

CONSTANT CHANGE

**EXPLORING ON SITE CIRCULATION OF MATERIAL
THROUGH NEW BUILDING DESIGN**

Ylva Wilder
Master's Thesis at Chalmers School of Architecture

Department of Architecture and Civil Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2017

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CHALMERS

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Cover: Photograph of a concrete wall at Tredje Långgatan © Ylva Wilder, 2017

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abstract

The building sector in Sweden generates approximately 9 million tonnes of material every year. This material is generally referred to as demolition waste and seen as a large problem. A changed view upon waste and the concept of demolition will have large environmental benefits - as a reduced demand for new resources and decreased amounts of waste. Through architecture and design for material circulation, our existing resource system can be challenged. The purpose of this Master's Thesis is to explore how contemporary architecture is influenced by design for circular resource use. Such knowledge can generate perspectives on current design, construction and demolition processes. The aim is to investigate the phenomenon through on site circulation of building material at Tredje Långgatan, Göteborg. This is achieved by exploring how the existing material at the chosen site can be combined with new building design.

This Master's Thesis was carried out as a Research for Design project. The main focus has been the inventory of existing material, the evaluation of reuse potential and the exploration of how to integrate existing and new material. Through this process, nine design strategies were developed to address the opportunities of material circulation and to manage some of the difficulties. These strategies were further tested on site- to illustrate the feasibility by meeting the suggested detail plan proposal for the area. This Master's Thesis shows that on site circulation of material involves many challenges, mainly related to a lack of established procedures and guidelines. Still, this approach highlights the value of resources and gives an opportunity to learn from the existing - possibly leading to more conscious material and design choices.



Detail of one of the existing window frames.

preface

This Master's Thesis of 30 credits was written within the Master's Programme Design for Sustainable development at the Department of Architecture and Civil Engineering, Chalmers University of Technology, Sweden. It was carried out between January and June 2017 with examiner Emílio da Cruz Brandão and supervisor Joaquim Tarrasó.

The project originates from two different perspectives in my educational background – Architecture and the engineering field Industrial Ecology. From my studies in Architecture I have developed a creative and explorative approach to sustainable development and design. Within Industrial Ecology I have studied a more systemic view upon resources and sustainable development. During the last year I have explored the link between these two approaches to sustainability. In the autumn of 2016, I wrote a Master's Thesis in Industrial Ecology where I investigated the relation between design for circular resource use and environmental certification schemes for buildings. I observed a focus on preparation for future circulation of material rather than an actual implementation of reused, remanufactured and recycled material today. My starting point in this project was to contribute to the latter by begin with existing material and explore how to integrate it in new building design. It led to an interesting process and I hope this project can contribute to increased reuse within architecture.

I would like to thank my examiner Emílio da Cruz Brandão and supervisor Joaquim Tarrasó for inspiration and guidance which helped me to define and carry out this Thesis. A large thanks to Siri Ersson at Göteborg City Planning Office for material and support. I would also like to thank Sigillet for giving me the opportunity me conduct the material inventory on site. Lastly, a special thanks to my family for always being there.

June 2017, Göteborg
Ylva Wilder



Copper sheets from the existing facade.

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Bricks from one of the existing facades.

1

INTRODUCTION

After a short introduction to the explored topic, the main purpose and aim of this Thesis are presented. It is followed by the research questions, delimitations and the method used in this project.



A blank slate after demolition.

a blank slate

The building sector in Sweden generates approximately 9 million tonnes of material every year. This material is generally referred to as demolition waste and seen as a large problem. To challenge this view upon resource, various concepts related to circular resource use are increasingly discussed in society as well as within architecture and design. A change towards a more circular resource system creates large environmental benefits - as a reduced demand for new resources and decreased amounts of waste.

As architects, this change can be enhanced by exploring new ways to design buildings as well as considering how to approach buildings which has reach their end of life. Existing buildings consist of large amounts of material which usually not are taken into account after the decision of demolition is taken. Today, the demolition procedure is an efficient and quick approach – leaving a more or less empty space for a new building.

What if some of the building material were to be reused on site? Can the concept of demolition involve more than a blank slate for a new building?

purpose

The purpose of this Master's Thesis is to explore how contemporary architecture is influenced by an increased circular resource use. Such knowledge can generate perspectives on current design, construction and demolition processes. It can also create a discussion about our existing resource system and architecture's role in changing that.

aim

The aim is to investigate on site circulation of building material at Tredje Långgatan, Göteborg. This is achieved by exploring how the existing material at the chosen site can be combined with new building design in the same location.

research questions

The following research questions have been the focus of this Master's Thesis.

*Which are the possibilities related to on site
circulation of building material?*

*Which are the challenges and how can they
be managed to facilitate future circulation?*

delimitations

PRESERVATION

This Master's Thesis is delimited to focus on the process after the decision of demolition is made. It is assumed that some buildings have to be demolished due to their poor condition or to allow for urban development. From this starting point, the project is exploring the concept preservation in relation to future design possibilities rather than to conservation.

BUILDING MATERIAL

A building consists of a large amount of material within different elements, products and components. This project is delimited to focus on the most site specific and permanent building elements – site, structure and skin (which includes facade, roof, windows and external doors).

method

This Master's Thesis has been carried out as a Research for Design project, which means that the research has functioned as a base for the design. This approach is shown in the schematic illustration on next page, the process was in reality considerably more iterative. Through an instrumental case study – the phenomenon of material circulation was explored on a project level. A case should be chosen on the possibility to learn (Stake 1995) and the studied site was such an opportunity. Multiple sources have been used to collect a diverse data to develop the project and the most important ones are presented below.

ON SITE OBSERVATIONS

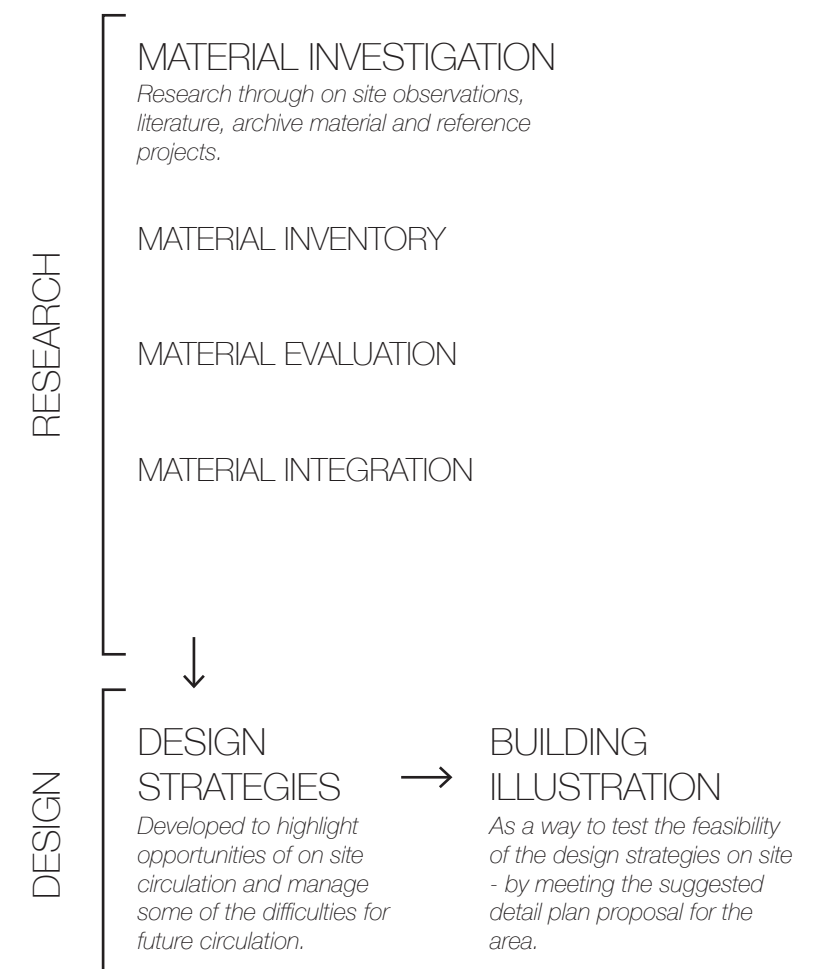
Observations of the studied building were used to collect information about the existing material and how it was constructed. This part of the inventory was supported by photographs, sketches and notes.

LITERATURE AND ARCHIVE MATERIAL

Various types of literature have been used for the background research, for developing the theoretical framework and the evaluation strategy. It has also been an important source of information for the material research. To support the observations on site about the studied building, archive material from Göteborg City Planning Office (SBK, 2017) have had an important role.

REFERENCE PROJECTS

Reference projects within architecture as well design have been an important source of inspiration during the whole process.



Schematic illustration of the research approach.



Demolition waste (or maybe resources?).

2 RESOURCES / WASTE

In this chapter, the resource use and waste production of the building sector is presented. It is followed by the theoretical framework of alternative approaches to the current resource system, such as circular resource use, the waste hierarchy and shearing layers of change.

definitions

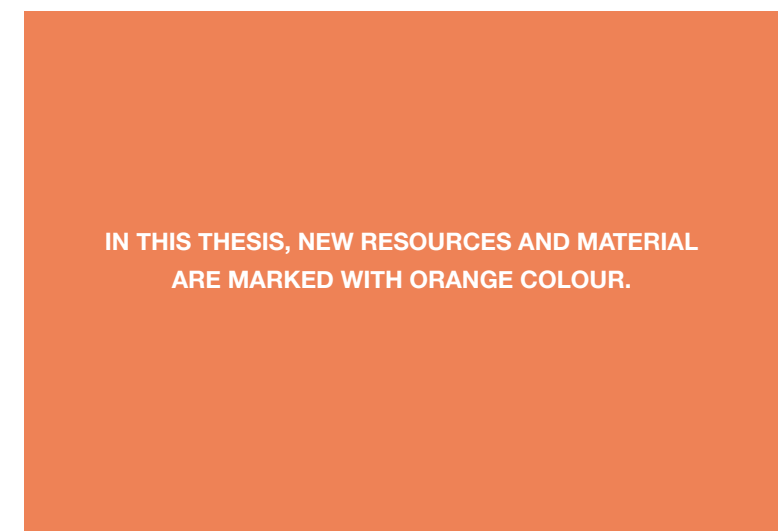
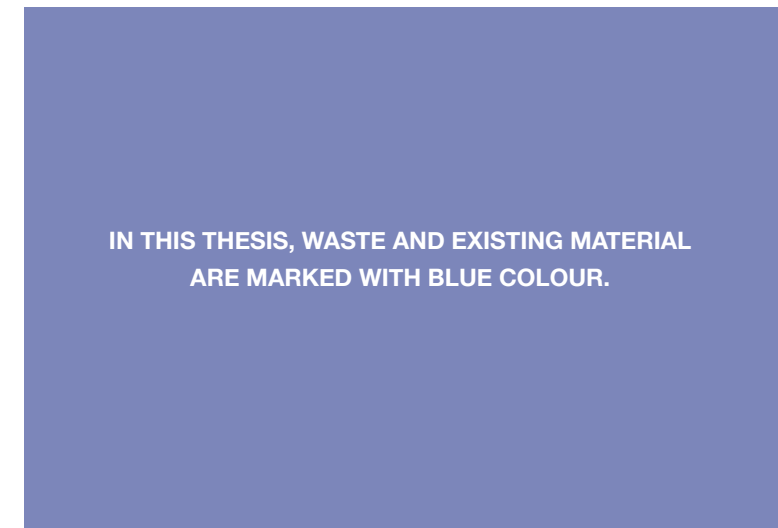
WASTE

In society, there is a common understanding of what the concept of waste represents. According to the Swedish Environmental Code (1998:808) chapter 15, paragraph 1, waste is referred to as “every substance that the holder discards, intends to discard or is obliged to discard” (translated by the author or this Thesis). This is also the definition used in the Swedish Ordinance of waste (SFS 2011). Thus, the generation of waste is dependent on when the owner of a material or object defines it as waste.

