Panel and Wind barrier, 200mm Insulation with shuttering, 200mm Insulation with shuttering, 2mm Vapor barrier, 45mm Insulation with 45x45mm shuttering, 13mm Plasterboard,13mm Plasterboard

Ill. 5

"A building's walls are particularly significant because they are the major architectural element marking private and public space. The wall is the "face" of the building where private and public worlds typically meet. Norberg-Schulz points out that inner and outer "forces" meet in the wall—it is there that architecture takes place" (Dr.A van Ness 2012 p 1)

PRESENTATION
SOLINSIEME: ALONE -TOGETHER

Chapter 6
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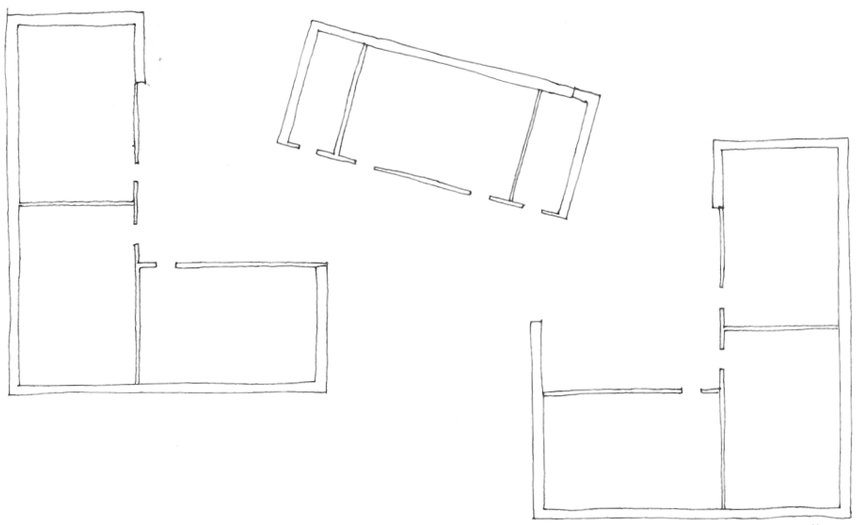
Ill. 6.1

The grid – generating the columns – generating the folding wall



Ill. 6.2

Ill. 6.3: Site plan 1:1000 N

6.1 Urban space

The site plan communicates the relation to the courtyard, through the stairs which emanates from the folding wall in the institution. Further the relation to the surrounding activities in the development plan is perceived as the courtyard opens up to invite people in. Inside the courtyard 'Grow Your City' and the square towards East further underlines the public atmosphere.

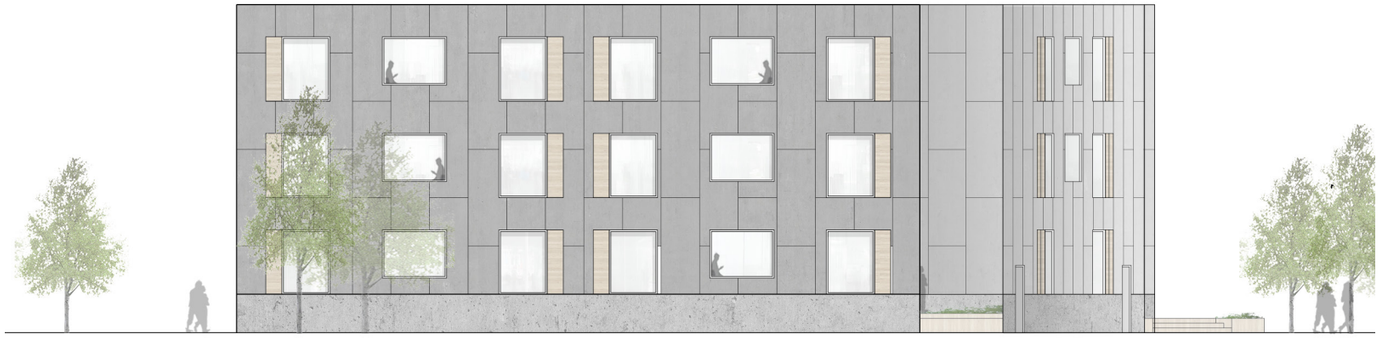
6.2 Façade

Through material and differentiation of transparency in the façade, the different functions in the building are perceived. Thus the façade communicates the potential of the typology, which embraces the combination between social and private spaces.

The grey Cembrit fiber cement boards break down the scale, as the elements are arranged in vertical bands, thus further provide verticality to the building. The wooden panels are applied, to create a contrast to the grey tone of the fiber cement; hence they add warmth to the colors of the building.

Ill. 6.4: East facade 1:200

Ill. 6.5: South facade 1:200



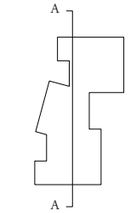
Ill. 6.6: West facade 1:200

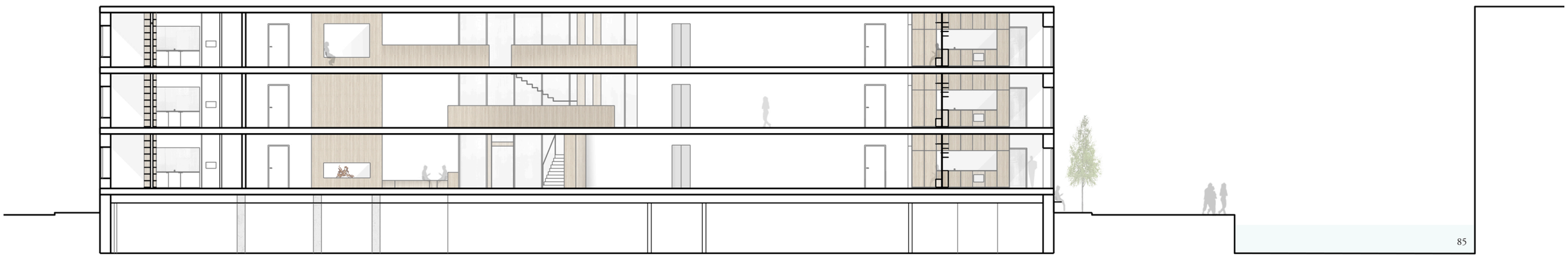
Ill. 6.7: North facade 1:200

6.3 Sections

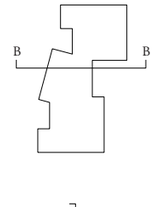
The sections clearly shows the potential of the folding wall, which is perceived in its movement throughout the building. It creates relations between the houses and the institution in terms of material and detailing. The qualities of the wall are further seen in the different functions applied to it, as well as its spatial potential. Furthermore the wall clearly indicates the axis and enhances the ascending movement up the stairs, as the cladding guides from ground floor to second floor.

