LEFT [OVER]

Methods to make use of the unused

Olof Hedner

Master's Thesis

2024

Chalmers University of Technology
Department of Architecture and Civil Engineering

Examiner: *Daniel Norell*
Supervisor: *Daniel Norell*

There will be people who say “you can't”, but you will.

There will be people who will say “you don't mix this with that” and you will say “watch me.”

There will be people who will say “play it safe, that's to risky” and you will take that chance and have no fear.

You won't let these questions restrain or trouble you.

You will point yourself in the direction of your dreams.

You will find the strength in the sound and make your transition.

Underground Resistance
“Transitions”

Excerpt from lyrics

LEFT [OVER]

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UNIVERSITY OF TECHNOLOGY

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C : 100 %
M : 90 %
Y : 10 %
K : 0 %

Abstract

In an extractive building sector marked by substantial turnovers, recent supply disruptions have exposed the fragility of long-term material planning. Tiny delays can cause seismic effects in a reality where just-in-time orders are key for meeting deadlines. Dealing with leftover building materials due to safety margins is a common dilemma in the construction industry, and the lack of regulations in Sweden has created an informal but small market of reselling. However, this alternative turns out insufficient for big actors where irregular quantities, processing time, and unprofitable returns make leftover trade into a mostly avoided concern.

This thesis develops a method where common leftover building materials are used outside of their conformity. Referencing Charles Jencks' and Nathan Silver's notion of *Adhocism*, the research employs urgency and purpose through assemblage design. Research on current reuse practices are conducted to create a systematic view, including *Rotor DC* in Brussels and the Swedish initiative *CCBuilds*. Much like Martino Gamper's project *100 chairs in 100 days*, the method strives to map and use what is discarded and readily available instead of searching for perfect parts.

Departing from an assemblage case study of 400 leftover roof tiles, a site has been selected in the rural municipality of Sotenäs, north of Gothenburg. At the former granite quarry Udden in Hunnebostrand there is currently a discussion to establish *Stenens Hus*, a national centre for stone industry and art. Sotenäs, a municipality with a relatively large building stock compared with its population, acts as a sourcing ground for materials in quantities approximated from annual municipal leftover rates. The proposal suggests how *Stenens Hus* could be assembled using such leftover material, including discarded granite quarried at Udden.

The research design employs mixed methods, combining quantitative and qualitative approaches in four stages: inventory, translation, embodiment and implement. The outcome suggests systemic ways in which leftover materials could be organized in a rural Swedish context as well as speculative ways to combine various building materials outside of their intended use.

Keywords: *Adhocism, Assemblage, Reuse*

Contact

Olof Hedner

+46 (0) 72 330 60 20
olof.hedner@gmail.com

Academic

Master of science (MSc) *2022 - 2024*

Chalmers University of Technology
MPARC - Architecture and urban design
Gothenburg - Sweden

- *Master's thesis in architecture*
- *Master's thesis preparation courses*
- *Matter space structure 2*
- *History, theory and methods 5*
- *Architectural competitions*
- *Architecture and urban space design*

Erasmus student exchange *2021*

Instituto Superior Técnico
Integrated Master in Architecture
Lisbon - Portugal

Bachelor of science (BSc) *2018 - 2021*

Chalmers University of Technology
Architecture
Gothenburg - Sweden

Professional

White Arkitekter AB *2022*

Internship
Gothenburg - Sweden

Award

Wernstedt sketch fund *2023*

Student competition
2nd prize

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Index

Introduction

Background

In the realm of the Swedish building sector, characterised by its multi-million kronor turnover rate, there has traditionally been an emphasis on long-term planning for facilitating the right amount of material at the right time to a certain construction site. However, this structured approach has revealed its fragility in recent times, most notably during the disruptions caused by the recent global pandemic. Delays, uncertainties and increased material costs has exposed a trade network susceptible to shocks, forcing us to reconsider our methods of planning and the utilisation of available building materials.

The uncertainty generated by an overly optimized supply chain are increasingly subject to inaccurate assessments of material orders, leading to an oversupply of surplus materials accumulating at construction sites. In Sweden, there is a lack of clear legal statements regarding the responsibility for these new leftovers, resulting in the emergence of informal markets for building materials that many times fail to circulate materials that are notoriously difficult to manage and dispose. This unsustainable model inadvertently perpetuates an extractive economy, failing to encourage and appreciate the potential for creative use of new but leftover materials.

In stark contrast, the use of leftovers as a result of resourcefulness is epitomized by architectures of the impoverished. By looking at the favelas of Brazil or any other non-pedigreed architectural culture as famously documented by Bernard Rudofsky (1964), it underscores the value of making use of what is readily available close to the construction site. It is a form of spontaneous architecture, flexible enough to withstand the tides of societal change. Leftover use by our means thus boils down to a question of will and determination, as it regards new and fully classified materials but in small and indeterminable quantities. Implementing resourceful building practices marks one of the most substantial attitudinal changes our modern construction industry has to adopt, however, this shift firstly has to start by questioning the conventional paradigm of wastefulness.

By referencing Jencks' and Silver's notion of Adhocism (1973), this thesis seeks to explore the realm of ad hoc solutions, which are deeply rooted in human creativity, and to ascertain what can be done to return to more imaginative, resource-efficient methods in the construction industry, harnessing the inherent potential of leftover building materials in dialogue with the specifics of a site.

Reading instructions

This thesis is laid out as a design-research academic paper. By following the index headings, the work is divided into a mainly theoretical part covering the subject background (Introduction, Theory, Method) and a mainly practical part covering the design material (Inventory, Translation, Embodiment, Implement). Pages are coordinated according to the subheadings listed in the index, meaning that one subheading covers one topic. References are conducted through the APA reference guide, including a bibliography at the end.

Research questions

Main questions

What methods are there to use new but leftover building materials outside of their conformity to form larger architectural assemblages?

What methods are there to combine small quantities of different leftover materials with site-specific artefacts for a public building proposal?

Subquestions

How can new leftover resources be systematically organised in an area without the current infrastructure for reuse circulation?

How can a building proposal be predicted by the specific measurements of standard products most likely to be left unused?

What aestetic and functional qualities can be achieved by the creative use of leftover materials and site-specific artefacts?

Objectives

By conducting this thesis, the main objective is to propose a public building design which utilises new but leftover materials. Additionally, it aims to critically examine leftover theories and practices, identify common leftover materials in a Swedish context and explore various design methods for incorporating leftover materials into architectural assemblages. By the selection of a site for the proposal, new leftover materials are combined with site-specific artefacts to inform a situated public building design.

Discourse

The idea for this subject comes from a personal belief that all material bears potential use when approaching with a frugal mind. For example, when in the process of laser-cutting a slice of plywood, I want to make use of the board as much as possible. This leads me to also print pieces that was not part of the intended output, just because there was room for it on the board. As one of the limits are set by the material scope, it is way more fulfilling to work creatively.

As theorised by Kate Raworth in her formative work Doughnut Economics (2017), all economical endeavours should and will be set by social and ecological boundaries. Social, as the human collective has stipulated a social foundation of well-being that no-one should fall below. Ecological, as there are an ecological ceiling of planetary pressure that we should not go beyond. Raworth calls the space created in-between these boundaries for "the safe and just space for humanity" and illustrates this model in the form of a doughnut (Raworth, 2017). The aspiration is to operate within this space by finding solutions that are both ecologically responsible and socially beneficial. However, this is not true for the current ordering basis in the building sector.

As Mark Wigley (2021) resonates, the current economical model is feeding extractive thinking through an architecture that veils material geography, as contemporary buildings are likely to be constructed by parts from every continent. In this context it is relevant to question the existing trade system, one with razor-thin margins and fragility to delays. Small disruption can cause devastating effects as global trade routes relies on a handful of choke points. Meeting a deadline can be more valuable than having the right parts, thus stakeholders will be urged to replace delayed parts with other available sources. This could cause an accumulation effect where ordered material will be replaced and the delayed material will not used in the project, thus becoming a leftover.

As pressing as the climate crisis is and the impact the contemporary building sector imposes, the topic of enabling building material left unused as a result of delays and faulty orders is a relatively unexplored field. In a Swedish context, there are physical locations where unused building material can be turned in, such as Återbruket in Gothenburg or Återbyggsdepån in Malmö. However, the issue is foremost logistical as these institutions have more to garner than they have room for.