Within the building sector, waste is divided into two main types - demolition and construction waste. Demolition waste is generated from the destruction of a building or other structure. Construction waste is the undesired surplus material from a construction process, including the ground preparation.

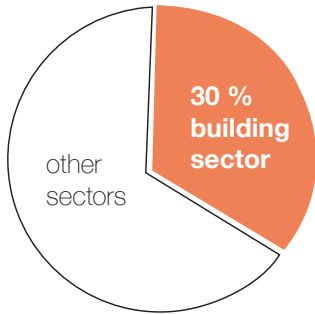
RESOURCES

Resources is a broadly defined concept, depending on the context or theoretical discipline. In this report, a resource is defined as a source or supply from which benefit can be produced (Merriam Webster, 2017). Resources are generally divided into the two categories ‘renewable’ and ‘non-renewable’ material.

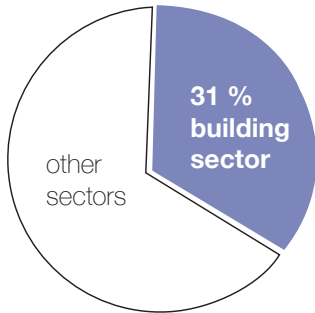


Explanation of the colour coding in the report.

RESOURCE CONSUMPTION
GLOBALLY / YEAR
Source UNEP 2011



WASTE PRODUCTION
SWEDEN / YEAR
Source Naturvårdsverket 2014



Diagrams showing the building sector's global resource consumption and the share of the waste production in Sweden.

the 30% sector

GLOBALLY

Many of today's environmental challenges are directly or indirectly related to our existing resource and waste system. The building industry is considered as one of the most critical sectors as it is responsible for more than 30 % of the global resource consumption (UNEP 2011). UNEP (2011) also estimates that the same share of the total volume of global solid waste can be derived from the construction and demolition processes.

SWEDEN

The figures regarding waste are similar in Sweden and according to Naturvårdsverket (2014), the building sector generates around 9 million tonnes of waste every year. If mining and quarrying is excluded, this represents 31 % of the total waste generated in our society. Statistics from Naturvårdsverket also shows that the total amount of construction and demolition waste increased with 1,7 million tonnes from 2012 to 2014. The same trend can be observed in the whole European Union (Fischer & Werge 2009). To mitigate further increase and to also decrease the demolition and construction waste, the building sector is highlighted as one of four prioritised areas in the Swedish National Waste Management Plan (Naturvårdsverket 2012).

TYPE OF MATERIAL

The waste from the building sector can be divided into two main categories – hazardous and non-hazardous waste. Around 10 % is considered to be hazardous such as polluted soil, polluted mineral waste (as concrete, bricks and asphalt) and impregnated wood. The non-hazardous waste is dominated by large soil and othe material derived from the ground preparation. If those masses are excluded, the mixed demolition and construction material is the largest part (1.7 million tonnes), followed by metal waste (0.3 million tonnes) and wood waste (0.2 million tonnes) (Naturvårdsverket 2014). The mixed waste consists of concrete, gypsum, bricks but also some metals, plastic, wood and paper (Palm et al. 2015).

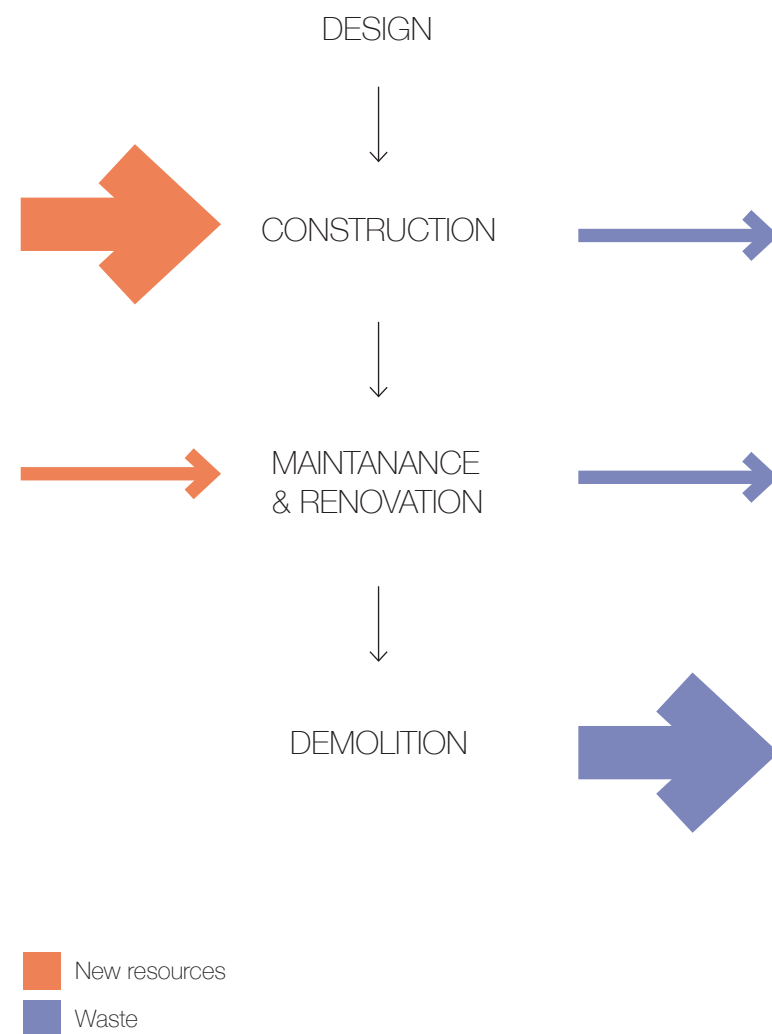


Illustration of the material input and output during a buildings lifetime.

MATERIAL FLOW

Several processes during a buildings lifetime are connected to resource consumption and waste production. The design process does indirectly contribute as choices in this stage influence the material flow during the buildings whole lifespan. For the construction process, large amounts of new material are needed. Waste is also generated during this process, both from ground preparation but also from surplus material from the construction work. A building is generally refurbished a number of times during its lifetime which creates a need for new resources as well as generates waste. The largest waste production can be derived from the final stage, the demolition process. The Swedish Construction Federation has developed guidelines for managing the waste from both from construction and demolition process. (Swedish Construction Federation 2015).

HOW MUCH WASTE IS REUSED?

Waste which is treated at the same place as it is generated is not a part of the Swedish Waste Statistics (Naturvårdsverket 2014). Thus, there is a lack of knowledge about how much material that is reused within the building sector. According to Sundqvist et al. (2013), this can partly be explained by the large number of different waste fractions. To be able collect more information about the waste streams, there is a need for well defined methods to (Ek et al. 2009). The building sector is a heterogeneous sector with many types of actors which together with project based assignments generates unclear responsibilities regarding waste reporting (Sundqvist et al. 2013). According to chapter 15 § 1 in the Swedish Environmental Code (1998:808), the holder of the waste is under obligation for that the waste is managed responsibly.

waste hierarchy

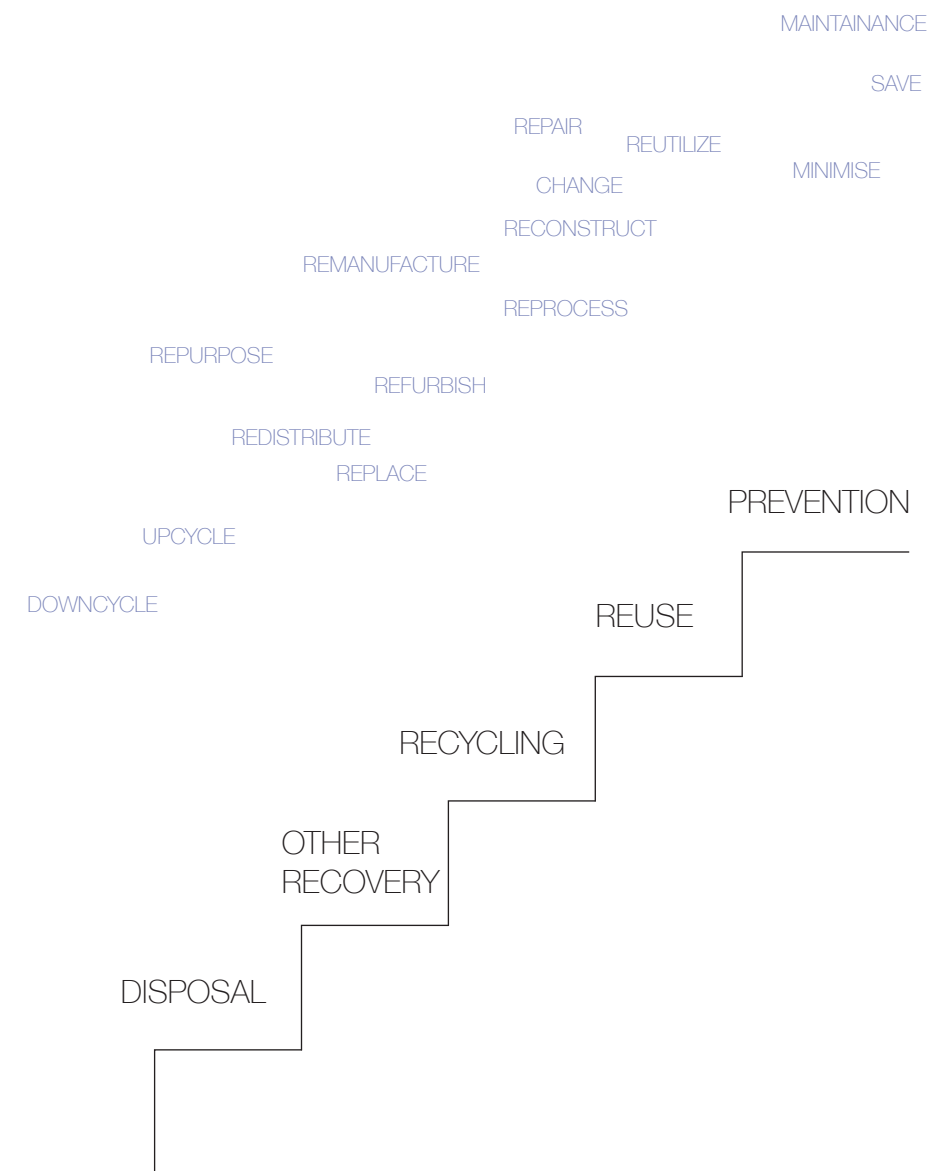
Over the last decades, the waste hierarchy has functioned as a guiding principle in Sweden and EU. It consists of five steps where 'prevention' is the most preferable option, followed by 'reuse', 'recycling', 'other recovery' and finally 'disposal' as the least favourable choice (European Commission 2010). Other recovery is mainly considered as energy recovery through incineration. Disposal includes landfill and other types of disposal.