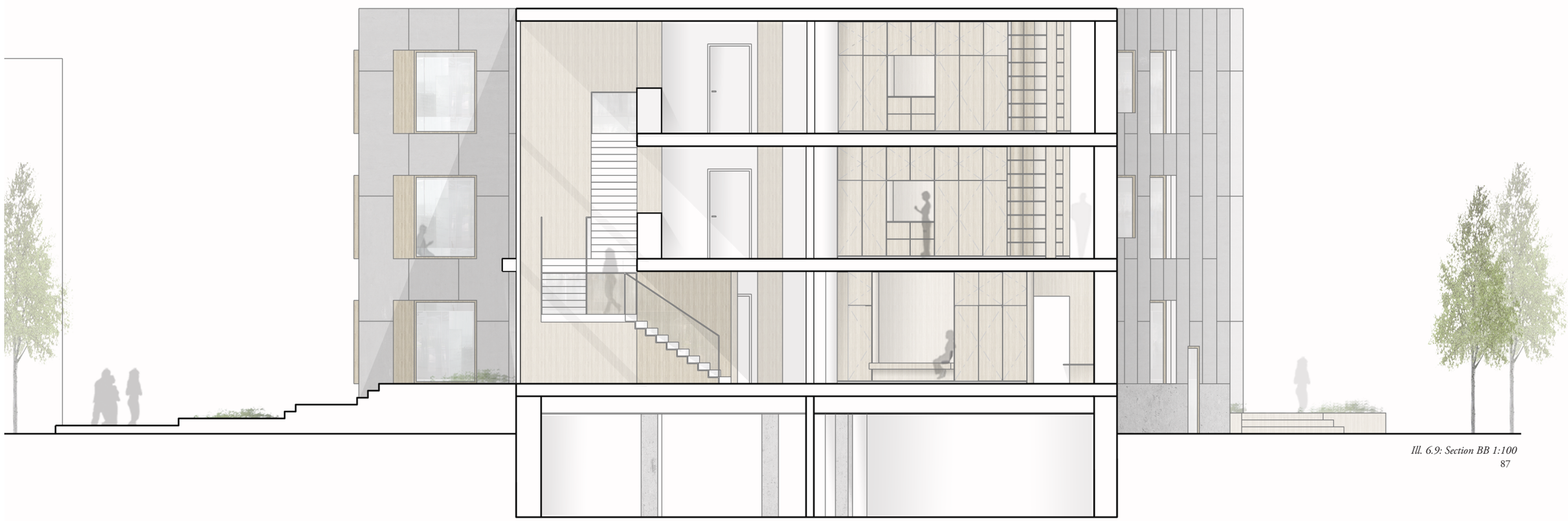
The high ceiling in the entrance provides an overview of the movement through the building and also lets people get a glimpse of what is going on the other floors as the openings are extended to the common kitchen and the hobby room on the third floor. Thereby an enhanced feeling of being one institution is achieved, together with an encouragement to participate in social life is provided.





Ill. 6.8: Section AA 1:200





Ill. 6.9: Section BB 1:100

Ill. 6.10

6.4 Ground floor plan

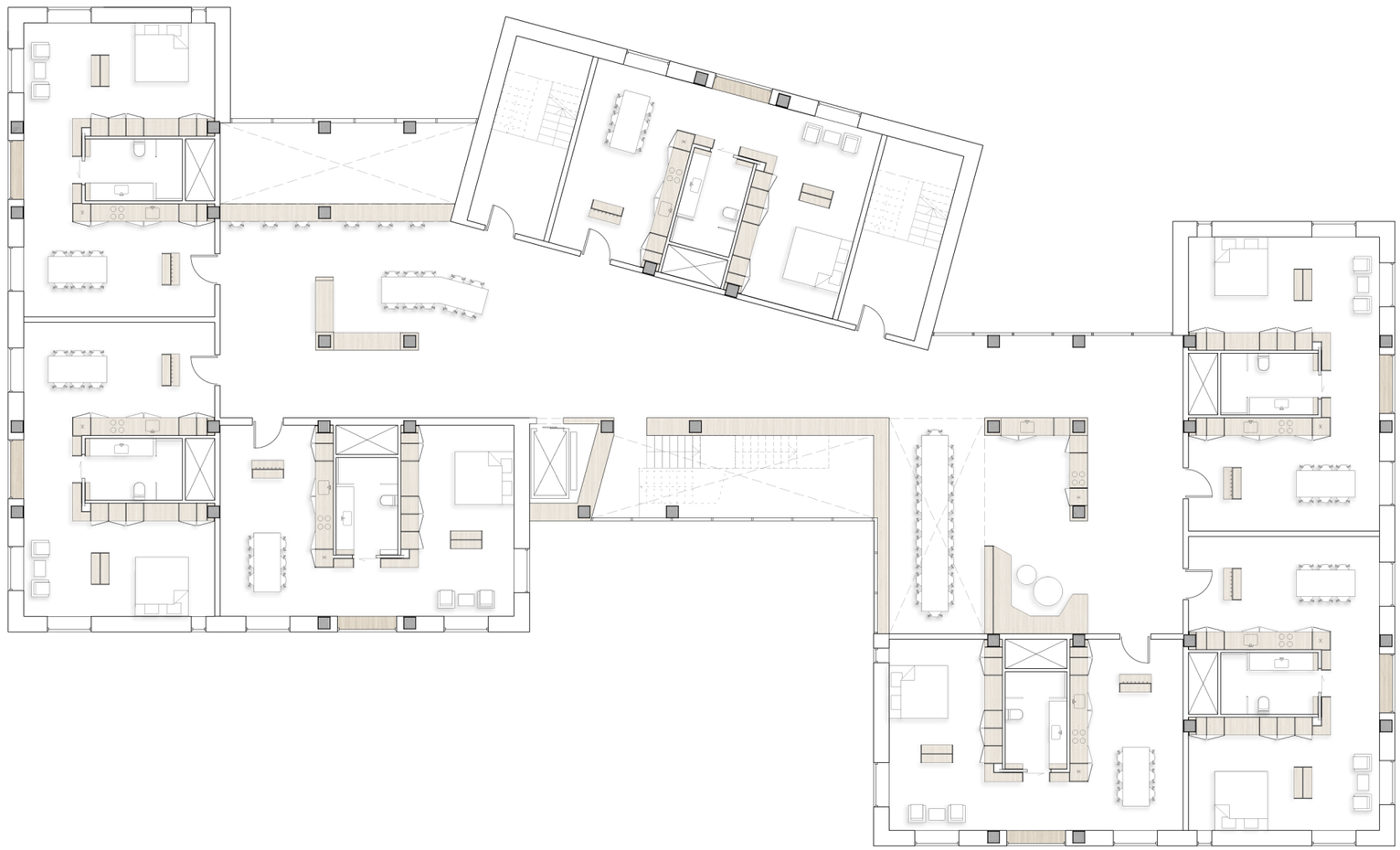
The floor plan underlines the relation from the institution to the urban space, through the stairs, which reach out into the courtyard and the green line towards North. The stairs end in terraces that serve as a gradual transition from the institution to urban space and thus they are semi-public. The stairs have integrated planters, containing plants according to how they are exposed to the sun. Thus the stairs towards North has Golden Strawberries, small yellow flowers, which are compatible with this orientation and shading.

The institution on the ground floor includes the main gathering room, through the living room that provides the opportunity to meet in an informal and relaxed atmosphere. From the main entrance, it is possible to look into the living room and the integrated fireplace, thus encouraging the aspiration to gather and socialize with the other residents.

At the other entrance, the cladding of the wall forms an integrated sitting space for two persons, who can read with the newspaper or a book. Further the folding of this wall guides the residents and visitors towards the center of the institution and the stair.