Another side of the logistical problem was examined in a recent feasibility study for the Swedish Environmental Research Institute (Miliute-Plepiene & Moalem, 2020), set to research how to increase the circular use of construction and demolition material within the Swedish building sector. When conducting surveys with companies and craftsmen on the topic of donating materials for reuse, the main reason not to conduct reuse practices is that it is too expensive to disassemble and prepare the material. The second-most chosen reason is that the material quantity is too insufficient. (Miliute-Plepiene & Moalem, 2020, p.21)

One could argue that the act of storing unused materials for "better use" is a typical endeavour in Swedish vernacular tradition. However, in a reality where building processes are exceptionally optimised and time triumphs resource frugality, the problem lies in finding creative approaches of utilisation before the leftover materials falls into neglect. The problem calls for methods where materials can be used with urgency for specific purposes, as theorised in Jencks' and Silver's book Adhocism (1973), discussed further on. As a concept, even though being of postmodern origin, adhocism inherently challenges the historical separation between sustainability and creativity. Emphasising the use of readily available materials and building techniques, it represents a good starting point for leftover material embodiment.

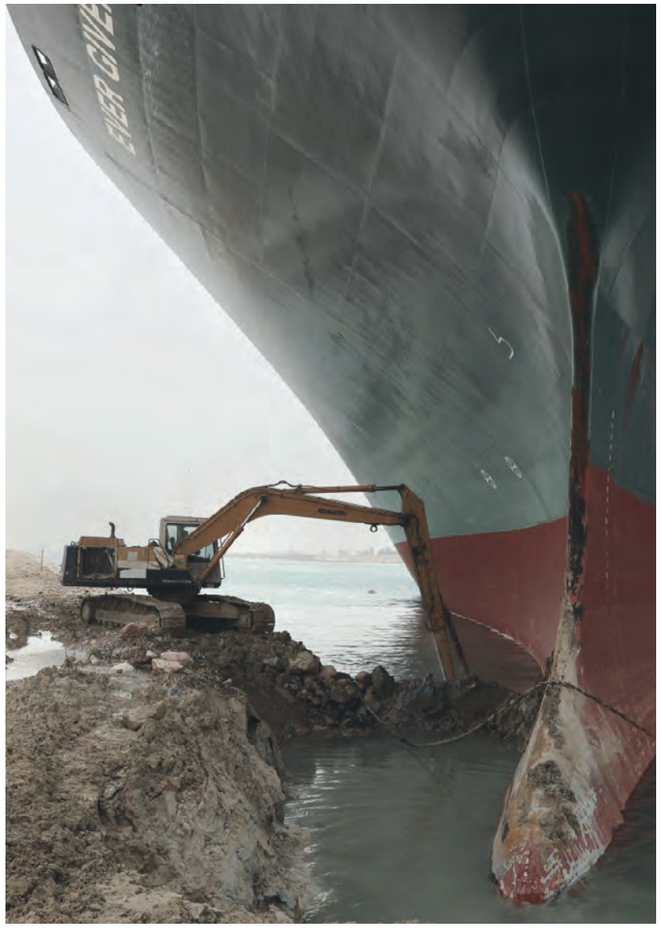


Figure 1: *During the six days the Ever Given container ship was blocking the Suez Canal in march 2021, an estimated US$9.6 billion worth of trade was held up from passing through the canal each day (Harper, 2021). The blockade caused long-term delays and a spike in prices for various consumer goods.*

Note: *"Photo release" by Suez Canal Authority. Copyright 2021. Reprinted with permission. Edited by author.*

Aim and delimitations

This thesis aims to find methods where typical materials found leftover are used in larger architectural elements through assemblages and material combinations. The methods used should challenge the attitude regarding building material as an always available, just-in-time, product. By doing so, the conducted research asks whether there are ways to combine typical leftover material with more site-specific elements at a site of implementation. If yes, how can these combinations be aesthetically and functionally implemented and organised into an chosen architectural spatial program?

When choosing this topic, the aim is to make sustainable practice an intrinsic part of the thesis. It is of utmost importance to critically address the abundance of extracted material in a world where resources are finite and environmental impacts are clearly visible. Theoretically, this thesis should probe the economic and extractive underpinnings of the building sector by interrogating its very core, the optimised yet fragile apparatus which is global trade. This process can thus uncover sustainable models benefiting both stakeholders and the environment.

The material definition in this thesis is not only confined by unused new material. In an extended definition, leftovers also includes materials extracted but left unused for a long time, such as processed stone from former granite quarries. A distinction is made by referencing to these old leftover materials as artefacts. By salvaging and creatively re-purposing the extracted material that might otherwise go to waste or become forgotten, this thesis suggests ways to imagine architectural creation by resource frugality. However, it is important to note that this thesis does not cover materials salvaged as building demolition material, thus defining the research scope. The strategy is to base the research within the broader context of sustainability and point towards the urgency to include alternative ways of thinking about material use within the building sector. Aligning with the sustainability imperative, it seeks to contribute rather than redefine the present discourse.

Hence, It is pivotal to emphasize that this thesis does not seek to provide definitive solutions to broader sustainability issues through material use. Instead, its purpose is to spotlight the potential of leftover materials as available resources for building design. It is also essential to note that this thesis will not address the legal ramifications for combining specific building materials outside of their conformity. The focus remains firmly on design and the creative possibilities inherent in leftover materials.

As this thesis will take a global perspective on systemic problem formulations, it will base the design research in a situated context. As design is situated, the inventory will be defined in scope while taking the systematic view into consideration.

To summarise the stated aim and delimitations as procedure, the research will evolve design methods from assemblage techniques into bricolages, essentially a do-it-yourself approach. From this, a site is selected for implementation and the possible use of site-specific artefacts. The goal of this thesis is thus to find new and spontaneous ways to deal with this type of leftover building material, unused post-assembly. This is then combined with the material possibilities a selected site has to offer. This will result in a situated building design proposal.

This thesis is about:	*This thesis is not about:*
▪ *New leftover materials*	▪ *Reused demolition materials*
▪ *Site-specific artefacts*	▪ *Broader sustainable solutions*
▪ *Assemblages*	▪ *Legal possibilities for reuse*
▪ *Public building design*	▪ *Systemic solutions*
▪ *Situated design*	▪ *Generic design*
▪ *Small to medium scale*	▪ *Global scale*

Vocabulary

Ad hoc	From Latin meaning “for this” or “for this situation.” In modern English it is used to describe something that has been formed or used for a special and immediate purpose, without previous planning.
Adhocism	Noun form of ad hoc, used to describe the temporary, provisional, or improvised methods to deal with a particular problem, the tendency of which has given rise to Jencks and Silvers theory with the same name.
Artefact	An object made by human hands with high cultural and historic significance. In this thesis, artefact is used to describe processed granite objects left unused at the quarrying site due to faults or changes in the order.
Assemblage	From French meaning a collection or grouping of unrelated objects. It can also point to materials joined together forming a new function or meaning. In this thesis, assemblage is used to describe a certain technique or method of joining materials.
Bricolage	From french meaning “DIY” or “do-it-yourself projects”. In the arts, bricolage is the construction or creation of a work stemming from a diverse range of things that happen to be available, or a work constructed using mixed media.
Leftover	Something remaining after the rest has been used. In this thesis it is used to describe extracted and prepared materials left unused after the process where it was intended to be used or have been produced.
Spontaneous	Something proceeding, developing or occurring from natural feeling or native tendency without apparent external influence, force, cause, or treatment. In this thesis, It is used to describe the use of material without any preconceived notion of what it is purposed for.

Urgency and purpose

The starting point of the theoretical framework for this thesis surrounds the idea of ad hoc practice. The term adhocism was coined by Charles Jencks and Nathan Silver in 1968 and later expanded in a book with the same name (Jencks & Silver, 1973). At its core, adhocism embodies the spirit of urgency and purpose towards goal-oriented problem-solving. It is a type of methodology driven by the notion of "for this," where immediate solutions are sought and crafted with whatever resources are readily available. In the most rudimentary definition, adhocism is human creativity in what develops into vernacular solutions. It is also an approach integrating resourcefulness and adaptability in its very definition to architectural design and problem-solving, as it aims to make use of whatever is available or left unused to create functions of higher value.