A GENERAL APPROACH

The waste hierarchy is a simplification of reality which has been widely discussed in research (Schmidt et al. 2007). The environmental benefits between the different steps varies depending on the material. According to Thormark (2001), the energy savings from material recycling is approximately 95 % for aluminium and only 5% for glass wool. Thus, there is a small difference between reuse and recycling for aluminium while for glass wool reuse is significantly better.

IN BETWEEN

The focus in this project is on the second step of the waste hierarchy - reuse of material. According to the Swedish Ordinance of waste (2011:927), reuse is defined as something that is not waste and used again to fulfil the same purpose. Thus, legally a product or material is only reused if it serves the exact same function. In this project, the term reuse is used as "making use of existing material". This can be done for the same or another purpose, within or outside the building industry.



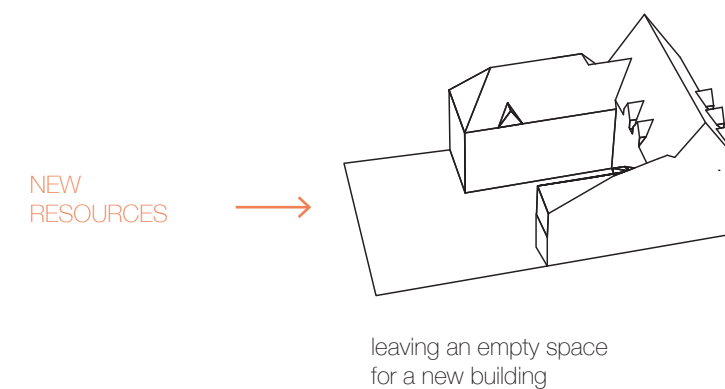
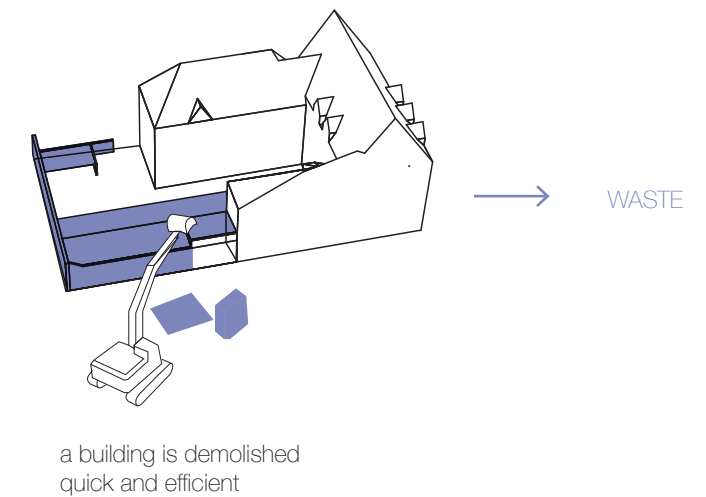
The European Waste Hierarchy and a number of related concepts.

concept of circularity

As an alternative to our current (often described as linear) resource system, the concept of circular resource use is increasingly discussed in our society. Various approaches as Circular Economy (Ellen MacArthur Foundation 2015), Cradle to Cradle (McDonough & Braungart 2002), Regenerative design (Lyle 1996) and Biomimicry and Biomimetic design (Biomimicry Institute 2016) involves the idea of a changed resource system. To leave our current linear take-make-dispose system involves various types of transitions within different levels. At a more societal level, change involves new regulations, waste management procedure and business models. The focus of this Thesis is on the project level and how an alternative resource system can be applied at a project level and through design.

CLOSING THE LOOP THROUGH DESIGN

Closing the resource loops within architecture involves both designing for future reuse, remanufacturing and recycling as well as by implementing those types of material into the design. To design for future material circulation facilitates renovation, changes and finally the demolition process. The latter, implementation of reused, remanufactured and recycled material decreases the need for new resources and is a way to manage construction waste. Sassi (2006) emphasises the importance of designing with reutilised material to create a market for reclaimed building material and products with recycled content. Considering that a building's lifetime is at least 50 years (hopefully much longer), the development of a closed loop system involves many challenges.



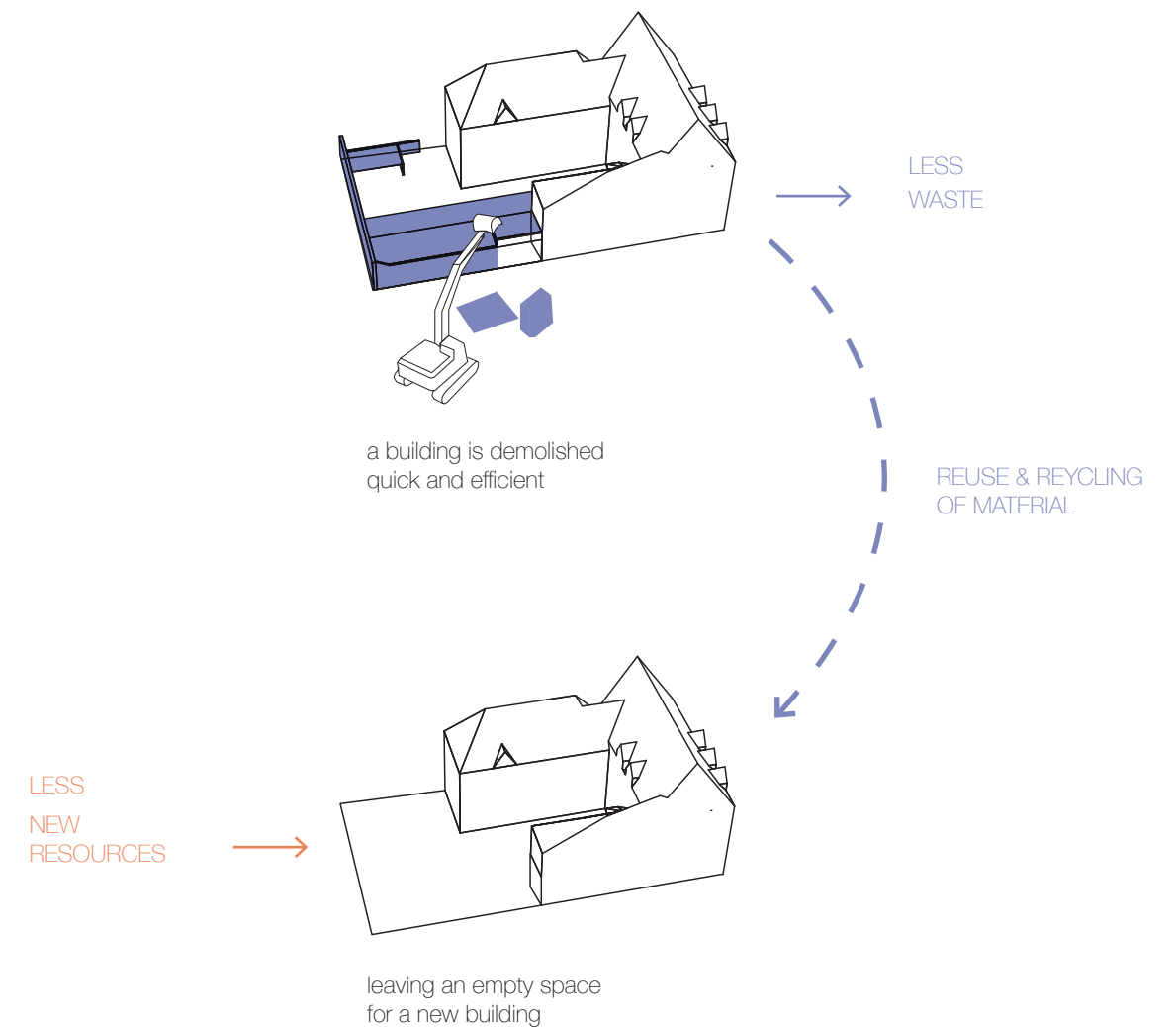
Today's linear approach to demolition.

TODAY AND TOMORROW

From a systemic perspective, to design for future circulation as well as for current implementation is necessary for a change towards a circular resource system. Nevertheless, contradictions and challenges exist between the two approaches. As an example, documentation of building material supports the future reutilisation potential. At the same time, such demand might limit the possibilities of reusing material, as detailed information about producer or material content seldom exists. Standardisation and a lower number of different material is another example which facilitates future reutilisation but might be a barrier for designing with reused and remanufactured components. Reused products are not always available in large quantities.

Closing the loop for the material streams going into a building is done by specifying material which is reused, remanufactured or has recycled content. The material can be derived both from on and off site, within or outside the building sector. On site reuse reduces the environmental impact from the transport (Arm et al. 2014) It can also be used for the same or a different purpose.

Preparing for future material circulation is done by facilitating future demolition or renovation and choosing material which can be reused, remanufactured or recycled. To facilitate future demolition is done through design for deconstruction, also discussed as design for disassembly which is derived from the product design industry – to facilitate the disassembly of multi material products for recycling (Thormark 2001).



An increased circular approach to demolition.

shearing layers of change

Shearing layers is a concept coined by architect Frank Duffy. It was later developed by Stewart Brand in his book 'How Buildings Learn: What Happens After They're Built' (Brand, 1994) which discusses buildings as composed of several layers of change. When reuse within architecture is discussed, this idea is often referred to (Thormark 2008; 3XN & GXN Innovation 2016; Vandkunsten 2016). The layers are (quoted from Brand, 1994):

SITE

This is the geographical setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings. "Site is eternal." Duffy agrees.

STRUCTURE

The foundation and load-bearing elements are perilous and expensive to change, so people don't. These are the building. Structural life ranges from thirty to three hundred years (but few buildings make it past sixty for other reasons).

SKIN

Exterior surfaces now change every twenty years or so, to keep up with fashion or technology, or for wholesale repair. Recent focus on energy costs has led to re-engineered skins that are air-tight and better-insulated.

SERVICES

These are the working guts of a building: communications wiring, electrical wiring, plumbing, fire sprinkler systems, HVAC (heating, ventilating, and air conditioning), and moving parts like elevators and escalators. They wear out or obsolesce every seven to fifteen years. Many buildings are demolished early if their outdated systems are too deeply embedded to replace easily.

SPACE PLAN

The Interior layout—where walls, ceilings, floors, and doors go. Turbulent commercial space can change every three years or so; exceptionally quiet homes might wait thirty years.

STUFF

Chairs, desks, phones, pictures; kitchen appliances, lamps, hairbrushes; all the things that twitch around daily to monthly. Furniture is called mobile in Italian for good reason.