Ill. 6.11: Plan ground floor 1:200

Ill. 6.12

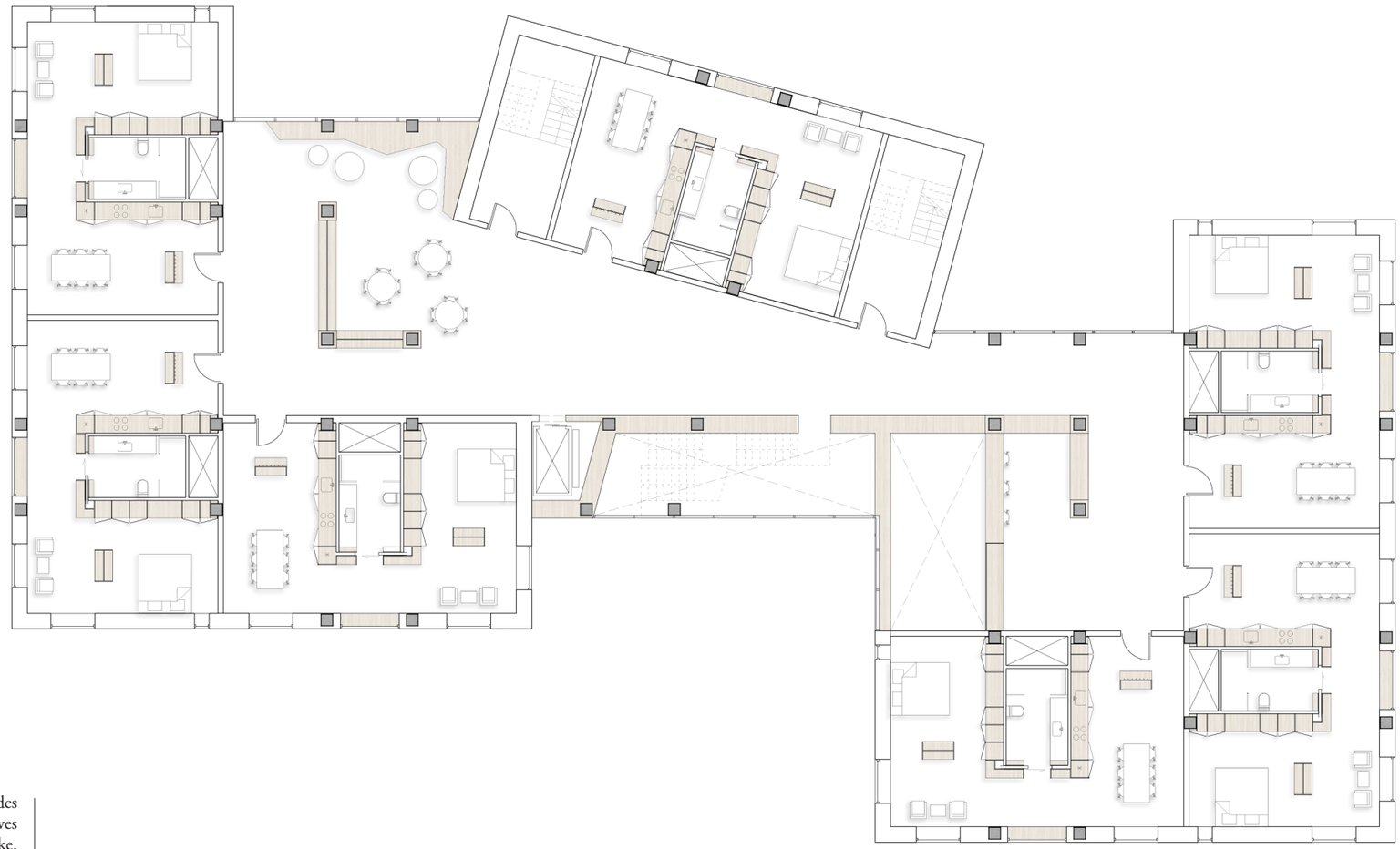


6.5 1st floor plan

The institution on the first floor contains a hobby room, with shelves and desks for creative activities. In the hobby room the wall becomes a long desk, with the orientation towards the green line, which can be observed through the glass façade of the entrance. Further the institution of the first floor includes a common kitchen, which permits gatherings of all the residents of the institution or larger gatherings for family and friends.
The kitchen is double height and is placed next to the facade facing the courtyard, hence a relation between is obtained, as well as good daylight conditions. Through the wall coming out from the house next to the kitchen, a smaller spaciousness is created, thus allowing for smaller gatherings as well.