In a more general sense, adhocism is creation through the manipulation and rearrangement of existing elements that is available at the moment, in order to answer a very specific problem. This is, philosophically speaking, a behaviourist perspective on process. Jencks and Silver (1973) contrasts this to a deterministic approach, e.g. scientific hypothesis, where rigid structures and singular methodologies are key for result conclusion. Adhocism thus embodies flexibility and adaptability in both tools and method as well as material and outcome. According to the authors, the modern world is too complex for singular planning principles. Nothing can be created "ex nihilo", out of nothing. Cities and buildings are several structures put together to form interconnected networks, or systems. In relation, adhocism thus seeks to address creation from subsystems, where a new system is created through combination of former systems (Jencks & Silver, 1973). In relation to this, one can argue that adhocism is too permissive as it preserves the status quo of former systems. However, as it also is transitional, ad hoc lives on the premise that the future goal of mankind cannot be specified in advance.

The book Adhocism is coloured by a time when there was a huge influx of standardised production. As a method of reducing cost and increasing speed, Jencks and Silver points out the sheer investment needed for producing a single production line for a mass market product. Consequently, a myriad of people are responsible for one design in standardised production, for example in car production where every part of the car is the optimised result of a production team consisting of several engineers and designers. Uses of ready-made subsystems thus becomes a hard task in a streamlined consumer democracy. However, humans use conventional products in new ways, as Jencks and Silver exemplifies with the use of knives as screwdrivers or toothbrushes as cleaning tools. In this context, the authors estimates that perhaps 80-90 percent of the built world is ad hoc and that there is no need to start every design problem from scratch (Jencks & Silver, 1973).

Jencks and Silver connects this expanded definition of adhocism to architecture through questioning the extreme visual simplicity found in the built form of the modern movement. In contrast, adhocism would look towards the aesthetics of solving a specific problem articulately. In the combination of subsystems, it would then become evident what their previous history was, why they were put together and how they work (Jencks & Silver, 1973). The articulation of subsystems would thus celebrate the unique expression of individual solutions.

Figure 2: *Jencks and Silver (1973) mentions Bruce Goff as an exemplary architect utilising ad hoc embodiment. In the case of Hopewell Baptist Church, designed by Goff in 1952, the exterior frame are made out of salvaged drill stem pipe from surrounding oil fields.*

Note: *"Hopewell Baptist Church" by Rocketchess is licensed under CC BY-SA 3.0. Edited by author.*

The unexpected outcome

There is a modern conception and possibly a contemporary reality that architects does not involve themselves in design tasks utilising unplanned leftovers and thus produces unexpected results. As the prime task for an architect is to plan ahead, there are nowadays little to few possibilities for spontaneous design by involving in ad hoc undertakings. As Jencks and Silver (1973) puts it in the opening section of Adhocism, ad hoc design strives towards an action that leads to an immediate and purposeful result. Semantically, the authors compares adhocism to the French label of bricolage, as explained by anthropologist Claude Lévi-Strauss (1966):

> *The "bricoleur" is still someone who works with his hands and uses devious means compared to those of a craftsman… The Bricoleaur is adept at performing a large number of tasks; but unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and pronounced for the purpose of the project. His universe of instruments is closed and the rules of his game are always to make do with "whatever is at hand" … The engineer is always trying to make his way out of and go beyond the constraints imposed by a particular state of civilization while the "bricoleur" by inclination or necessity always remains within them*

Claude Levi-Strauss (1966. p. 11–13)

In contrast to traditional craftsmanship, where specialised tools and materials are employed, the bricoleur works with a diverse range of tools and materials, often adapting them for novel tasks. The modern translation to a bricoleur would be a handyman, able to improvise with the means of material he or she has to work with. Examples of bricolage structures are plentiful, often unknown and undocumented, but it is maybe not always the primary method for mainstream architectural practices, where time is connected to a budget plan. However, there are some exceptions.

An example of an office that commonly works out of these principles is RaumlaborBerlin. In the project "[Working on] common ground", RaumlaborBerlin was involved to lead a workshop and summer school in the realm of a former brick factory in Prishtina, Kosovo (Foerster-Baldenius & Liesegang, 2022). As a future goal is to turn the factory into a cultural hub, the workshop engaged citizens and volunteers to reclaim and re-imagine the site by conducting practical tasks such as dismantling, rearranging and constructing the material of the buildings. With a mindset of a bricoleaur and spontaneous underpinnings, as in by using whatever material lying in front, new functions were created based on civilian imagination and interests.

Even though the pure definition of bricolage puts emphasis on non-planning principles, design stemming from these fields are commonly a result of a target approach within the framework of a time limited task. A visual example would be the work of Martino Gamper and the project "100 chairs in 100 days'' (2007). As the title suggests, Gamper assembled one chair a day for 100 days with parts from former discarded chairs. It is an example of a method-into-design approach, as the goal was simply to produce a spontaneous design with the elements collected. As Gamper himself describes:

> *I didn't make one hundred chairs just for myself or even in an effort to rescue a few hundred unwanted chairs from the streets. The motivation was the methodology: the process of making, of producing and absolutely not striving for the perfect one. This kind of making was very much about restrictions rather than freedom. The restrictions were key: the material, the style or the design of the found chairs and the time available — just a 100 days. Each new chair had to be unique, that's what kept me working toward the elusive one-hundredth chair.*

Martino Gamper (2007)

Figure 3: *Exhibition of "100 Chairs in 100 Days" by Martino Gamper (2007) at Cromwell Place, London.*

Note: *"100 Chairs in 100 Days, Cromwell Place" by Angus Mill. Copyright 2007. Reprinted with permission. Edited by author.*

Temporary permanence

The examples of Gamper and RaumlaborBerlin both delve into the topic of ad hoc design through practical intervention. However, the projects are made possible through their limited time frame. The project by Gamper was initiated as a personal project with a methodology in mind whereas the basis for the Common Ground project was to engage citizens in participation. They both result in a great variety of outputs but they are both temporary in nature. That temporary interventions can transform into permanent solutions is widely known, especially in settings where planned solutions are not economically viable, such as in Brazilian favelas (Loschiavo Dos Santos, 2000).

The aesthetics of such informal solutions has in some occasions been translated into planned permanent design, even though that not always include the material aspect. In a Swedish context, this has been achieved by firms like Byggfenomen in Stockholm and their project “Fenced Maximalism,” described in The Swedish Review of Architecture (Zimm, 2020). Confined within a tightly defined plot in order to minimize the elimination of surrounding trees, the exterior is articulated by a fence-like facade. The plan is spread out over ten different elevations with both interior and exterior functions such as kitchen, bedroom, bathroom as well as a tulip garden and a rain water pool. Every level is treated with different material atmospheres, alluding to an temporary aesthetic created ad hoc, although the spatial program is a result of client requests and materials were traditionally ordered.

In the field of urban planning, there are numerous examples of methods testing temporary solutions before establishing them as permanent. Within the framework of Gothenburg’s 400th anniversary, the Jubileumsparken park emerged from a vision of planning through place development (in Swedish: Platsutveckling), a method developed by the city municipality to understand the character and function of a location before significant permanent solutions are introduced (Göteborgs Stad, 2016).

This kind of temporary urban planning methods may bear various names such as “living labs”, “test beds” and “innovation hubs”. What they have in common is an exploratory approach to testing architectural approaches in a provisional state before construction. In a recently published book (Dahl et al., 2023), the project Prototyp Göteborg, a municipal initiative focusing on the jubilee summer of 2023, is summarised in short texts and illustrations by various urban planning stakeholders. As described, Prototypes are used in the manufacturing industry to test and develop new products in mass production, however they have become the subject of architectural interventions in recent years. Within the initiative, architects, designers, and students have all contributed with the construction of architectural prototypes at a 1:1 scale, in connection to the permanent development of Jubileumsparken. The book discusses the reasons for building prototypes and highlights various prototype structures constructed during the emergence of the project.

Figure 4: *The rain water pool at “Fenced Maximalism” by the Stockholm office Byggfenomen, where rain water is collected at one floor and drained as a natural shower into the pond below.*

Note: *“Fenced Maximalism - Byggfenomen” by Henrik Nielsen. Copyright 2020. Reprinted with permission. Edited by author.*

Leftovers as trade

When it comes to constructive materialisation of any type, the most conventional approach for material planning is centred around just-in-time ordering. This approach, as dissected by Nellie Jepsson (2021) through interviews with representatives from PEAB (one of the largest construction firms in Sweden), is particularly favoured by large enterprises due to its practical advantages. According to a PEAB project manager, the procurement of materials is primarily resolved within the contracted construction firm where just-in-time ordering decreases the amount of stored materials, otherwise subject to external damage. Nevertheless, several factors can lead to ordered materials being left unused, as the project manager counts the three leading reasons being (1) altered design post-order placement, (2) material spillage during installations such as window fitting and (3) faulty orders due to overestimations (Jepsson, 2021).