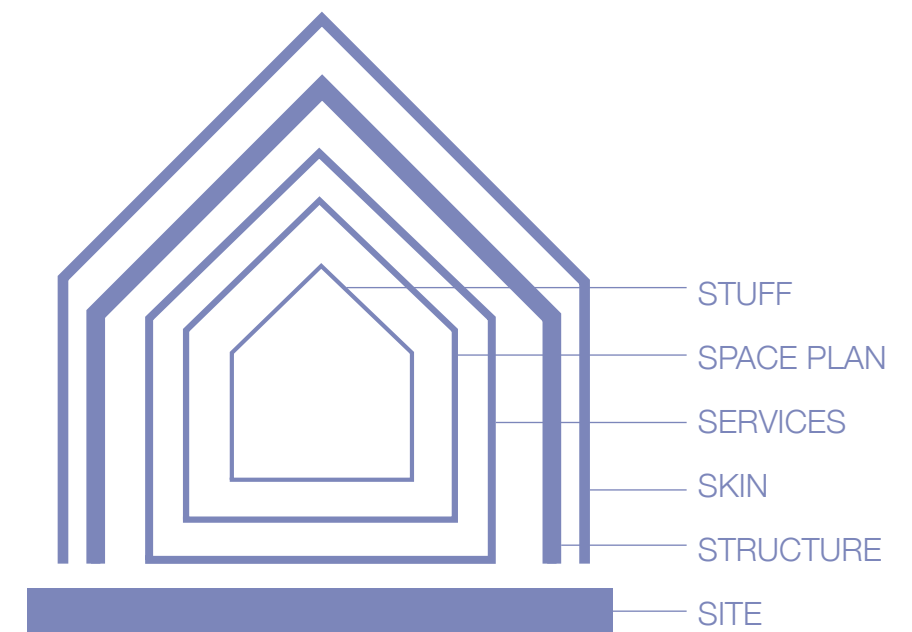


Illustration of the Shearing Layers of Change (Brand, 1994)



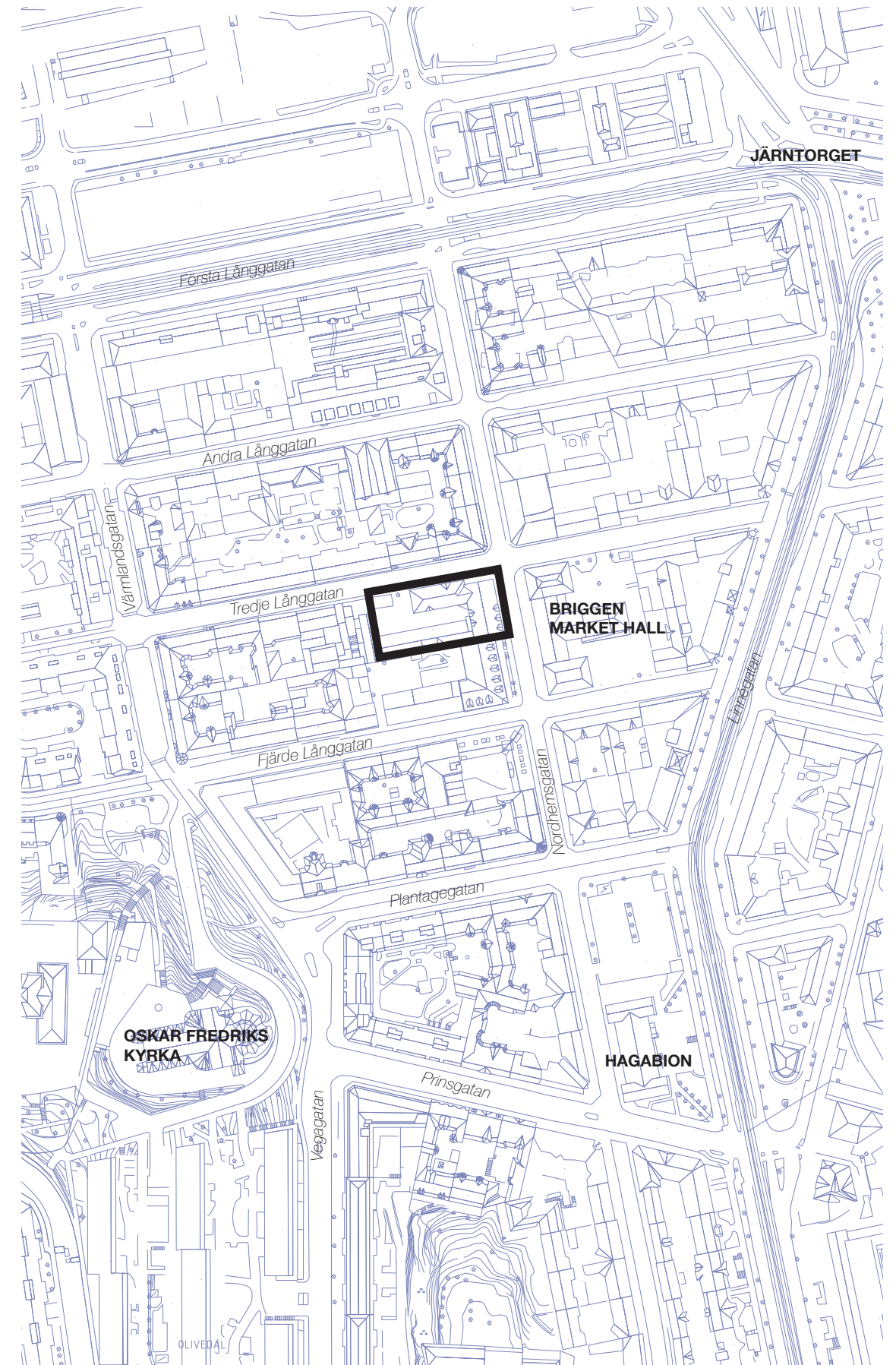
Part of the studied custody building.

3 SITE

This chapter introduces the site and the studied building - an old custody. The historical settings, the built environment and the character of the area are described together with current development plans.



Overview of central Göteborg.



The area of Långgatorna and the site marked with a black rectangle.

the area

SOME HISTORY

The block Kv. Barken belongs to the neighbourhood Masthugget, an area which from the beginning was excluded from the city's building regulations. Initially, this area was developed in close connection to the harbour and relating industries such as timber trade and mast manufacturing. In 1866s large city plan, the current grid network was established and the expansion of the area was mainly performed in 1860-1930. The new buildings in this area were primarily developed for housing, often mixed with retail business in the ground floor and workshops on the courtyard. This type of buildings were combined with public buildings as the police building, fire station and auction house but also other types of buildings as industries, stall and storages. (Ander et al. 1999) In 1948, a new city plan was established. The current detail plan in Kv. Barken was developed to rearrange the area as the existing mix of housing, workshops and commerce was not considered appropriate at that time (Göteborg SBK 2016). The north part of the area was planned for commercial activities while the southern part, including Kv. Barken, was assigned for residential purpose. A park was also included in the development of Kv. Barken, but nothing of the 1948 plans was implemented in the block. (Hultgren et al. 2012)

TOWNSCAPE

The area of Långgatornas consist mainly of closed blocks with a clear destination between the blocks. The long time span for the the devleopment of the area togheter with small properties has created heterogenous built environment. Also, the large amount of different owners has contributed to the special townscape and mixture of architecture. According to Ander et al. (1999), many of the building were designed according to neo-rennaissance ideals or got imaginative brick facades from the turn of the century. There are also some more recent buildings in national romantic style. Some of the buildings have a high cultural heritage and are included in the conservation program Kulturhistoriskt värdefull bebyggelse i Göteborg (Ander et al. 1999).

”

The urban identity of Långgatorna is not only an imagination but a concrete compilation of peoples stories about the area, activities (as Andra Långdagen), web sites used to connect people, organisations and companies (Andra Långdagens Facebook Group and the blog about Långgatorna) as well as the companies active in the area”

FROM RADAR, 2013
Translated by the author of this Thesis

old custody building

In the northeast corner of Kv. Barken is an old police station from 1911 situated. The original building consists of two parts, designed in national romantic style. In 1961, an old stall on the courtyard was demolished to give space to custody building. The whole building was changed to office purpose in the 1980s and the spaces are currently used by Stadsdelsförvaltningen. (Lindman 2015). The property is currently owned owned by Sigillet. The custody building is a one floor building which is empty today, but will be rented out as an office hotel until the new detail plan is established.

current development

NEW DETAIL PLAN

Kv. Barken is under an ongoing development process and Göteborg Stadsbyggnadskontor (City Planning Office) is establishing a new detail plan for the neighbourhood. The reason for this process is to protect some of the culturally valuable buildings as well as allow for new developments in the area. The main changes are situated at the east part of the block, where a new passage, a square and new buildings are suggested. The new buildings will mainly be for residential purpose and 80 new apartments are suggested. In addition, 700 m² of other functions at the ground floor is proposed, such as cafés, commercial or other non-disturbing activities. (SBK 2016)

DEMOLITION

According to the proposed detail plan, buildings in three properties are allowed to be demolished. These are shown in the picture on the next page.



Overview of the buildings which are allowed to be demolished, the arrow marks the old custody building. (3D picture from Apple Kartor, 2017)



Construction of light weight concrete elements (AB Lättbetong, 1968).

4 MATERIAL INVESTIGATION

The realisation of the material research is described in this chapter. After a description of the process, the evaluation strategy are described more in detail as well as some reference projects.

process

Shown in the figure on next page, a schematic illustration of the different steps in the process is presented. The three main steps in the material investigation is described below.

MATERIAL INVENTORY

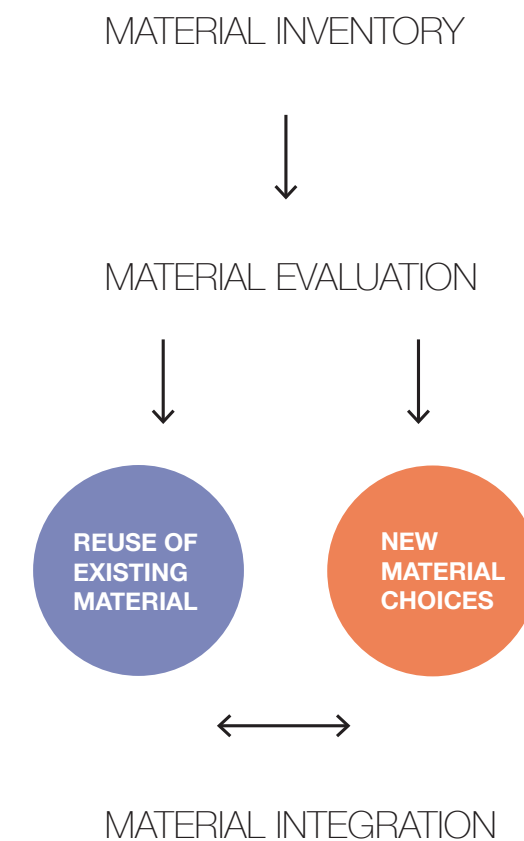
The inventory of the old custody building was done through on site observations by the author of this Thesis, research through archive material (Göteborg SBK 2017) and literature. Photographs were used to support the observations. Information which was not retrieved through literature was collected through discussions and consultations with experts. A part of the inventory was the categorisation the material. This was done trough an iterative process by exploring different alternatives on how to sort the material – as elements, components or pure material (which was the chosen approach).