Ill. 6.13: 1st floor 1:200 N

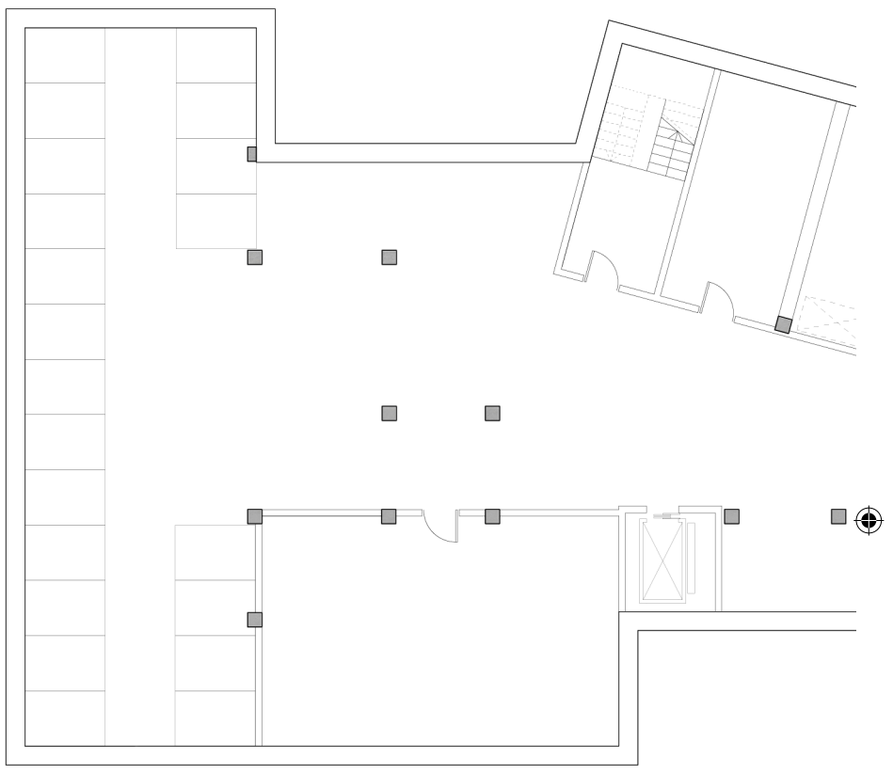
Ill. 6.14



6.6 2nd floor plan

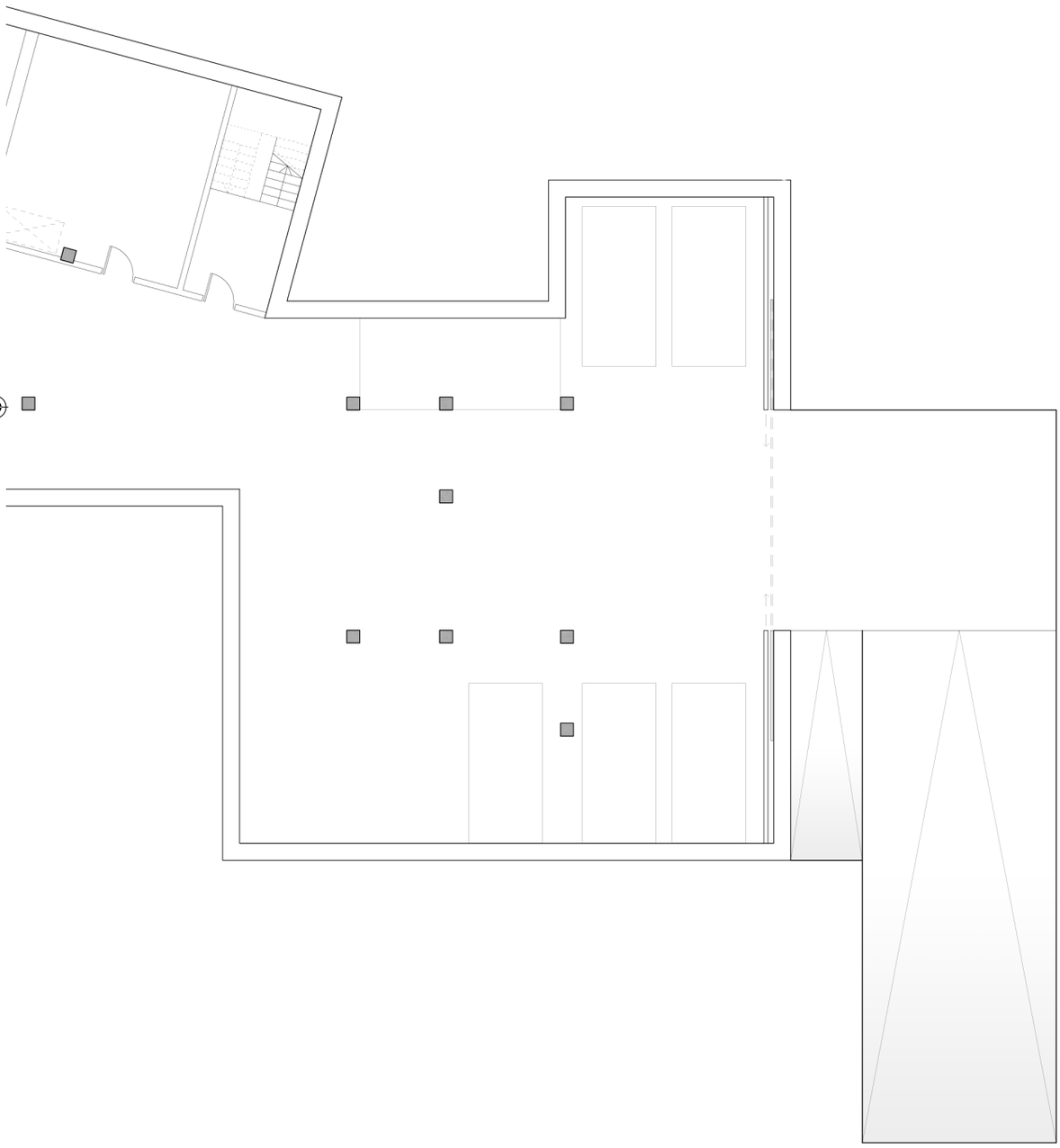
On the second floor the institution includes a library with an integrated sofa and shelves for common books, magazines and alike. Further a second hobby room is integrated with a view from the desk to the kitchen below, as well as the courtyard. On the backside of the wall facing North a sitting place is integrated in the cladding, hence the residents can inhabit the wall and enjoy a view to the green line and the city of Fredericia behind. The wall in the kitchen below is continued up in the hobby room and thus relates the two floors spatial with each other. Further the detailing and material of the wall clearly shows the relation to the wall of the house, thus provides recognition and a sense of belonging.

Ill. 6.15: 2nd floor 1:200 N



6.7 Basement

The basement holds five parking spaces and bicycle parking, which are reached by ramps. Additional the basement contains private storage for the residents, refuse and technical room.



Ill. 6.16: basement 1:200

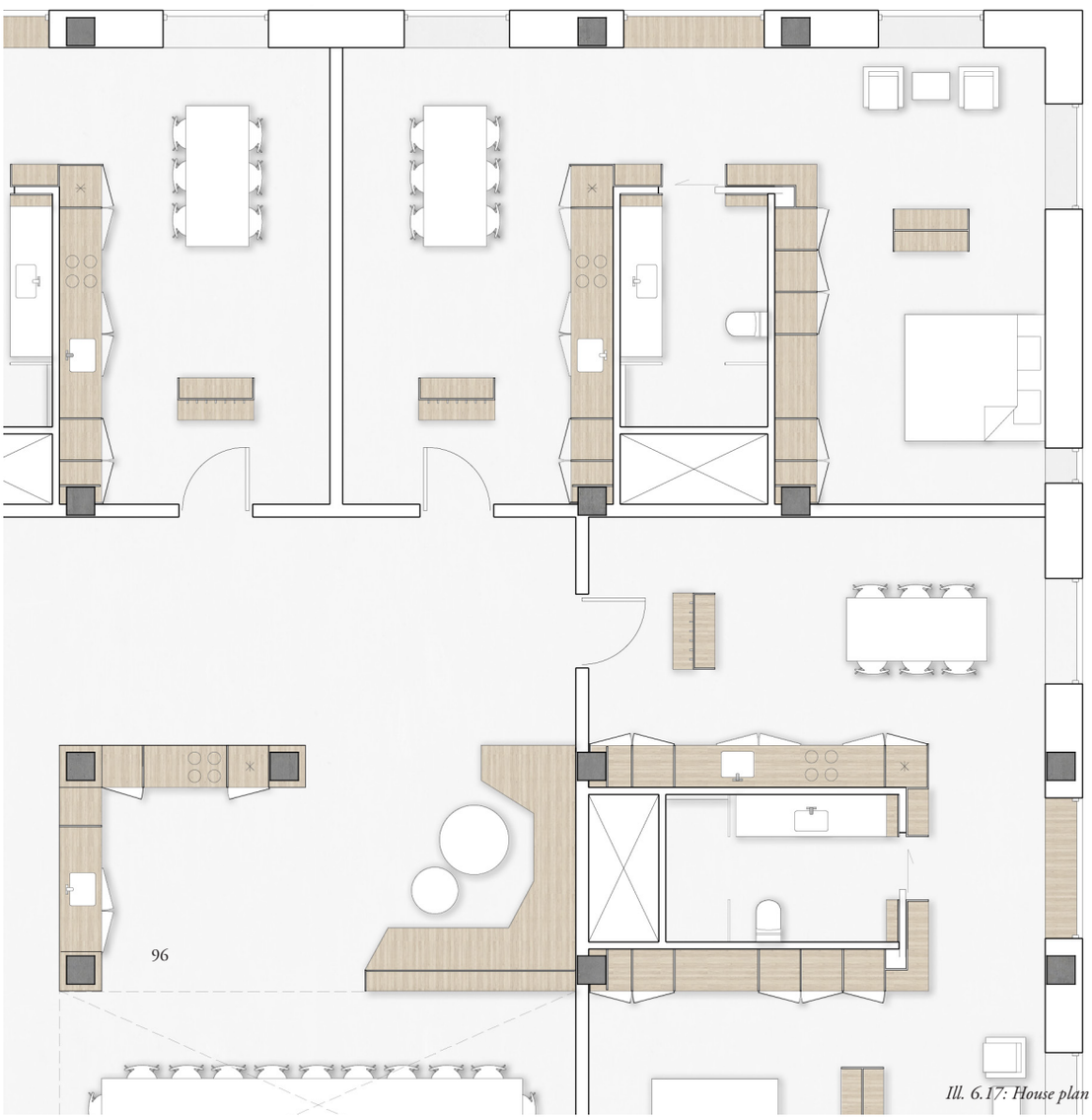
6.8 House

The concept of the wall as being a connecting and recognizable element, as well as its spatial potential, is clearly perceived in the relation between the wall in the institution and the one in the houses.