While there may be opportunities for larger construction firms to redistribute surplus materials to other ongoing projects, the extent to which this occurs varies (Jepsson, 2021). Despite this, a notable volume of leftover material circulates to the extent that there are specialised institutions dedicated for the handling and resale of such materials. Prominent actors in Sweden include Återbyggsdepån in Malmö and Återbruket in Gothenburg where materials, old and new, can be turned in. The quantities are substantial, exemplified by the 600 metric tonnes of materials processed at Återbruket in 2023 (P. Hogedal, personal communication, February 2, 2024). However, these institutions cater mostly to private stakeholders as the unpredictable nature of their supply makes it an unreliable partner for larger firms, where precise procurements and correct classifications is of utmost importance (Miliute-Plepiene & Moalem, 2020, p. 17-18).

As for reuse institutions, it can be argued that effective exchanges correlates with size and comprehensiveness in cataloguing available resources. Ideally, there should be a minimal distance between resource preparation and design, a methodology not uncommon among specialised architectural firms. One of the more well-known actors in this field is Belgian office Rotor, awarded for their reuse design research in the Global Award for Sustainable Architecture (UNESCO, 2024). In 2016, Rotor introduced a subsidiary named RotorDC, a specialised affiliate for deconstruction, in charge of a marketplace for recycled construction products existing both physically and online. What distinguishes Rotor is their approach of transferring demolition materials from their own projects to the marketplace, accompanied by thorough documentation and procurement. Every item is properly catalogued and listed in their online shop, facilitating easy access for stakeholders seeking specific products. Additionally, Rotor boasts an acquisition team in charge of scouting new materials and forging partnerships, making the office highly proactive in its operations (Rotor DC, 2024).

Similar to Rotor, the Swedish Centre for Circular Building, or CCBuild, managed by the Swedish Environmental Institute, boosts a comparable digital platform and offers expert advisory services for the resale and reuse of surplus construction materials within the Swedish building sector (CCBuild, 2024). Although still in development, the platform has already gained interest from numerous major construction entities. What distinguishes CCBuild's platform is its robust categorisation and inventory capabilities, which assess factors such as aesthetic condition, environmental impact, and market value, streamlining the practice of reuse.

Figure 5: *RotorDCs facility in Brussels, Belgium. As their prime specialisation lies within the procurement of building parts, they have a vast selection of doors, windows, fixed furniture, ceramics, wood and much more.*

Note: *"Doors Pavilion" by RotorDC. Copyright 2024. Reprinted with permission. Edited by author.*

Method

Research design

As a matter of choosing a research question based on a general questioning of material use, this thesis calls for a mixed methods research design. Initially, a more quantitative (general) research is put to use in order to form a library of possible leftover building material. Data will be collected from literature studies by asking what types of material usually end up unused and by making observations of various sites. As a parallel process, this method is also used to determine possible sites for a design intervention.

Following this, a more qualitative (specific) research will be used for conducting a design proposal at a chosen site. In this iterative research-through-design process, leftover materials will be assembled and combined with site-specific material in order to form a building proposal.

As with both research designs, but especially with the specific research, there has to be room for unexpected results. Thus, these phases are meant to be general enough for iterative design changes.

The general research is divided into two phases:

Inventory A quantitative collection phase where sites, materials and techniques are investigated and mapped. A case study is conducted in order to test materials in various assemblage techniques.

Translation A modification phase where the knowledge gathered is being tested in a situated scenario. By analysing the site for a design intervention, Materials are adapted according to the specific typology of the region.

The specific research is conducted in two phases:

Embodiment By using the knowledge created in previous phases, materials will be iteratively combined to form architectural elements, according to the spatial configuration of the site intervention.

Implement Taking the designed elements from the previous phase and implement them according to a program and adapted so that created spaces benefit the site in terms of value and usability.

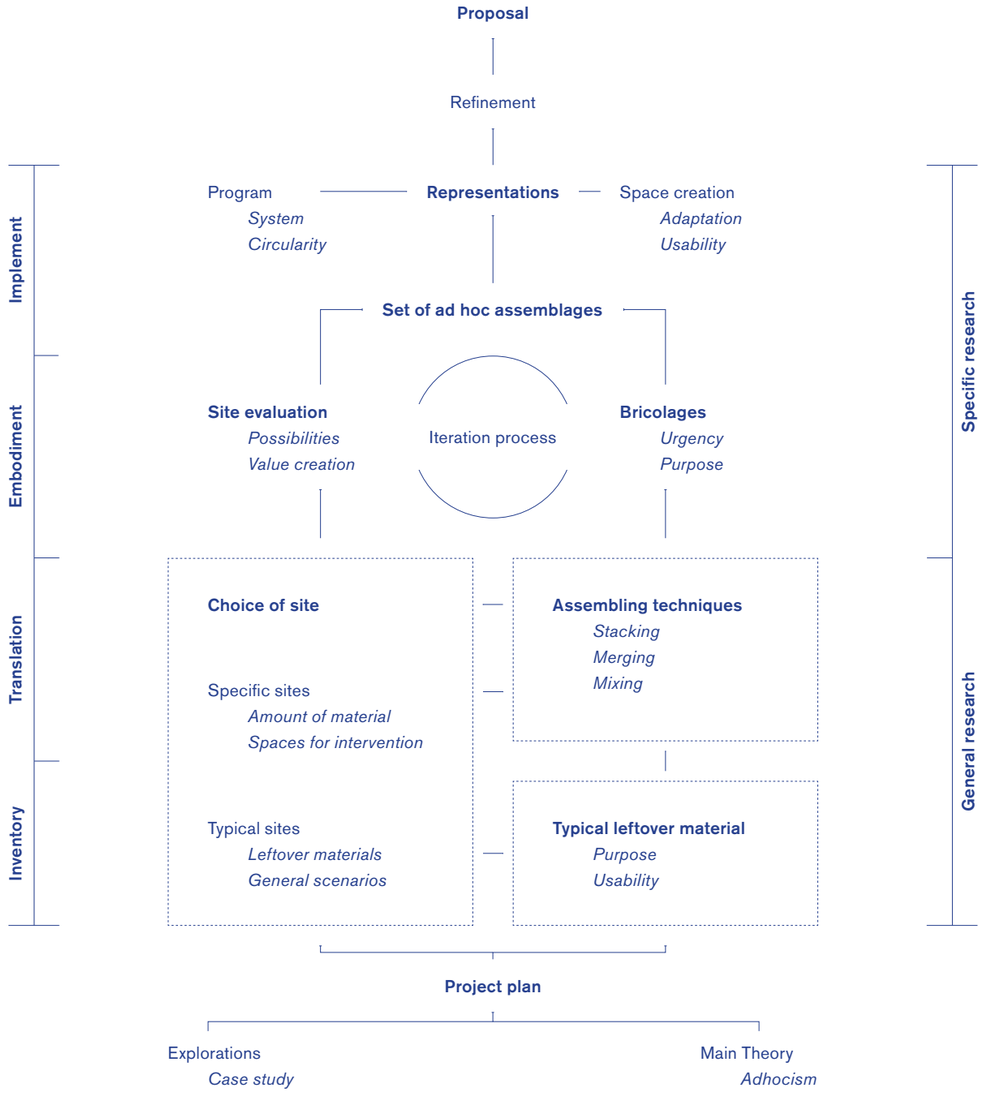


Figure 6: *Methodology diagram covering all pre-planned phases from project plan to final proposal. Please note that the following chapters, using the same names as the phases presented, contain outcomes which overlap with the contents of the pre-planned phases.*

Graphics: *Author*

Method references

Figure 7: *San Clemente al Laterano*

Rome, Italy
1123

The Basilica of San Clemente in Rome is built upon several former structures that are excavated and open for visitors (Basilica of San Clemente, 2024). The uppermost middle-age basilica stands as the quintessential example of spolia usage, which is the Roman term for reuse of building materials (Oxford Reference, 2022). In the courtyard, visually similar capitals taken from former Roman structures has been incorporated to form a colonnade.