MATERIAL EVALUATION

The evaluation strategy was developed through theoretical research. The strategy was used to conduct a qualitative assessment of the reuse potential material - made by the author of this Thesis. To fully classify the material, measurements and certain assessment has to be. Due to time limitations and lack of possibility to do measurements of the material in the studied building, certain assumptions had to be made. Theoretical research was done to support these assumptions as well as consultancy with a civil engineer in construction and architects.

MATERIAL INTEGRATION

Through model making, sketches and drawings - the relation between existing and new material was explored. This part of the research was also developed through reference projects, as an important source of inspiration and broadening of the reuse possibilities.



Schematic illustration of the process of the material investigation.

evaluation strategy

To determine 'if' and in particular 'how' a building element, product or material can be recirculated into a new building, various parameters have to be considered. The circulation potential is both related to the actual material as well as systemic factor such as economics and current building practise and waste management. Described in the following subsection, four important parameters for determination of a material's reuse potential are presented. Not all subcategorise applies to every material and the evaluation also differs depending on the purpose of the new building.

All the four parameters are closely related to if it is economically feasible to salvage building products and material. Even though reused material can be found at a low cost - new material is generally very inexpensive. For on site circulation of building material, the material is free to use and cost for waste management is avoided. On the other hand, there is probably an increased cost for both deconstruction and construction as well as an increased economic risk. In addition, the material has to be stored in between the deconstruction and construction. The economic risk is mainly related to the uncertainty regarding future maintenance and generally no guarantees of the material. As there seldom are written verification chemical content, there might also be necessary to do measurements of the material. To use material with poor energy properties or old water might also result in increased expenses for heating of the building or increased water consumption.

The economic aspect is changeable and might develop over time, therefore it is not incorporated in these four material specific categorise. An increased demand for reused product wold create a larger market which might lead to lower costs both for the material and the labour as well decreased risks through guarantees and certifications.



CONDITION

Age
Life-Expectancy
Repairability
Aesthetics



PERFORMANCE

Structural Capacity
Energy
Noise Reduction
Water Resistance



RISKS

Hazardous Substances
Material Emissions
Fire Protection
Security



DECONSTRUCTION

Joints & connections
Amount of material
Time
Knowledge

The four parameters used to evaluate the reuse potential of the existing material.

CONDITION

The condition of an existing material is directly dependent on the quality, age and the predicted life-time of that type of material. In addition, other circumstances as weather conditions, how exposed the material has been to usage and the level of maintenance. According to Sassi (2006), finishing boards, roof tiling, timber, bricks, stonework, doors, windows and ironmongery have good reuse potential. Other structural elements as pre-cast concrete, steel and timber can also be suitable for reuse. The condition of the material must be evaluated carefully, as there is risk of increased future maintenance compared to new material. A less tangible aspect but still of high importance is the aesthetics of a material. The perception of what a contemporary architecture is and should consist of can be discussed at both a societal and personal level. It is related to concepts as what is modern and new but also the value of patina and heritage. Various types of material have different aesthetics qualities; old handmade bricks are perceived differently than a window from the 70s. The age also influences the aesthetic value, either positively or negatively. An important aspect to consider is the visibility of reuse. It can either be visible that a material is reused or not visible – if it is recycled or remanufactured to look like new.

PERFORMANCE

Depending on the type of material and what it will be reused for, the performance demands vary. Energy efficiency, noise reduction, water resistance and structural capacity are important parameters for evaluation of the material performance. Energy efficiency is a challenge in the case of windows and doors as they have lower U-values than the standards today.

RISKS

An important factor which has to be evaluated for reuse of material is the risks. Regulations and other demands regarding hazardous substances, material emissions and fire protection have to be considered. Regulation and building practice have changed over time which might influence the reuse possibilities. The demands also differ within a building and there is a large difference between outdoor and indoor purpose. In relation to the different demands on a material, there are certain guidelines and regulation about hazardous substances and material emission. Both regulations and classification of high concern substances have changed over time. The Swedish Chemical Agency (KEMI) develops regulation and policy instruments. Substances which are considered necessary to phase out are defined by KEMI and based on the European regulation REACH. The risk of hazardous substances is directly related to material emission which might affect human health and natural ecosystems. The hazardous substances can be found in pure and composite building material as well as paint, furnishings finishes, adhesive, sealants. It is not only synthetic material that impose a risk, natural material such as wood does also consist of components as formaldehyde and xylene (Gelfand & Duncan 2012).

DECONSTRUCTION

Crucial to consider and closely related to the condition of a material is the possibilities of deconstruction and construction of the material. Depending on how material or products are assembled, the possibility to deconstruct varies. Visible and mechanical joints are easy to disassemble without destroying the material (3XN & GXN Innovation 2016) while it is generally more difficult to maintain the quality if the material is glued or nailed together.

reference projects

A large number of reference projects, both architectural and other, have been used as a way to explore the possibilities of the material. Three of these projects are presented here, which have had some extra influence in the design process.

GRINDBAKKEN

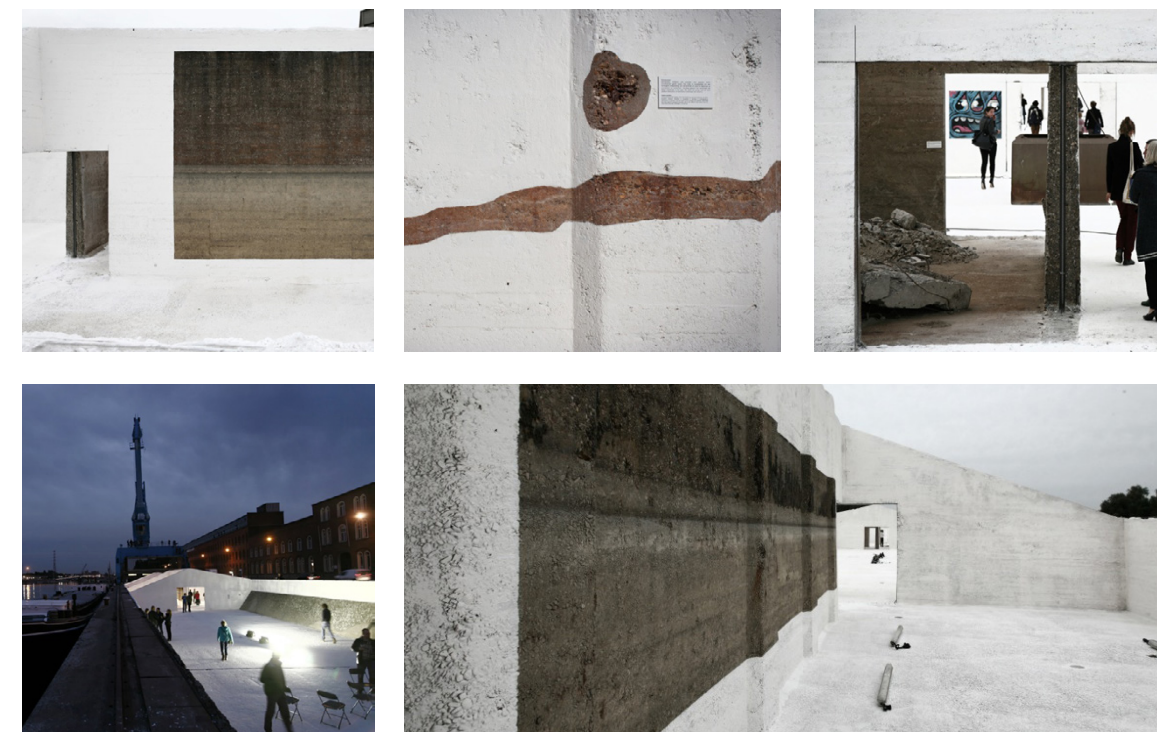
Located in the docks of Ghent, Belgium, a 160 meter long concrete structured has been transformed by the Belgian Design Collective Rotor. In the past, it was used to transfer gravel between ships and trucks. According to the new master plan for the docks, the area was about to be transformed into a multi-purpose area accessible to the public. Rather than paint the whole building white as an empty canvas for future activities, Rotor selected specific areas of interest and 36 of the existing paintings, holes, material and greenery were preserved. Since then the project has been developed further and taken over by other interventions. (Rotor, 2012)

EXCAVATION : EVICTED

After being evicted from his studio, London Designer Paul Cockshedge started digging and drilling up the concrete floor. He says: "The resulting findings epitomise London's multi-layered history, with the initial concrete hiding Victorian bricks left over from the building's former life as a stable". The material was used to produce a series of new furniture. (Frearson, 2017)

GAMLE MURSTEN

Reuse of bricks is nothing new, but the Danish company Gamle Mursten has developed industrial procedures for cleaning and testing the bricks. For every reused brick, 0,5 kg of CO₂ is saved. They are mainly working with bricks from building between 1900-1955, keeping some of the soul of the material in new buildings. (Gamle Mursten, 2017)



Grindbakken (http://rotordb.org/project/2012_Grindbakken_expo)



Concept illustration of the existing concrete wall and a new surface finish.

5

RESULT

In this chapter, the outcome of the Thesis is presented. After a summary of the reuse potential of each of the studied material, the general design strategies are described. These were further tested on site to illustrate the feasibility – which is shown in the last section.

material specific outcome

BRICK

Brick has a high reuse potential and procedures exist for cleaning, testing and preparing the bricks. Facades with lime mortar is easy to deconstruct while Portland cement demands a lot more work. Therefore, the best reuse option is to preserve as large elements as possible of Portland cement facades. By selecting new brick of the same standard dimension as the existing, the new stones can easily be integrated. Lime mortar should be used to facilitate future disassembly and reuse.

CONCRETE

The reuse potential varies among the different types of concrete. In today's building practice, concrete is mainly reused as aggregates. Regarding in situ-casted concrete, deconstruction is almost impossible and the best reuse option is to preserve large elements. For new material choices, minimise the amount of in situ casted concrete. The prefabricated walls and blocks are also difficult to disassemble because of the none reversible connections – if that were to be used for new prefabricated concrete the future reuse potential increases. Smaller blocks might be easier to implement in a new design, while large elements are less time consuming to deconstruct. The light weight concrete might contain radon and an option is to reuse it outdoor. Less different types of concrete facilitate a future inventory and reuse.

WOOD

Wood has a high reuse potential and as it is an organic material it is a preferable option for material circulation. It is easy to repurpose the wood panels but disassembly is difficult without damaging the material due to the use of nails. Thus, the material has to be reused in smaller pieces. If the new wood has larger dimension, the future reuse potential increases.

GLASS

Glass has in itself a good reuse potential (and also high recycling possibilities) but the today's high energy regulations makes it difficult to reuse them for the same purpose. To reuse the windows inside or by remanufacturing the material, those demands can be met. Regarding new material choices, standard dimension facilitates future reuse and integration with new windows later on. To minimise the different types of windows does also simplify future inventory and integration in a new design – it is easier to reuse or remanufacture a large amount of the same type.