Thereby the wall amplifies a connection between the levels and gives the feeling of being in one home thought-out the institution. This is achieved through the material and the visible presence throughout. The wooden cladding gives texture and warmth to the surfaces, thus embraces the residents occupying it, hence it addresses sensuousness. The assigned functions corresponds to the rooms, hence the wall provides storage space, wardrobe and a small bench in the bedroom. Additional shelves and a build in table provide spaces for the residents to personalize their home, through storing and display of personal belongings.

Similar the wall of the kitchen contains all the needed functions, space for storage as well as cleaning utensils and washing machine in the scullery behind the partition wall. The partition wall prevents direct views from the institution, hence ensures privacy and a gradual transition to the social areas.

Between the kitchen and the living room, a sitting place is integrated in the window bay. From there life in both in the kitchen and the living room can be observed, as well as the life outside. Opposite the bay window the wall contains shelves, and a subdued transition to the bathroom, which, as the most private space, is placed inside the wall.



Ill. 6.17: House plan 1:100

Ill. 6.18

Ill. 6.18

RECAPITULATION

Chapter 7
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7.1 Reflective conclusion

The aim of the thesis

As stated in *'1.1 Motivation'* it has been an aim for us through this thesis, to develop a comprehension on architecture, amongst, how it has the potential to influence human beings and how dwelling is achieved. Throughout the process, this ongoing exploration has been informed by gathered knowledge from the five years of studying at Architecture and Design at AAU. This complies with our aim of this master thesis, as being a toolbox of accumulated knowledge, gathered through a hodgepodge of different experiences, semester projects, courses and so on, thus preparing us for our architectural careers.

The realm of the thesis

By treating the theme of creating dwellings for elderly, a new but relevant theme in the architectural practice is addressed. Relevant in the sense that, as referred to in the motivation, in the future, the elderly population is rapidly increasing as a result of i.a. an increasing life expectancy. This knowledge, together with the fact that elderly people are healthier and thus more active than ever, laid the initial foundation for this thesis and gave us the opportunity to delve into how elderly people live today and how we think they ought to live. Therefore we started to investigate the contemporary living conditions of elderly, through the current state of research in this area by Mary Ann Knudstrup et. al., and hence addressed, how this complied with the good dwelling. This resulted in the recognition that, although the research on this area is thorough and include many important aspects, it is however mainly concerned with the functional and practical demands of a dwelling for this age group. Therefore it was soon clear to us that the need for a rereading of the appropriate dwelling for elderly was necessary.

This led to curiosity about what the good dwelling is and how the notion of dwelling influences our lives in general. Hence, this further raised the issue of how we as architects design dwellings today and chose to balance the immeasurable and the measurable qualities of architecture.

Theories and methodology of the thesis

In that relation, through the defined tectonic approach, to us the immeasurable and measurable qualities of architecture should both be treated to obtain a tectonic outcome. Accordingly to ensure, that both the technical, functional and practical demands are meet, to the same extent as must sensuousness, the human scale and implementation of different atmospheres. This approach further allowed us to work simultaneously on immeasurable and measurable qualities, hence assured an integrated design process, with iterations as the process progressed. This is reflected in the way, in which we have included calculations, especially the structural grid, in our design process. Also the way we used detailed drawings of the presentation emphasize this convergence of the structural engineering and the design proposal.

Addressing the notion of dwelling, through the studies of Christian Norberg-Schultz, expressed in *'The Concept of Dwelling'*, where he introduces his four architectural levels, their related modes and two aspects of dwelling, this informed us on how dwelling can be achieved. Hence, this laid basis for understanding the theory, why it became evident to us that, to make it possible to rejoice the pleasure of dwelling, all levels, modes and aspects must be comprised in an interrelationship, this further motivated our interest in how to obtain the relation between the levels, which influenced the form of the new typology, as well as introduced the concept of the folding wall.

Studying cases, which respectively exemplified each of Norberg-Schulz's levels (house, institution, urban space), through the

method of Simon Unwin, this enabled us to understand and identify relevant architectural means applied in the cases to be able to extract the principles that could be transferred to our project. The method of using hand drawings, along with photos, helped us in understanding the cases along with a better understanding of our own project.

The field trip to Fredericia and the interviews with FredericiaC and Senior Bo created an awareness of the site, its possibilities and the scale of the chosen plot, as well as ensured us further in the need of creating a new social typology for elderly.

The potential of the thesis

The study on elderly and the notion of dwelling led us to realize that the dwellings for elderly should; *"… be much more than a place, where maintenance and mobility in and outside the house, are the generating factors. It should be a place, which is carefully detailed, so one is able to dwell and is encouraged to keep living an active and participating life; a place for both encounters and refuge*" (1.2 Introduction, p.11). Therefore, through the tectonic approach we defined a new typology, which encompass both social and private atmospheres and in that way both allows for social gatherings as well as makes room for privacy.

Through readings on the theories of Gottfried Semper, the significance of the wall was studied and further evolved our understanding of tectonics, as being both the architectural means of structure and construction, along with the embracing gesture of a cladded wall when inhabiting it. In this way, we have learned how different scales can inform one another, thus achieving an enhancement of the both.

Hence, introducing the concept of the folding wall, the link between the house, the institution and the urban space was emphasized and thereby a sense of belonging and connection is achieved.

Using the grid as the guiding element, in the achievement of obtaining the dual qualities of the wall, undoubtedly gave us some restrictions, but at the same time guided us in the right direction. However, we came to understand that we often chose restricted choices with the most obstacles, though we like to believe that this led to sound discussions and rethinking, as well as led to questions on tectonics and our position on this.

In the beginning of the project we asked how we get beyond the present state of how we treat elderly. We believe that this proposal offers some qualities, especial in relation to the social potential of living together in a common house, however still with a private home to retreat to, as stated in the opening quote by Norberg-Schulz, and here as an extract from it; *"… To participate we have to leave the house and choose a path. When our social task is accomplished, however, we withdraw to our home to recover our personal identity…"* (Norberg-Schulz, 1985, p.8).

Consequently, the proposal offers the immeasurable qualities of dwelling, a high level of detailing, along with the relation between the levels, which enhance the transition between them and consequently participation in the institution and urban space. Hence, the result is not just a home or a social housing complex, it offers something more. If not the perfect solution, it offers a proposal on how elderly ought to live in the future and has laid the ground for a discussion on this subject, a discussion, which will be necessary in the near future.

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7.3 Illustrations

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(retracted 24.02.2014).