Photography: *Author*

Figure 8: *Frankish Castle of Parikia*

Paros, Greece
1260

Built in the 1200s by the Venetian family of Sanoudo, the tower wall of the former castle stands today which is said to be the ancient temple of Demeter (Perantinou, 2012). The wall is another example of spoilation, however it is unclear if the various stones was once used for building purposes. This makes for a visually striking composition, especially with the incorporation of the circular stones.

Note: *"Tower, Frankish Castle of Parikia" by w_lemay is licensed under CC BY-SA 2.0. Edited by author.*

Figure 9: *Muuratsalo Experimental House*

Alvar Aalto
1954

The Muuratsaalo Experimental House by Alvar Aalto stands as the primary reference for handling small quantities of different materials to create an entity. The house itself consists of a small courtyard where the surrounding walls consists of more than 50 types of bricks arranged in different patterns, allowing Aalto to test various arrangements and follow how they react differently to natural wear (Sveiven, 2012).

Note: *"Muuratsalo Experimental house inner yard" by Alexignat is licensed under CC BY-SA 4.0. Edited by author.*

Figure 10: *Wall Assembly*

Andrew Kovacs
2018

Wall Assembly is an architectural folly constructed by Andrew Kovacs and his team at Maple St. Construct in Omaha, Nebraska. As the intention was to compose an installation fully from ready-made building materials, Kovacs has created a collage-like spatial feature where materials are arranged playfully (Kovacs, 2023). For this thesis, it will be used as a reference of how to create ambience out of standard materials.

Note: *"Wall Assembly" by Dan Schwalm. Copyright 2018. Reprinted with permission. Edited by author.*

Material quantities

As it seems like a rather simple task, finding measurements of what the most common materials in the Swedish building stock is and which expected quantities of each material will end up as leftovers is rather complicated. There are only a few conducted studies looking at the gross material stock in Sweden, which would be vital for prioritising what material quantities would be a reasonable assumption for a hypothetical leftover material library. Existing studies are also in turn somewhat outdated for a present understanding of material quantities and categories.

In a study by Roth and Eklund (2005), construction materials were analysed according to energy and resource perspectives in order to pinpoint what materials should be the main pragmatic focus in future sustainable construction. The authors argue that the main problem of the study was, as pointed out, to find representative and reliable data specifying materials. Thus, data was mostly collected from an outdated national inventory of materials in the Swedish building stock, conducted by the Swedish Environmental Protection Agency in 1996. This data was further summarized by Roth and Eklund in categories of quantity (see figure 11).

The study by Roth and Eklund (2005) further examines how materials could be prioritised according to embodied energy coefficients (energy per mass unit) and the expected service life for each material category. This results in a priory list with the most critical mainstream materials for reuse adoption, seen to embodied energy and service life. The four top materials will also become the main focus further on in this thesis:

1: *Wood materials*
2: *Bricks and ceramics*
3: *Concrete*
4: *Steel*

Roth and Eklund (2005)

Regarding what quantities of each material expected to be found left over differs widely between projects, materials and geography. One measure for understanding gross leftover quantities is the spillage share of materials during construction processes. In a report by Toller et al. (2022), conducted for Trafikverket (The Swedish Transport Administration), spillage is defined as material waste at the construction site for various reasons such as over-dimensioning of constructions, incorrect handling of materials, over-buying, cutting and more. As the definition goes, this would also include leftover materials within the framework of this thesis. According to a previous study by Trafikverket, Toller et al. (2022) lists the approximate spillage from concrete works as follows:

Structural concrete:	*5%*
Shotcrete:	*20%*
Prefabricated concrete:	*2%*
Rebar steel:	*10%*
Structural steel:	*5%*
Asphalt:	*5%*

Toller et al. (2022)

Even though these shares apply to large-scale infrastructural projects (as it originates from case studies of infrastructural projects conducted by Trafikverket), it gives an approximate indication of how much leftover material could be expected after an building process in general. Considering that most building materials will differ from the ductile nature of concrete types, the common leftover rate will be set to the lower share of 5% for the simplicity of this thesis. This is also due to not overestimating the possible quantities that could appear for the sake of the coming building program, which will use leftover materials as a primary source.

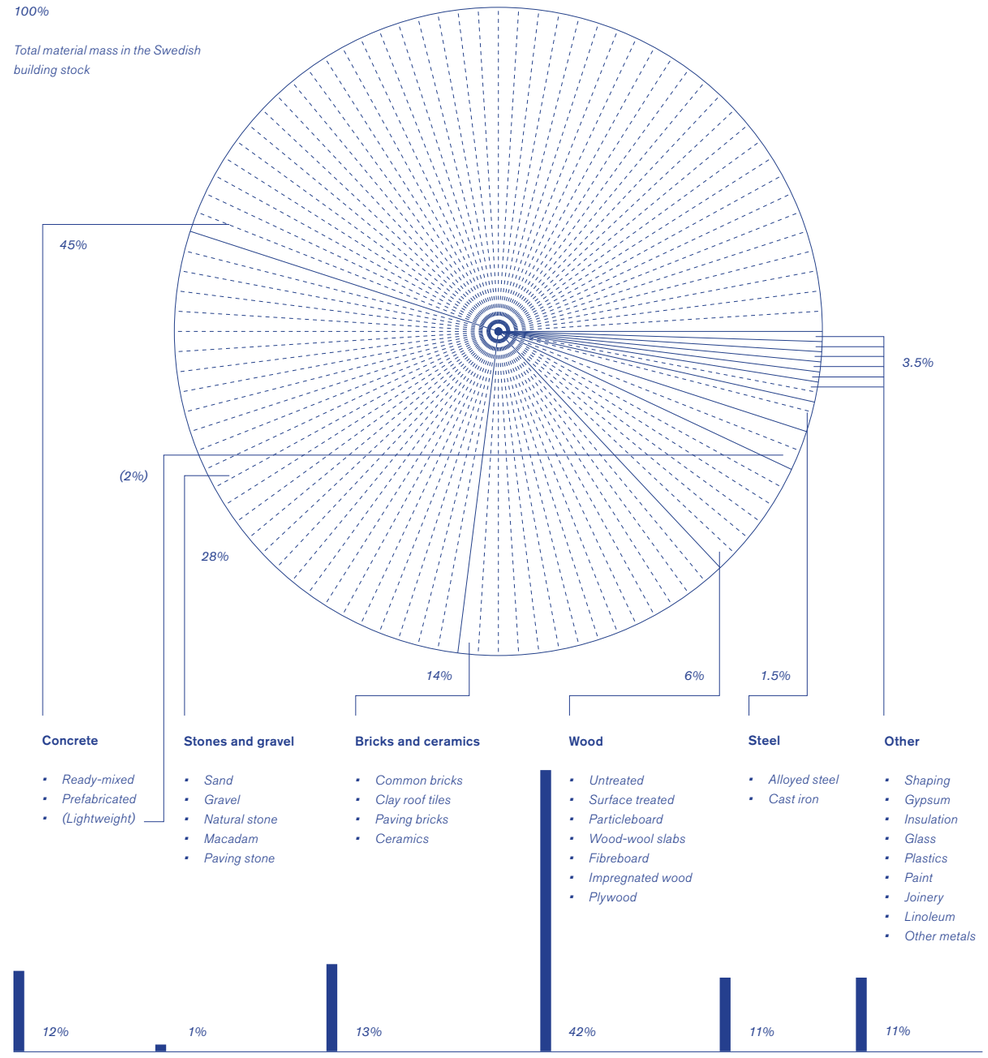


Figure 11:

Mass share of each material category in the Swedish building stock according to data from the Swedish Environmental Protection Agency. The categories are prioritized according to embodied energy and service-life indicators, as shown by Roth and Eklund (2005), resulting in which materials are most critical for reuse adoption.

Data source: *Roth and Eklund, 2005*
Graphics: *Author*

Assemblage case study

In order to explore various assembling techniques, one material was chosen for the scope of a case study. Acting as an available resource at the time, there was three pallets of roof tiles left over from a recent roof renovation at my parents house in Gothenburg. The reason behind this large amount is simply a wrongly calculated order. As the pallets were not intact, meaning the plastic wrapping was broken, the tiles could no longer be returned to the retailer.