METAL

Metal has a high reuse potential (as well as recycling potential) with long life-expectancy. But be able to reuse the metal sheets, reversible connections instead of screws is necessary for deconstruction without damaging the material. By selecting new material of the same type that existing on site, in this study copper, material integration and future reuse is easier. The patina of the copper creates incentives for reuse, both today and in the future. The emergency steel doors can be reused easily and can be refurbished with a new surface.

BITUMEN

Bitumen is very difficult to reuse for the same or another purpose, both as roofing paper and as asphalt. It is almost impossible to deconstruct the material and it is such a bad condition that it cannot be preserved as it is. Thus, avoid roofing paper and asphalt if possible. Glue and other permanent adhesives makes it also difficult to deconstruct a material without damage – minimise that too.

design strategies

In the process of conducting the material inventory, evaluating the material as well as integrating the existing material with new, a large number of possibilities and challenges were observed. From this, nine design strategies were developed to address the opportunities of on site reuse of material as well as to manage some of the difficulties for future circulation. These design strategies are general, however, it has to be considered that they are developed for the studied site.

On next page, the nine strategies are presented. The strategies are all related to reuse of existing material, integration with new material as well as preparation for future circulation of the material. This is visualised in the figure below.

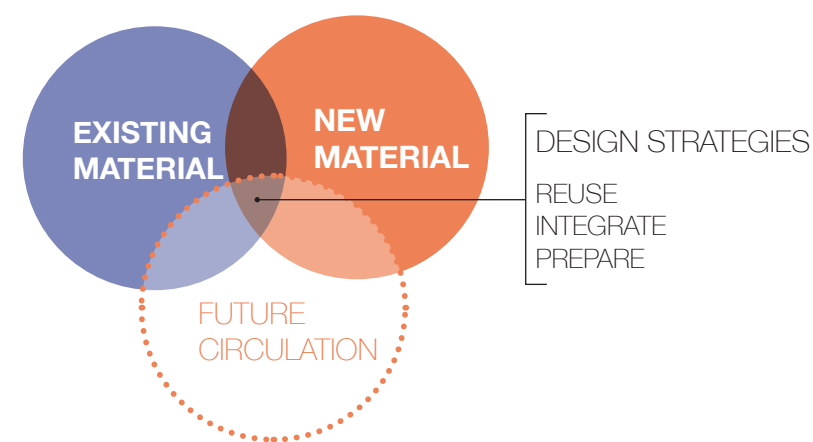


Illustration of the focus of the design strategies.



LARGE ELEMENTS

The main opportunity of on site circulation is the possibility to reuse whole building elements - it maximises the environmental benefits and preserves some of the character in the area. Also, it decreases the the amount of work needed for future material inventory and deconstruction.



CURRENT POTENTIAL

Chose new material which has a high reuse potential today. More reuse options will most likely be available in the future but possibilities which already exist will probably be even more well developed.



LESS IS MORE

Minimise the number of different material in the building and within each component. By using as few and as pure material as possible, future reuse as well as the material inventory, evaluation and deconstruction processes are made easier.



CHARACTER

Except environmental benefits, reuse is usually motivated by the aesthetic value of a material. On site circulation creates a possibility to preserve some of the character, by reusing material specific for the site and material with patina. Incentives for future reuse are also created by selecting new material which ages with beauty.



SIMILARITY

Select new material of the same type and dimensions which already exist on site to facilitates the integration both today and in the future. To use standard dimensions also simplifies future reuse, inventory procedures and deconstruction.



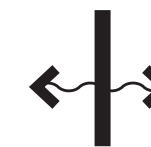
REVERSIBLE JOINTS

Even if the material itself has a good reuse potential, the connections and adhesives might make it impossible to reuse the material. Thus, design with reversible joints such as screws, lime mortar, bolts as well as avoiding nails and glue.



BROADER HIERARCHY

The waste hierarchy is a general approach which limits the perception of reuse. Material can be reused in so many ways - explore the possibilities through remanufacturing, repurposing and integration with new material.



INDOOR / OUTDOOR

To relocate the material is a good approach to to meet current demands and regulations. Energy or security demands can be met by using windows or doors inside while the risk of hazardous substances might be met by reusing the material outdoor.



VISIBILITY

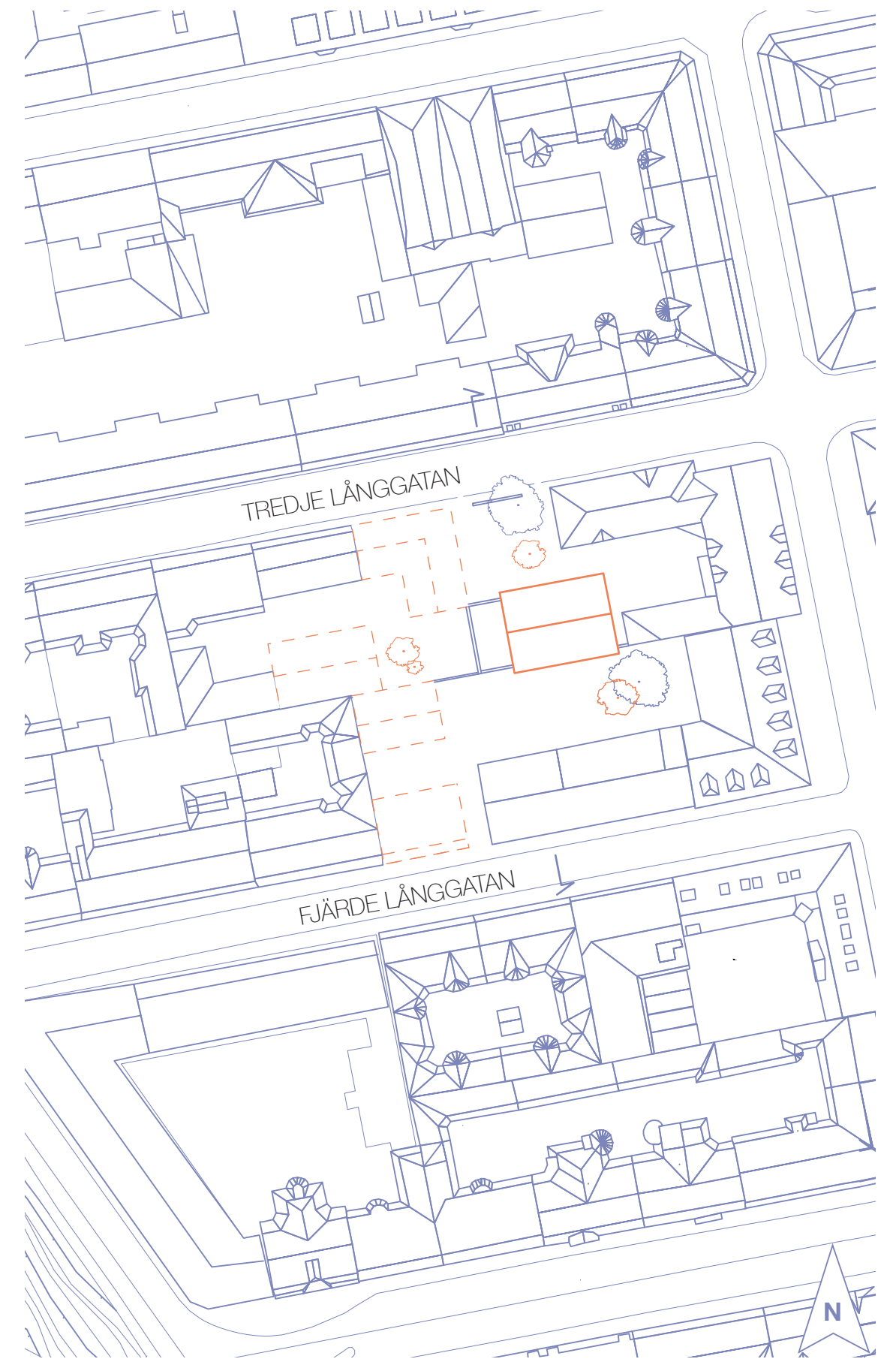
To show both the existing and the new is a respectful way to integrate the material which also highlights the value of the existing. Increased visibility of the material as well as the joints does also facilitate future inventory and deconstruction.

building proposal

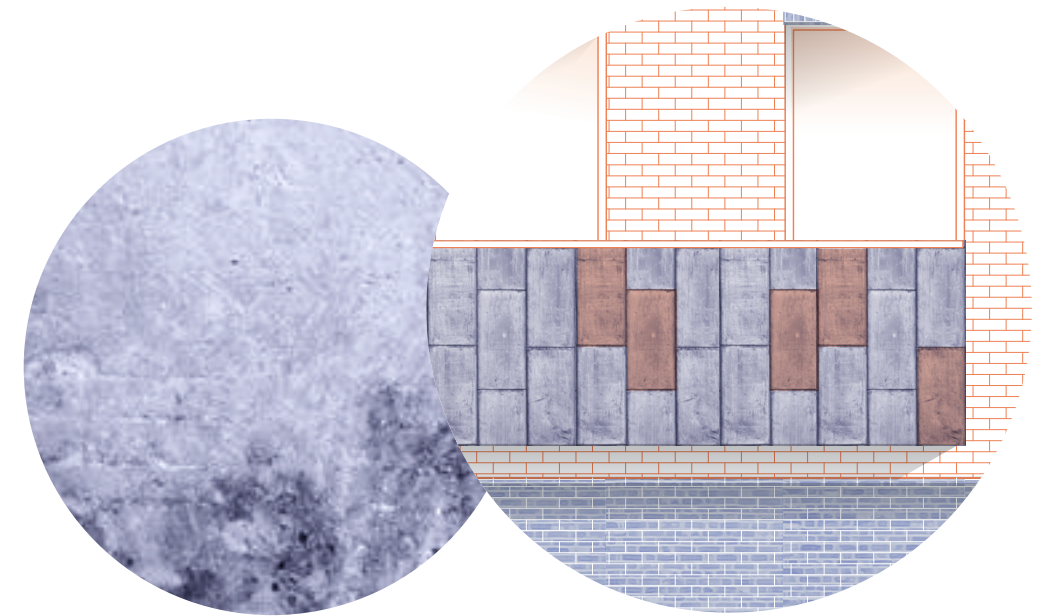
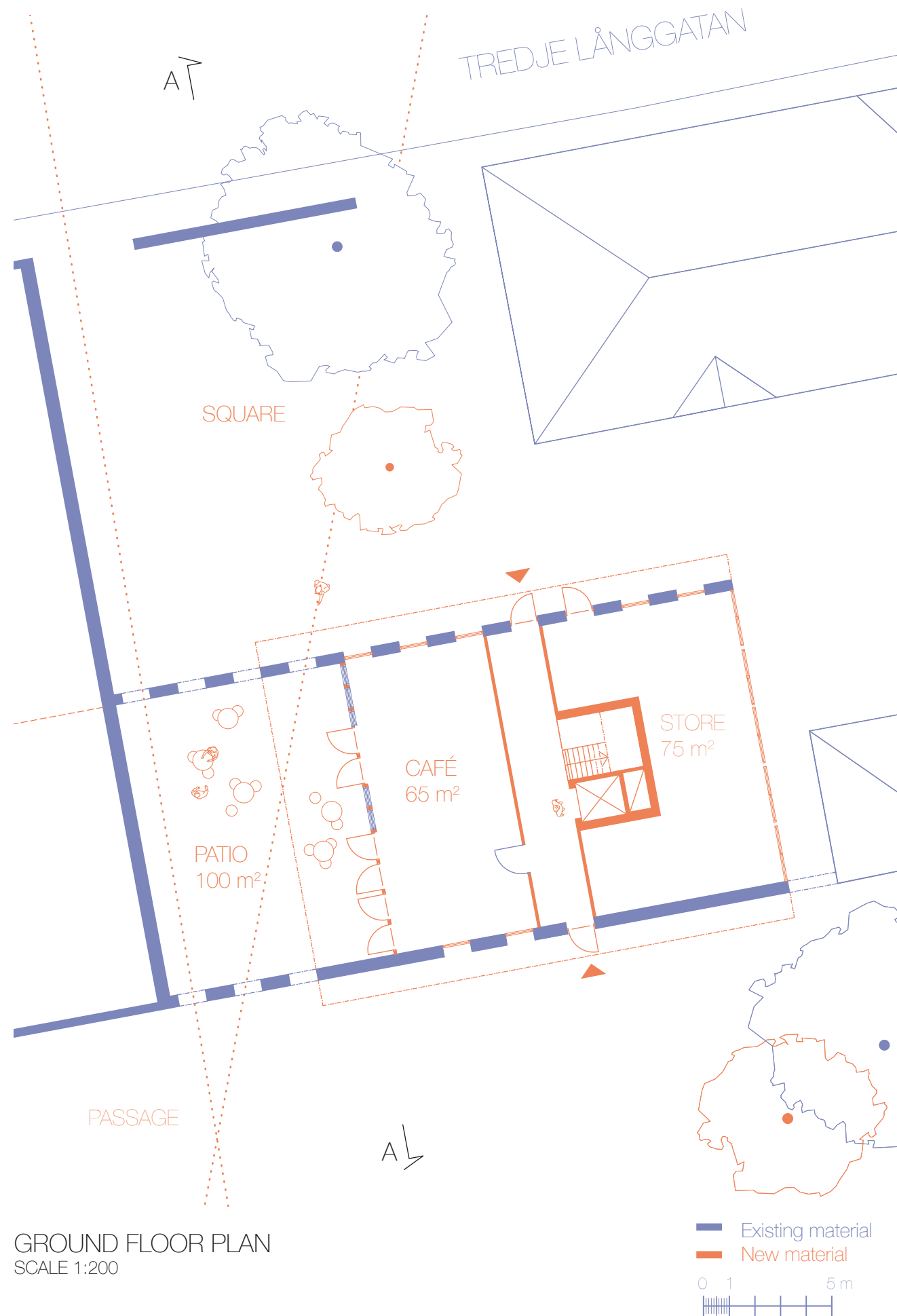
The design of the building has been explored during the whole process as a way to develop and test the design strategies. The building presented here is an illustration of how the design strategies can be used at the studied site – with some highlighted material approaches. It is not a detailed proposal but rather a way to show the possibility to combining reuse of existing material with urban development. The building program presented below is taken directly from the suggested detail plan – to show that change can be compatible with material preservation.