2.7 http://www.panoramio.com/photo/3476006
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4.1 www.kcap.eu
(retracted 04.02.2014)

4.2 www.kcap.eu
(retracted 06.02.2014)

4.3 www.dmi.dk
(retracted 17.02.2014)

4.4 www.dmi.dk
(retracted 17.02.2014)

4.5-8 www.kcap.eu
(retracted 04.02.2014)¨

4.9 On the basis of material from FredericiaC

5.11 On the basis of material from PLYSTUDIO + Stzernstudio

6.3 On the basis of material from FredericiaC

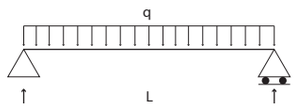
All other illustrations are own, and are not to be redistributed.

APPENDIX

Chapter 8
PAGE 106-118

8.1 Dimensioning of beam

Calculation basis:



- Consequence class 2
- Environmental class: passive

Materiale data:
(Jensen, 2011)

Concrete 25: $f_{ck} = 25\ MPa$
Steel – ø16: $f_{yk} = 550\ MPa$

Modulus of elasticity: $E_{sk} = 2 \cdot 10^5\ MPa$

$$E_{sd} = \frac{E_{sk}}{\gamma_s} = \frac{2 \cdot 10^5\ MPa}{1{,}2} = 1{,}6\ \cdot 10^5\ MPa$$

Ultimate limit state:
Allowable troop according to EC2

The concrete design compressive strength:

$$f_{cd} = \frac{f_{ck}}{\gamma_c} \qquad f_{cd} = \frac{25\ MPa}{1{,}4} = 17{,}86\ MPa$$
$$\gamma_c = 1{,}4 \cdot 1 \cdot 1 = 1{,}4$$

The steel design compressive strength:

$$f_{yd} = \frac{f_{yk}}{\gamma_s} \qquad f_{yd} = \frac{550\ MPa}{1{,}2} = 458{,}3\ MPa$$
$$\gamma_s = 1{,}2 \cdot 1 \cdot 1 = 1{,}2$$

Deflection account:

$$h = \frac{1}{20} l = \frac{1}{20} 7900\ mm = 395\ mm$$

Dimensions of the beam

w: 500 mm
h: 400 mm
l: 7900 mm

Prescribed covering layer:
$c_1 = 1{,}5 \cdot ø = 1{,}5 \cdot 16\ mm = 24\ mm$

$d = 400\ mm - \ 24\ mm - \ \frac{16\ mm}{2} = 368\ mm$

Reinforcement area, A_s:

$A_s = 6\ \cdot 16^2\ mm\ \cdot \frac{\pi}{4} = 1206{,}4\ mm^2$

Pressure zone, x:
$x = 1{,}25\ \frac{A_s \cdot f_{yd}}{w \cdot f_{cd}} = 1{,}25 \frac{1206{,}4\ mm^{\ 2} \cdot 458{,}3\ MPa}{500\ mm \cdot 17{,}86\ MPa} = 77{,}4\ mm$

Strain zone, ε:
Concrete $\ \varepsilon_{cu} = 0{,}35\ \%$
Reinforce $\ \varepsilon_y \leq \ \varepsilon_s < \varepsilon_{uk}$

$\frac{\varepsilon_{c,u}}{\varepsilon_s} = \ \frac{x}{(d-x)}$

⇳

$\varepsilon_s = \ \frac{d-x}{x} \cdot \varepsilon_{c,u} = \frac{368\ mm - 77{,}4\ mm}{77{,}4\ mm} \cdot 0{,}35\ \% = 1{,}3\ \%$

$\varepsilon_y = \frac{f_{yd}}{E_{sd}} = \frac{458{,}3\ MPa}{1{,}6 \cdot 10^5} = 0{,}28\ \%$

$0{,}28\ \% \ \not\leq 2{,}3\ \% \ < 10\ \%$

Bending moment, M_{rd}:

$M_{rd} = A_s \cdot f_{yd}(d - 0{,}4 \cdot x)$
$M_{rd} = 1206{,}4\ mm\ \cdot 458{,}3\ MPa(368\ mm - 0{,}4 \cdot 77{,}4\ mm) = 183{,}6\ kNm$

Loads:

Dead load
$g_{beam} = 2650\ \frac{kg}{m^3}\ \cdot 0{,}4\ m \cdot 0{,}4\ m \cdot 9{,}82 \frac{N}{kg} = 4{,}2\ \frac{kN}{m}$

$g_{deck} = 1350\ \frac{kg}{m^3}\ \cdot 4{,}9\ m \cdot 0{,}2\ m \cdot 9{,}82 \frac{N}{kg} = 13\ \frac{kN}{m}$

$$g_{total} = 4{,}2\frac{kN}{m} + 13\frac{kN}{m} = 17{,}2\frac{kN}{m}$$

Live load

$$q = 3\frac{kN}{m^3} \cdot 4{,}9\,m \cdot 0{,}2\,m = 2{,}94\frac{kN}{m}$$

Load combination, Pd:

$$Pd = 1{,}0 \cdot g + 1{,}2 \cdot q = 1{,}0 \cdot 17{,}2\ \frac{kN}{m} + 1{,}2 \cdot 2{,}94\ \frac{kN}{m} = 20{,}7\frac{kN}{m}$$

Moment, M_{sd}:

$$M_{sd} = \frac{1}{8} \cdot pd \cdot l^2 = \frac{1}{8} \cdot 20{,}7\frac{kN}{m} \cdot 7{,}9^2 m = 161{,}5\ kNm$$

$$M_{sd} \leq M_{rd} = 161{,}6\ kNm < 183{,}6\ kNm$$

Service limit state:
The beam is studied according to the load combination 1.0 EC1. The partial coefficients are 1.

$$Pd = 1 \cdot g + 1 \cdot q = 1 \cdot 17{,}2\ \frac{kN}{m} + 1 \cdot 2{,}94\ \frac{kN}{m} = 20{,}14\frac{kN}{m}$$

Permitted deflection:

$$u = \frac{l}{400} = \frac{7900mm}{400} = 19{,}75mm$$

Deflection according to permanent long-term load:

$$P_1 = g + \psi_2 \cdot q = 1 \cdot 17{,}2\ \frac{kN}{m} + 0{,}5 \cdot 2{,}94\ \frac{kN}{m} = 18{,}67\frac{kN}{m}$$

Gathering areas: $\psi_2 = 0{,}5$
(Jensen 2011 p.166)

Moment:

$$M_{sd} = \frac{1}{8} \cdot Pd \cdot l^2 = \frac{1}{8} \cdot 18{,}67\frac{kN}{m} \cdot 7{,}9^2 m = 145{,}7\ kNm$$

$$\alpha p = \alpha_\infty \left(\frac{A_s}{bd}\right) = 34\left(\frac{1206{,}4mm^2}{500mm \cdot 368mm}\right) = 0{,}22$$

$\alpha_\infty = 34$
(Jensen 2011, p.200)

Values extracted from table 5.21 (Jensen 2011, p.208).

$\varphi_b = 0{,}196$
$\beta = 0{,}463$
$\gamma = 1{,}158$

Tension

$$\sigma_c = \frac{M}{\varphi_b \cdot b \cdot d^2} = \frac{145 \cdot 10^6}{0{,}196 \cdot 500mm(368mm)^2} = 10{,}9\ MPa$$

$$\sigma_s = \alpha \cdot \gamma \cdot \sigma_c = 34 \cdot 1{,}158 \cdot 10{,}9 = 429\ MPa$$

Neutral axis depth

$$x = \beta \cdot d = 0{,}463 \cdot 368mm = 170mm$$

Deflection

$$u_c = \frac{1}{10} \cdot \alpha \frac{|\sigma_{max}|}{E_s \cdot x} l^2 = \frac{1}{10} \cdot 34 \frac{10{,}9\ MPa}{2 \cdot 10^5\ MPa \cdot 170mm} \cdot 7900^2 = 68\ mm$$

The beam is not dimensioned sufficient with a deflection of 68 mm, where the permitted is 20 mm.