The tiles makes a very practical example of new, unused building material never used for its intended purpose. In this case, the material falls into a juridical limbo state where not the retailer nor the contractor bear the responsibility to resell it. It is up to the client to resell or re-purpose the material. As there are institutions for leftover material handling in Gothenburg, such as Återbruket (a municipal marketplace for building material), the sheer amount and weight of the tiles makes them inconvenient for the private person to manage logistically.

The following documentation explores potential ad hoc solutions of converting one subsystem (the tiles) into new uses, as covered by Jencks and Silver (1973). The rule is to look past the intended use by combining the tiles with other readily available material, typically found at a renovation site. The explorations were laid out as a series of workshops with no to little initial planning, thus alluring to the spontaneous nature of bricolage. Departing from a resourceful mindset, any potential spill should be taken care of as far as possible.

In order to test the idea of turning assemblage techniques into bricolage objects, the results of the workshop was moved into a speculative scenario where three different architectural follies was designed using the found techniques (see figure 17). As the context consists of my parents garden, the scenario connects to the idea of using leftover material at site before it ends up at the recycle facility.

The case study was conducted through the following three workshops:

Stacking

- 1h preparations
- 1h assembling

By stacking the tiles onto each other, different ways of arranging the tiles were tested and patterns of attachment started to appear. Nothing more than the tiles were used and the workshop took place in the garden next to the renovation site (see figure 13).

Merging

- 6h preparations
- 72h hardening

By looking at emerged patterns from the former workshop, a beam-like element could be extracted. The idea was to assemble the tiles in order to create a structural element that could act like a beam or a pillar element (see figure 14).

Mixing

- 4h preparations
- 72h hardening

When the merged model got damaged by accident, the broken pieces used as ballast for a concrete mix. As the shape of the roof tile then becomes transformed, the sole idea was to test if the tile could be reformed but kept as material (see figure 15-16).


12.


13.


14.


15.

Figure 12 - 15: *Results of the case study. An adopted pattern from the method of stacking (12) became the basis for the merging workshop (13). Since the merged bricolage broke (14), the broken pieces were used in the mixing workshop (15).*

Photography: *Author*

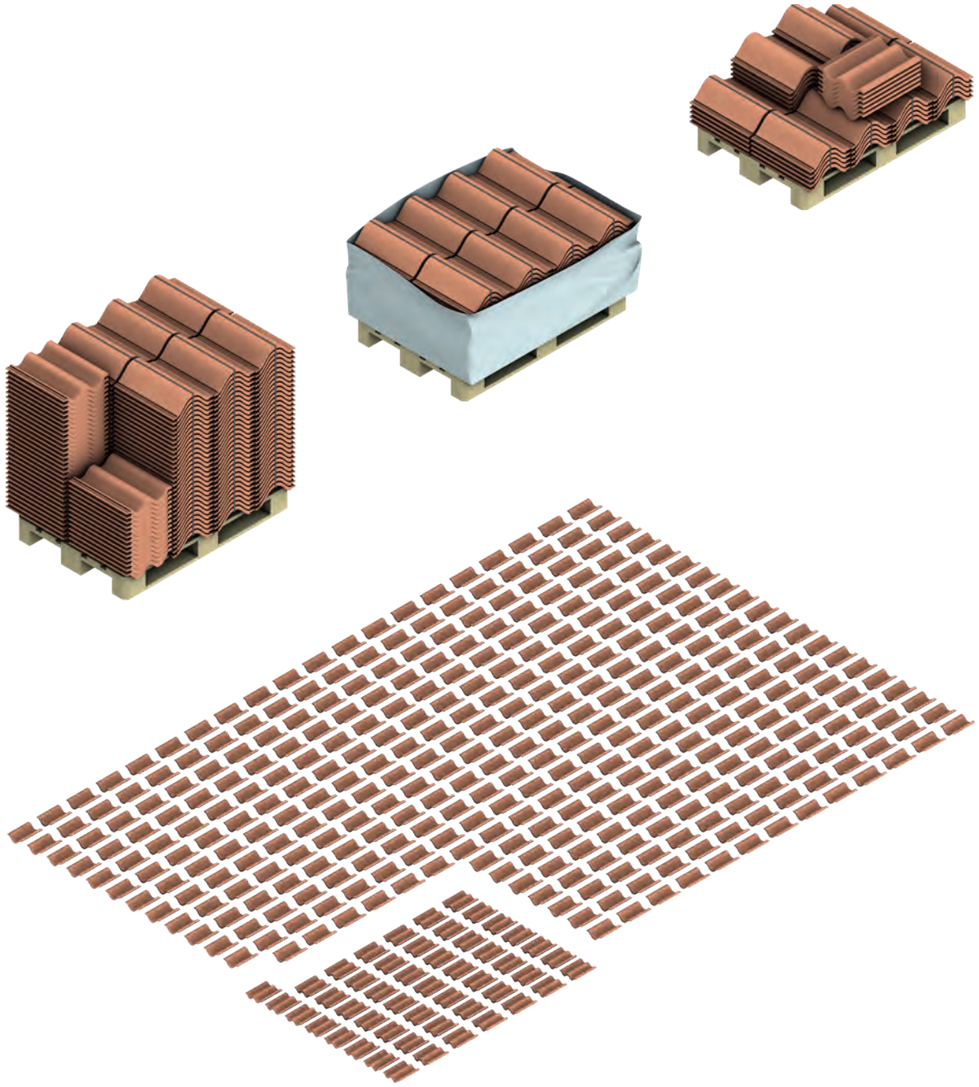


Figure 16:

Inventory of roof tiles, as found. At the site there was a total of three pallets that was left over from the renovation. There was a mix of both single and double cup tiles. In total, the pallets held 350 single-cup tiles and 50 double-cup tiles.

Graphics: *Author*

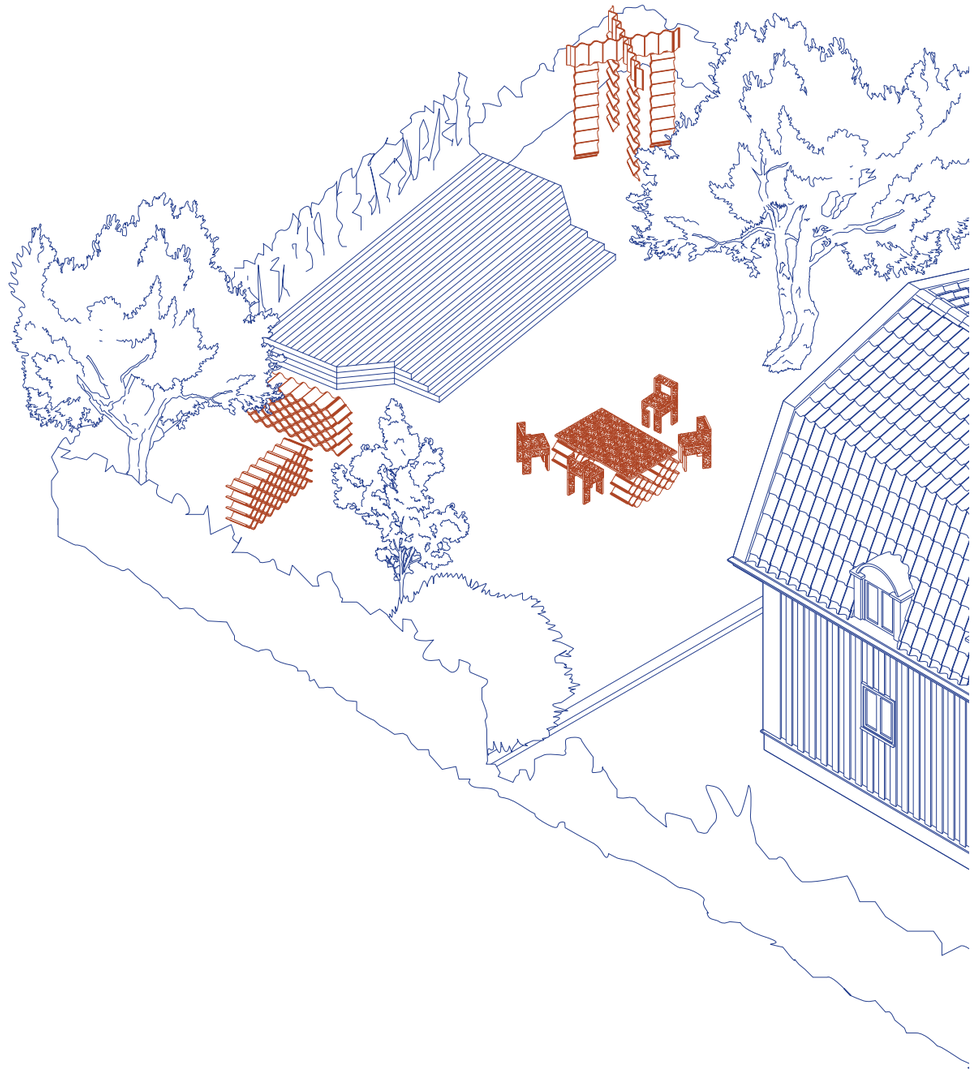


Figure 17:

Designed follies from the various assemblage techniques and their situated integration in the garden next to the renovation site. In a speculative scenario, the goal was to test how the various assemblage techniques can be used to spontaneously create pieces of architecture. Roughly 350 single-cup tiles have been used, the same amount as found post-assembly at the renovation site.