PROGRAM

For this site, a residential building is suggested with approximately 200 m² commercial functions at the ground floor level. Around 20-25 apartments are proposed, mainly small one to three room apartments. The suggested detail plan does also consist of a new passage through the block as well as a small public square.



SITE PLAN
SCALE 1:1000



CONCRETE PATIO

Existing concrete slab and concrete wall are grinded - preserved to define the patio space.

STRATEGIES

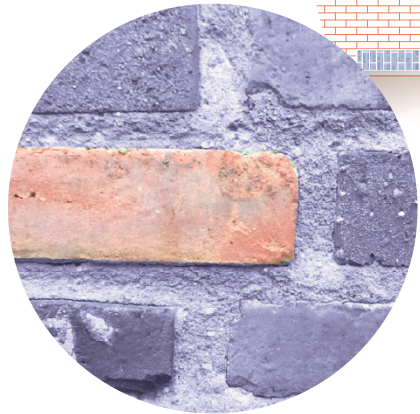


BALCONIES

The existing copper facade has a characteristic patina and is reused as balcony cladding - integrated with new copper.

STRATEGIES

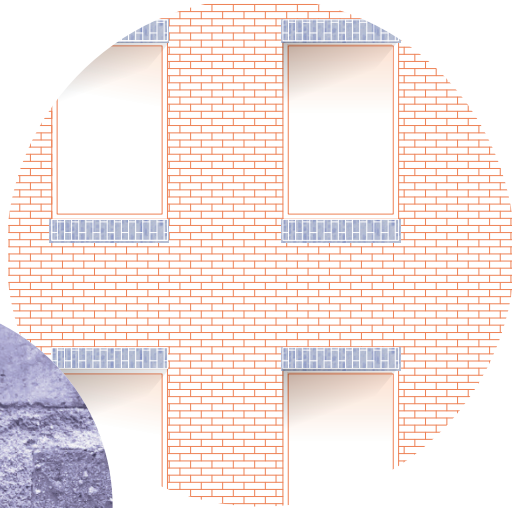




BRICK FACADE

Brick has a high reuse potential and by using standard dimensions it can be integrated with the existing bricks as well as other bricks in the future. Lime mortar is used to facilitate future deconstruction.

STRATEGIES



STANDARD WINDOWS

Same type of windows (with standard dimensions) are mainly used in the building - to facilitate future reuse, deconstruction and material inventory.

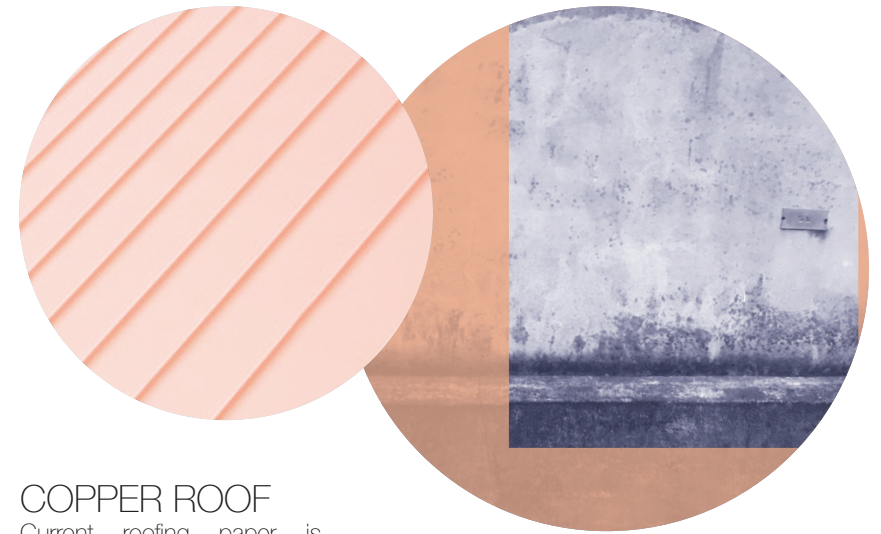
STRATEGIES



PAVEMENT

Concrete roof elements are remanufactured into new pavement. Soil and grass have a high reuse potential and is used in between the blocks.

STRATEGIES



COPPER ROOF

Current roofing paper is impossible to reuse. The new roof consists copper sheets, a material which already exists on site. Reversible joints make it reusable in the future.

STRATEGIES

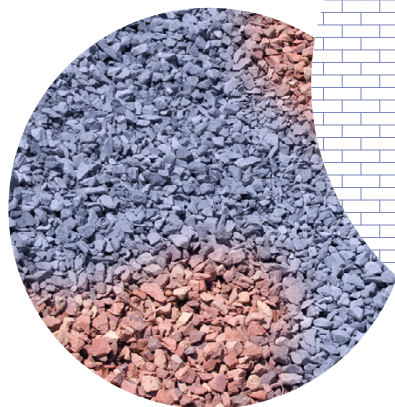


NEW FINISH

The old concrete wall is preserved and given a painted surface - to highlight the existing character and to show the age of the material for future inventory.

STRATEGIES

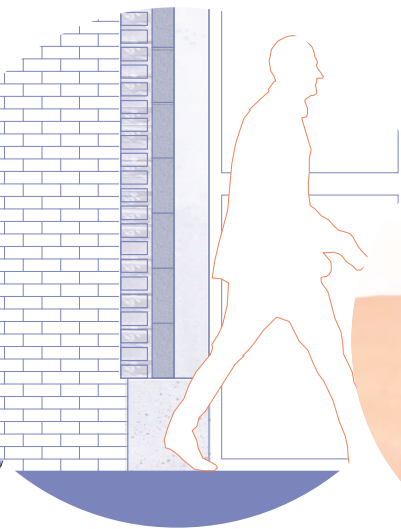




CRUSHED BRICKS

The leftovers from existing and new bricks are used gravel to define the square.

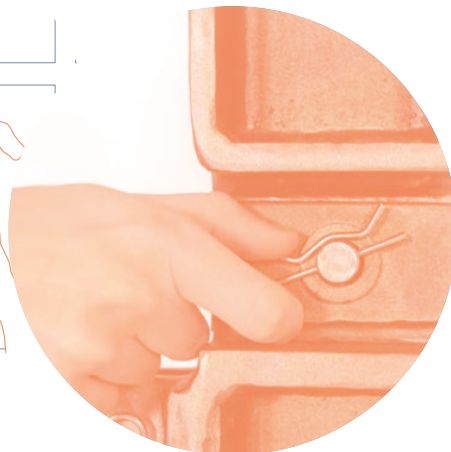
STRATEGIES



WALL OPENINGS

The existing brick facade and the concrete walls are preserved - new openings are made to allow for commercial functions and the new passage through the block. This also visualises the wall section for future material inventory.

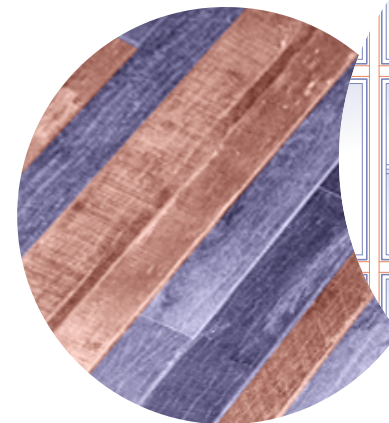
STRATEGIES



STEEL STRUCTURE

Steel has a high reuse potential (at least higher than concrete). Reversible and visible connections facilitate future reuse and deconstruction.

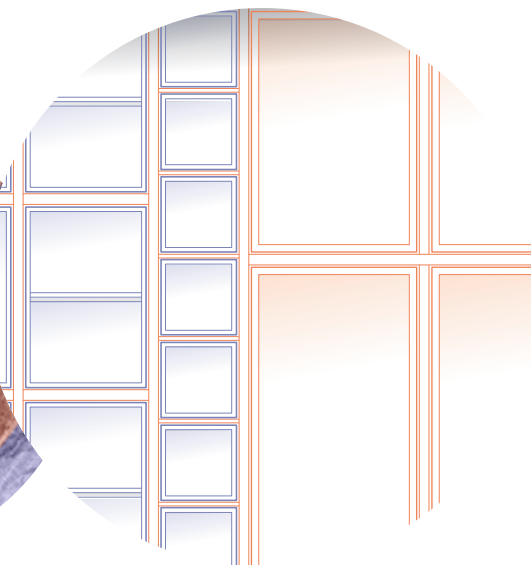
STRATEGIES



WOOD FLOOR

Existing wood panels are remanufactured into flooring and integrated with new wood.