8.2 Loads

Live load, q:

The live load for respectively apartment and access ways are:

Apartments, $q = 1{,}5\ \frac{kN}{m^3}$
Stairs and local access ways, $q = 3\ \frac{kN}{m^3}$
The live load applied to the Robot model is $3\ \frac{kN}{m^3}$, as the surface is one whole.

Snow load, s:

$$s = \mu_i \cdot C_e \cdot C_t \cdot s_k = 0{,}8 \cdot 1 \cdot 1 \cdot 0{,}9 \frac{kN}{m^2} = 0{,}72\ \frac{kN}{m^2}$$

μ_i, Form factor = 0,8 then roof pitch $0° \leq \alpha \leq 30°$
C_e, Exposure factor =1
C_t, Thermic factor = 1
s_k, Characteristic value of the terrain = $0{,}9\ \frac{kN}{m^2}$

(Jensen 2011, p. 168)

Wind load, :
Factor of terrain, k_r:

$$k_r = 0{,}19 \left(\frac{z_0}{z_{0,11}}\right)^{0{,}07} = 0{,}19 \left(\frac{1\ m}{0{,}05\ m}\right)^{0{,}07} = 0{,}23$$

Terrain category IV, a place where the high of the buildings in average are above 15 m and 15 % of the surface is covered by buildings.

z_0, Length of roughness = 1 m
$z_{0,II}$, Length of roughness category II = 0,05

(Jensen 2011 p. 169)

Peak wind load,

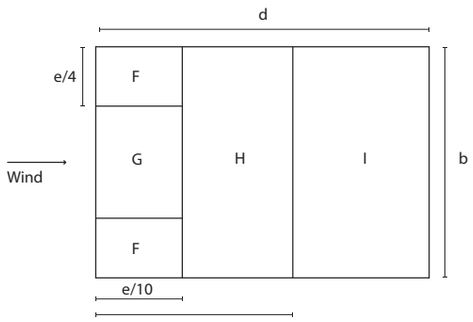
$$q_p(z) = \left(1 + \frac{7}{\ln\left(\frac{z}{z_0}\right)}\right)\frac{1}{2} \cdot \rho \left(v_b \cdot k_r \cdot \ln\left(\frac{z}{z_0}\right)\right)^2$$

$$q_p(z) = \left(1 + \frac{7}{\ln\left(\frac{11}{1}\right)}\right)\frac{1}{2} \cdot 1{,}25\ \frac{kg}{m^3}\left(23\frac{m}{s} \cdot 0{,}23 \cdot \ln\left(\frac{11}{1}\right)\right)^2 = 0{,}43\ \frac{kN}{m^2}$$

v_b, Speed of the wind = $24\ \frac{m}{s}$
z, Height of construction = 11 m

ρ, Density of the air = $1{,}25\,\frac{kg}{m^3}$
Form factor, distribution of wind pressure on the roof

The form of the building and roof is assumed as a rectangle:



e = the smallest of wide or two times the height.

Windforce, F_w:

$$F_w = C_{scd} \cdot cf \cdot q_p(z) \cdot A_{ref}$$

Extracted from table 7.2 EC1 p 99:
$cf(F) = -1{,}20$
$cf(G) = -0{,}80$
$cf(H) = -0{,}70$
$cf(I) = -0{,}20$

(Dansk standard, 2010)

$$F_w(F) = C_{scd} \cdot cf \cdot q_p(z) \cdot A_{ref} = 1 \cdot -1{,}2 \cdot 0{,}43\,\frac{kN}{m^2} \cdot 12{,}1m^2 = -6{,}24\ kN$$

$$F_w(F) = C_{scd} \cdot cf \cdot q_p(z) \cdot A_{ref} = 1 \cdot -0{,}8 \cdot 0{,}43\,\frac{kN}{m^2} \cdot 37{,}4m^2 = -12{,}87\ kN$$

$$F_w(F) = C_{scd} \cdot cf \cdot q_p(z) \cdot A_{ref} = 1 \cdot -0{,}7 \cdot 0{,}43\,\frac{kN}{m^2} \cdot 246{,}4m^2 = -74{,}17\ kN$$

$$F_w(F) = C_{scd} \cdot cf \cdot q_p(z) \cdot A_{ref} = 1 \cdot -0{,}2 \cdot 0{,}43\,\frac{kN}{m^2} \cdot 1008m^2 = -86{,}69\ kN$$

$$F_w = 186{,}21\ kN$$

$$F_w = \frac{186{,}21\ kN}{1316\ m^2} = 0{,}14\,\frac{kN}{m^2}$$

Load combinations:

With live load being the dominating:

$$1 \cdot K_{FI} \cdot g + 1{,}5 \cdot \alpha_n \cdot K_{FI} \cdot q + 1{,}5 \cdot 0{,}3 \cdot K_{FI} \cdot S_k + 1{,}5 \cdot 0{,}3 \cdot K_{FI} \cdot w_k$$

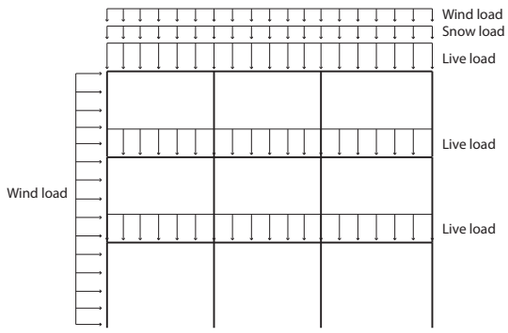
$$1 \cdot 1 \cdot g + 1{,}5 \cdot 0{,}8 \cdot 1 \cdot q + 1{,}5 \cdot 0{,}3 \cdot 1 \cdot S_k + 1{,}5 \cdot 0{,}3 \cdot 1 \cdot w_k$$

$$1 \cdot g + 1{,}2 \cdot q + 0{,}45 \cdot S_k + 0{,}45 \cdot w_k$$

Consequence class 2
K_{FI} = 1,0

$$\alpha_n = \frac{1+(n-1)\psi_0}{n} = \frac{1+(2-1)\cdot 0{,}6}{2} = 0{,}8$$

n = 2, because there are 2 stories above.