Graphics: *Author*

Site selection

In search of a site, regards is taken to find a place where the sourcing of leftover materials can be undertaken within a clearly defined geographical area. In a Swedish context, one such defined area, which also doubles as an administrative area, is the Swedish municipality. Even though the flow of materials can be traced on a national level, the planning legislation is primarily decided on a municipal level, making it the smallest unit in the decision-making process.

There is no doubt that different Swedish municipalities bear different possibilities for growth opportunities. As Swedish urbanisation patterns goes, differences between municipalities for growth and development largely depend on the geographical distance to larger urban areas. It is thus interesting to look at a more rural municipality for this type of material sourcing investigation. It also makes the task simpler in a sense, as rural municipalities tends to have less of a complex logistical network.

It also makes sense to look at a rural municipality in the context of reuse institutions. Whereas in urbanised municipalities, there are various networks for reselling reused materials, both physical and digital. These institutions are not as present in rural communities, where unused materials, if not saved and managed by the owner, tend to end up recycled rather than reused.

It should also be a site where there are concrete, or at least preliminary, plans for development. A requested building program could be used as a quantification tool in the scope of this thesis, in relation to what materials are available.

Sotenäs Municipality is located at the Swedish west coast, about 120 kilometres north of Gothenburg. Even though being a popular seaside holiday destination, the population lies at 9160 inhabitants as of 2022 which is the 57th lowest population count among Swedish municipalities (SCB, 2023). The municipality has a large building stock compared to its population as approximately 47 percent of all houses consists of holiday homes (SCB, 2022). With 91% of holiday home areas overlapping with urban area, Sotenäs has the highest share of urban vacation homes among Swedish municipalities (Lysekilsposten, 2022).

With this in mind, the site chosen for this thesis project is located at the former granite quarry Udden north of Hunnebostrand, Sotenäs. Nowadays being a grassy flat plane just next to the sea, the former quarry remind itself with its steep, clean-cut walls along the Nordre Hoge hill. As with all sites marked by the major quarrying boom at the turn of the century, the Udden quarry was left abandoned several decades ago. Today Udden counts as a recreational area, being a part of the seafront walkway between Hunnebostrand and Ulebergshamn.

When the municipal development plan for Udden changed (Sotenäs Kommun, 1996), it became clear that exclusive housing units were planned at the site. Loud protests rejected the proposal in 2010 and an EU-financed voluntary group emerged in the aftermath. The group initiated SkulpturSPARK, an annually reoccuring sculpure park at Udden, which is much appreciated by the local population as well as tourists (Lindberg, 2011).

After years of successful operation and the evident impact of SkulpturSPARK, the dedicated volunteer group identified an opportunity to further enhance Udden's status as the prime destination for stone culture. In a pilot study (Anderzon et al., 2020), the group advocated for the establishment of what they termed "Stenens Hus," or "House of Stone," to serve as a centre for stone industry, stone heritage, and stone art on a national scale. Drawing inspiration from similar Swedish publicly funded cultural institutions, such as the Museum of Watercolor in Skärhamn, the House of Glass in Limmared, and the nearby Nordens Ark zoo for endangered species, the group suggest that Stenens Hus would transcend mere exhibition status, offering a multifaceted experience (Anderzon et al., 2020).

However, constrained by funding limitations, the group has yet to materialize plans for an architectural competition. Nonetheless, to stimulate discourse and provide a concrete vision, the group consulted renowned Canadian architect Todd Saunders to conceptualise what the house could entail (Saunders, 2018). Saunders' proposal encompass an extensive program featuring exhibition spaces, an auditorium, and two restaurants, indicating the potential versatility of the envisioned institution (Saunders, 2018).

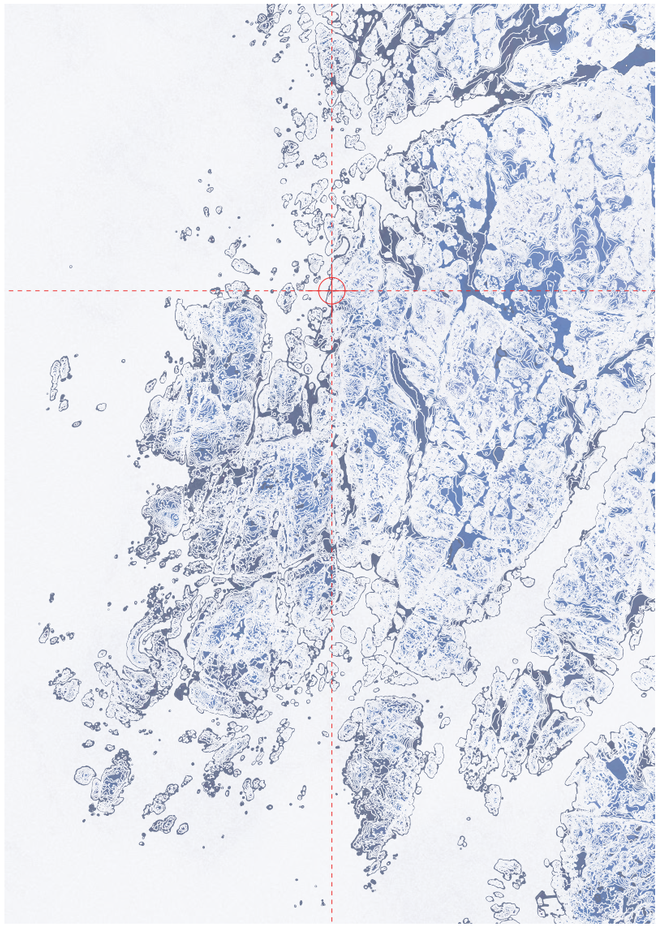
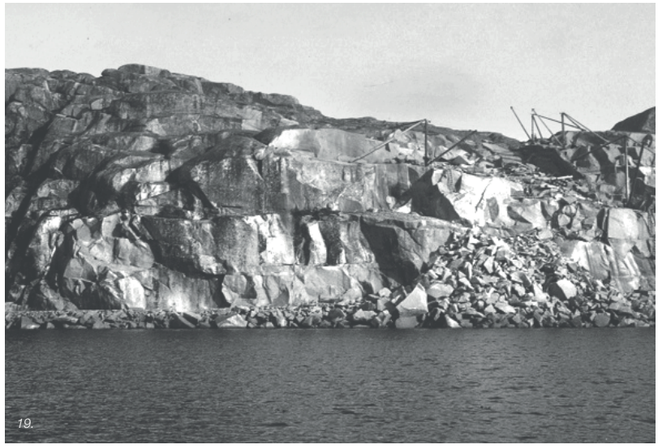


Figure 18: *Site location within the municipality of Sotenäs. As one of the main historic areas of granite quarrying in Sweden, Udden in Hunnebostrand serves as the planned site for a future "Stenens Hus", a national centre for stone industry and art.*

N

Scale: *1 : 120000 (A4)*
Graphics: *Author*


19.


20.

Figure 19 - 20:

Early view of Udden (19) and the same view captured in the last years of operation (20). The granite mine operated between 1914-1976, primarily by the firms AB Förendade Granitindustrier and later Fernströms Granitindustrier (Walentinsson, 2011). As the quarry gradually excavated the Nordre Hoge hillside, the processing site in front was refitted, including the construction of a more permanent production shed.