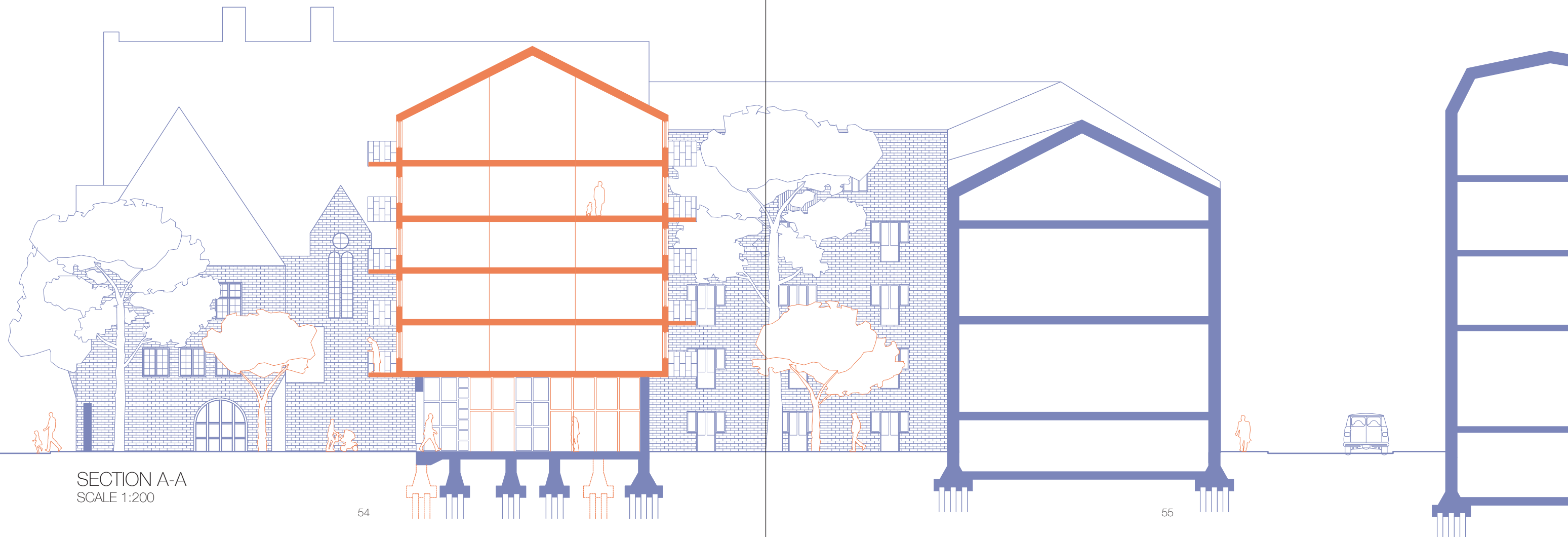
STRATEGIES



DOUBLE GLASS FACADE

Existing windows are remanufactured into a double glass façade to meet today's energy demands.

STRATEGIES



SECTION A-A
SCALE 1:200



Existing wood panels above windows.

6

TO SUM UP

This chapter provides a discussion about different aspects related to challenges and possibilities of on site circulation of material. Thereafter, a short conclusion of the Thesis is presented.

discussion

Various questions, thoughts and reflections have arisen during the process of developing this Master's Thesis. In this section, some of the most important aspects are discussed.

LACK OF PROCEDURES

The largest struggles during this process was related to how to approach the existing material and what to focus on. Today, there is a lack of established procedures for how to conduct a material inventory for reuse (on site or off site), how to categorise the material to facilitate an easy design process and how to evaluate the material. This makes the reuse process very time consuming and difficult. The large challenge with reusing is that a design project is complex as it is. Thus, there is for more guidelines and procedures to facilitate the reuse process. Existing approaches, such as the European Waste Hierarchy and Shearing Layers of Change, are general and also to some extent limiting. According to the Waste Hierarchy, reuse is only when material is reused for the exact same purpose which creates unnecessary boundaries. The Shearing Layers are often referred to in research about reuse within architecture and the normal age of exterior surfaces are according to Brand (1994) discussed as 20 years – an exceptionally short time which should be questioned.

The awareness of the environmental impact related to resource use is increasing in the building industry. In the future, this will probably result in increased demands and regulations for sorting of demolition material for waste treatment. To be able to sort the material, more guidelines for material inventory will probably be developed. If an inventory is done for recycling and waste treatment - that information might also function as a basis for reuse of the material.

PRESERVATION OF CHARACTER

To reuse material on site a narrow approach, as some of the material might be better reused in another building or even another industry. But for architects, this approach is a large possibility to preserve some of the character of a site. Even though it was never the main focus of this Thesis, cultural heritage is inevitable to consider when material is reused in the same location. Especially in this area, which has a lot of identity and history to take care of. One of the reasons for the new detail plan for this area is to ensure conservation of some building. It would be interesting to expand the concept of preservation to more than 'keep' or 'demolish'. There is a large gradient between those two concepts. What if the new detail plan would propose that some of the old concrete walls had to be preserved on site or maybe the bricks?

WHAT TO FOCUS ON?

A building consists of a large amount of different material and to decide what to reuse and what to focus on was very difficult. Even though the studied building is a relatively small building, it consists of a large amount of material within different elements and components. This complexity – together with the absence of guidelines of for reuse of building material – made it difficult to know what to focus on. Reuse of material comes with a lot of challenges and these differ depending on material. Various approaches on how to manage each of the existing material can also be developed, so one of the largest questions during this process was what to focus on. The largest amounts? The most environmentally demanding material? The most interesting from an architectural point of view? 100 % of the material or just a part? The easiest to reuse? The most characteristic for the area? Whole elements or smaller pieces? The list can be made endless – to have a clear strategy from the beginning facilitates the reuse process.



Detail from the existing wooden door.

conclusion

In this project, the possibilities and challenges of circulating material on site have been explored. This was achieved through a case study of a building at Tredje Långgatan in Göteborg, which according to the new detail plan proposal is allowed be demolished.

The challenges were mainly related to the lack of established procedures for how to approach the existing material. The large amounts of different material made the process time consuming and difficulties of which material to focus on were encountered. The largest opportunity of circulating material on site is to learn from the existing design and material. To consider the existing is a way to gain knowledge of what can be reuse and what cannot – which is probably the best way to improve future material circulation. This approach challenges the concept of demolition and generates an increased awareness of the value of resources.

The quote below comes from a discussion with a retired architect – highlighting the importance that architects are present and aware about the demolition of buildings. To explore the existing is a way to avoid making the same mistakes again and instead make some more conscious material and design choices.

”*Let’s make mistakes - as long as we make new mistakes*”

RETIRED ARCHITECT
about the lack of knowledge transfer from
the demolition process back to architects

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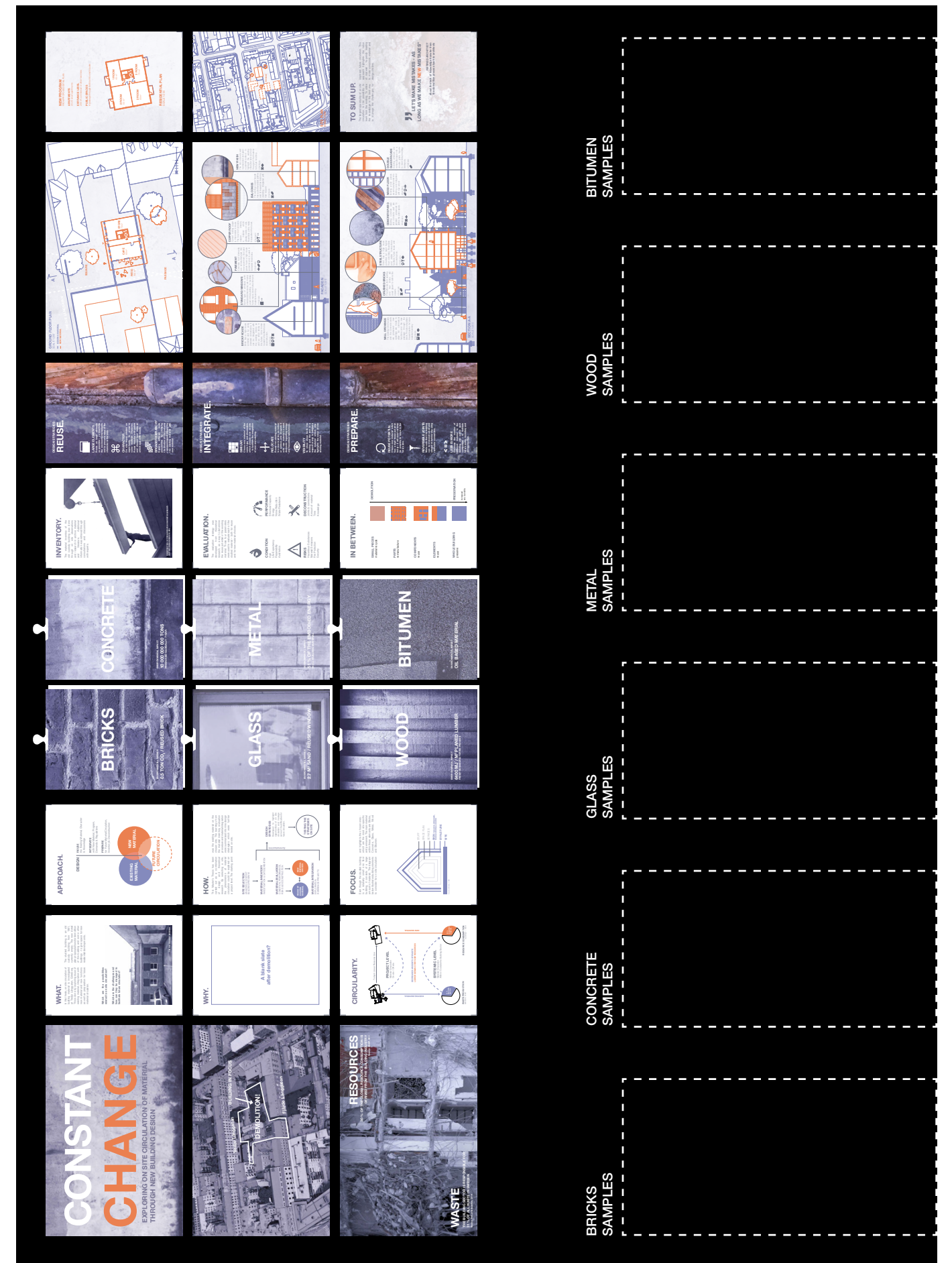
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APPENDIX I - POSTER LAYOUT

The posters for the final exhibition were a large part of the development of this project.



APPENDIX II - PROPOSED DETAIL PLAN

The suggested detail plan for the studied site (Göteborg SBK 2016).