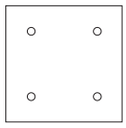
8.3 Dimensioning of column

Calculation basis:

- Consequence class 2
- Environmental class: passive

Dimensions of the column:

w: 400 mm
h: 400 mm
l: 2700 mm



Materiale data:
(Jensen 2011)

Concrete 25: $f_{ck} = 25\ MPa$
Steel – Ø16: $f_{yk} = 550\ MPa$

Modulus of elasticity: $E_{sk} = 2 \cdot 10^5\ MPa$

$$E_{sd} = \frac{E_{sk}}{\gamma_s} = \frac{2 \cdot 10^5\ MP}{1{,}2}$$

Allowable troop according to EC2

The concrete design compressive strength:

$$f_{cd} = \frac{f_{ck}}{\gamma_c} \qquad f_{cd} = \frac{25\ MPa}{1{,}4} = 17{,}86\ MPa$$
$$\gamma_c = 1{,}4 \cdot 1 \cdot 1 = 1{,}4$$

The steel design compressive strength:

$$f_{yd} = \frac{f_{yk}}{\gamma_s} \qquad f_{yd} = \frac{550\ MPa}{1{,}2} = 458{,}3\ MPa$$
$$\gamma_s = 1{,}2 \cdot 1 \cdot 1 = 1{,}2$$

Ultimate limit state:

Slenderness ratio, λ:

$$\lambda = \frac{l}{\sqrt{\frac{I}{A}}}$$

⇳

$$\lambda = \frac{l\sqrt{12}}{h} = \frac{2700\ mm\sqrt{12}}{400} = 23{,}4$$

The reinforcement ratio, ρ:

$$\rho = \frac{A_{sc}}{A_c} = \frac{4 \cdot 16^2 \cdot \frac{\pi}{4}}{400 \cdot 400} = 0{,}5\ \% \begin{Bmatrix} \geq 0{,}2\% \\ \leq 4{,}0\ \% \end{Bmatrix}$$

Beginning modulus of elasticity, $E_{0,crd}$:

$$E_{0,crd} = \begin{Bmatrix} 1000\ \cdot\ f_{cd}\ for\ f_{cd} \leq 25\ MPa \\ 0{,}75\ \cdot\ E_{0d}\ for\ f_{cd} > 25\ MPa \end{Bmatrix}$$

Where:

$$E_{0d} = \frac{51000}{y_c} \cdot \frac{f_{ck}}{f_{ck}+13} = \frac{51000}{1{,}4} \cdot \frac{25}{25+13} = 23966\ MPa$$

$$E_{0,crd} = \begin{Bmatrix} 1000\ \cdot\ 17{,}86 = 17860\ MPa \\ 0{,}75\ \cdot 23966 = 17974\ MPa \end{Bmatrix}$$

Critical tension, σ:

Concrete

$$\sigma_{crd} = \frac{f_{cd}}{1+\frac{f_{cd} \cdot \lambda^2}{\pi^2 \cdot E_{0,crd}}} = \frac{17{,}86\ MPa}{1+\frac{17{,}86\ MPa \cdot 23{,}4^2}{\pi^2 \cdot 17860}} = 16{,}9\ MPa$$

The relationship between reinforcement and the concretes modulus of elasticity, $\alpha = 24$

Steel

$$\sigma_s = \alpha \cdot \sigma_{crd} = 24 \cdot 16{,}9\ MPa = 405{,}6\ MPa$$

$$\sigma_s < f_{yd} = 405{,}6\ MPa < 458{,}3\ MPa$$

Column load capacity, N:

$$N_c = A_c \cdot \sigma_{crd} = 400\ mm \cdot 400\ mm \cdot 16{,}9 \cdot 10^{-3} Pa = 2704\ kN$$

$$N_s = A_{sc} \cdot \sigma_s = 804\ mm^2 \cdot 405{,}6 \cdot 10^{-3} = 326\ kN$$

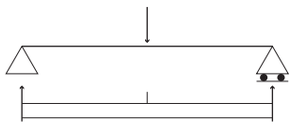
$$N_{cr} = N_c + N_s = 2704\ kN + 326\ kN = 3030\ kN$$

The force extracted from robot on the most exposed and critical column is: $1074\ kN$.
Thus the column is dimensioned to hold.

8.4 Dimensioning of beam in basement

Calculation basis:

- Consequence class 2
- Environmental class: passive



Material data:
(Jensen 2011)

Concrete 25: $f_{ck} = 25\ MPa$
Steel – ø16: $f_{yk} = 550\ MPa$

Modulus of elasticity: $E_{sk} = 2 \cdot 10^5\ MPa$

$$E_{sd} = \frac{E_{sk}}{\gamma_s} = \frac{2 \cdot 10^5\ MPa}{1{,}2} = 1{,}6\ \cdot 10^5\ MPa$$

Ultimate limit state:
Allowable troop according to EC2

The concrete design compressive strength:

$$f_{cd} = \frac{f_{ck}}{\gamma_c} \qquad f_{cd} = \frac{25\ MPa}{1{,}4} = 17{,}86\ MPa$$
$$\gamma_c = 1{,}4 \cdot 1 \cdot 1 = 1{,}4$$

The steel design compressive strength:

$$f_{yd} = \frac{f_{yk}}{\gamma_s} \qquad f_{yd} = \frac{550\ MPa}{1{,}2} = 458{,}3\ MPa$$
$$\gamma_s = 1{,}2 \cdot 1 \cdot 1 = 1{,}2$$

Deflection account:

$$h = \frac{1}{20} l = \frac{1}{20} 6{,}9\ m = 0{,}35\ m$$

As the previous beam calculation resulted in the beam being under dimensioned, then the dimensions of this beam is:
w: 500 mm
h: 500 mm
l: 6900 mm

Prescribed covering layer:
$c_1 = 1{,}5 \cdot ø = 1{,}5 \cdot 16\ mm = 24\ mm$

$$d = 500\ mm - \ 24\ mm - \frac{16\ mm}{2} = 468\ mm$$

Reinforcement area, A_s:

$$A_s = 6\ \cdot 16^2\ mm\ \cdot \frac{\pi}{4} = 1206{,}4\ mm^2$$

Pressure zone, x:

$$x = 1{,}25\ \frac{A_s \cdot f_{yd}}{w \cdot f_{cd}} = 1{,}25\ \frac{1206{,}4\ mm^2 \cdot 458{,}3\ MPa}{500\ mm \cdot 17{,}86\ MPa} = 77{,}4\ mm$$

Strain zone, ε:
Concrete $\varepsilon_{cu} = 0{,}35\ \%$
Reinforce $\varepsilon_y \leq \ \varepsilon_s < \varepsilon_{uk}$

$$\frac{\varepsilon_{c,u}}{\varepsilon_s} = \frac{x}{(d-x)}$$

$$\Updownarrow$$

$$\varepsilon_s = \frac{d-x}{x} \cdot \varepsilon_{c,u} = \frac{468\ mm - 77{,}4\ mm}{77{,}4\ mm} \cdot 0{,}35\ \% = 1{,}7\ \%$$

$$\varepsilon_y = \frac{f_{yd}}{E_{sd}} = \frac{458{,}3\ MPa}{1{,}6 \cdot 10^5} = 0{,}28\ \%$$

$$0{,}17\ \% \ \leq 2{,}3\ \% \ < 10\ \%$$

Bending moment, M_{rd}:

$$M_{rd} = A_s \cdot f_{yd}(d - 0{,}4 \cdot x)$$
$$M_{rd} = 1206{,}4\ mm\ \cdot 458{,}3\ MPa(468\ mm - 0{,}4 \cdot 77{,}4\ mm) = 241\ kNm$$

Loads:

The load is extracted from the robot model.
$Q = 1074\ kN$

Moment, M_{sd}:

$$M_{sd} = \frac{1}{4} \cdot Q \cdot l^2 = \frac{1}{4} \cdot 1074\ kN \cdot 6{,}9m = 1853\ kNm$$

$$M_{sd} \leq \ M_{rd} = 1853\ kNm \not\leq 241\ kNm$$

It will not be possible to replace a column with a beam in the basement, as the size of the beam would be unacceptable high.