Note: *Images provided by Hunnebostrands Bildarkiv. Copyright 2024. Reprinted with permission. Edited by author.*


21.


22.


23.


24.

Figure 21 - 24:

Work conducted at Udden during the operation of the quarry. The type of stone processed at the quarry was mainly for construction (e.g. building foundations) but also dock walls, industrial and agricultural tools (such as the circular "Kollergångar" seen in figure 23, made for crushing grain). Later on, decorations and statues was also produced at Udden. The quarry closed gradually during the 1970s due to poor profitability.

Note: *Images provided by Hunnebostrands Bildarkiv. Copyright 2024. Reprinted with permission. Edited by author.*

Site analysis

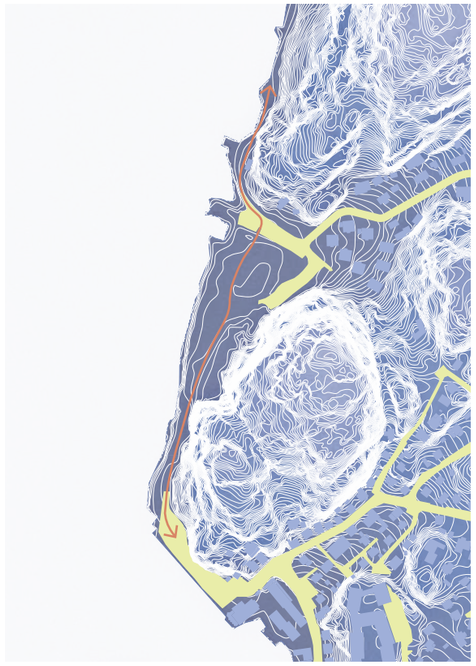


Figure 25: Paths and connections.

Municipal vehicle access

Walkway Hunnebostrand to Ulebergshamn

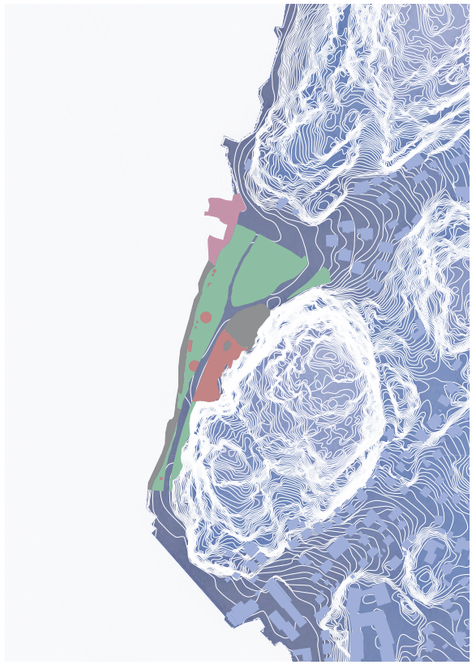


Figure 26: Current use of surface area on-site.

Grass

Exhibition display

Inaccessible / Stone cairn

Pier / Swimming area

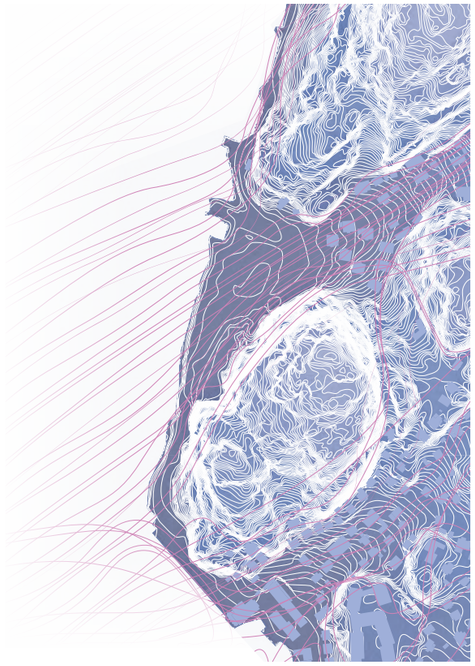


Figure 27: Wind directions at ground level.

Prevailing wind direction at ground level

N

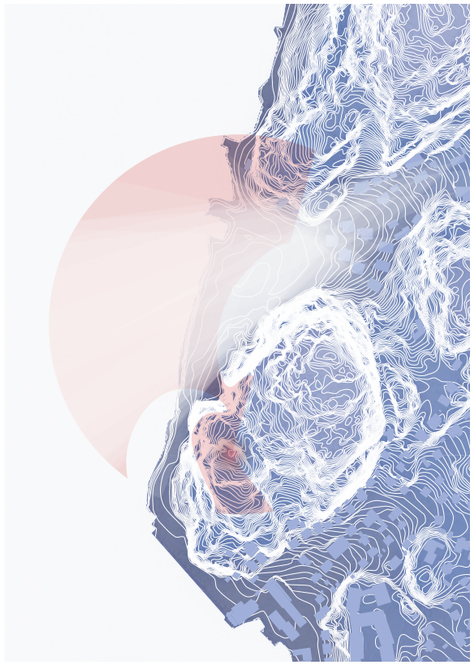


Figure 28: Views affecting any potential intervention.

Shared horizon view from affected houses

Field of vision from the current lookout platform

Site of current lookout platform

Scale: *1 : 6000 (A4)*
Graphics: *Author*

Material concept

Considering the prerequisites of the site, the objective of this thesis is to propose an alternative design for Stenens Hus which exclusively utilizes potential leftover materials. The municipality of Sotenäs currently possesses a recycling facility but currently lacks a dedicated physical site for managing surplus materials, such as a reuse institution (see Theory, Leftover as Trade). Therefore, Udden has the potential to become the physical location where leftover materials are collected within the municipality. It necessitates a systematic approach to material sourcing, conceptualised in figure 29. By having the full municipal reservoir of leftover materials on site, the Stenens Hus project would serve as a platform for iterative design.

There is a factor of uncertainty built into the sourcing of leftovers, as some items may require more time to acquire than others. Additionally, since building components might be constructed from materials not originally intended for those specific purposes (see Method - Case Study), it is proposed that a physical facility for material storage and testing are established prior to the construction of Stenens Hus. Similar to the model of Återbruket in Gothenburg, this facility would allow stakeholders to submit their surplus materials and function as a reuse marketplace. This initiative not only facilitates material exchange but also integrates the proposal within the local community.

Currently, the site boasts numerous granite artefacts from the quarrying era, varying from processed to unprocessed states. These artefacts include wedged stones resulting from rock blasting, as well as granite blocks prepared for use as building elements but damaged during the carving process. Furthermore, there are elements brought to the site in recent years as heritage pieces, such as cylindrical granite paper rolls and “Kollergångar,” circular stones utilized for various crushing mechanisms.

With this in mind, leftover materials can be distinguished into two separate categories:

- General leftovers: This refers to the new, unused building material overlooked in building processes.

- Specific leftovers: This refers to the specific leftover fragments found at site, both processed and unprocessed.

When considering the general category, it is key to examine the municipal building typology which, for the purposes of this thesis, is being broadly simplified. According to SCB (2022), Sotenäs comprises approximately 3750 single-family houses and 4250 vacation houses, collectively making up 8000 units. This primarily encompasses renovated “fisherman cottages,” vernacular two-story wooden houses. To estimate potential quantities and types of municipal leftovers, a nearby house at Skepparevägen 14 in Ulebergshamn was selected as a case study (see figure 30). For this study, as previously presented by Toller et al, the leftover rate is predominantly adjusted to 5% concerning new materials aimed for replacement.

In the specific category, granite fragments on-site have been surveyed using LIDAR technology. They will serve as the defining feature for the proposed building. Given the house’s intended role as a centre for stone industry and art, it is imperative that its primary external material identity uses stone as material. By utilizing leftover stone from the quarrying era, the building’s embodiment becomes distinctive and induced with significance. Each granite component possesses its own historical narrative, effectively transforming the design into an exhibition of its own.

Figure 29: *Graphics:* *Author*

General metal sheeting

Approximate quantity:
13.5 m2 / unit

Expected service life:
35 years

Leftover share:
5 %

Municipal turnover quantity:
1450 m2 / year

Municipal leftover quantity:
72 m2 / year

Scale 1:100 (A4)

Roof tiles

Approximate unit quantity:
1500 pcs

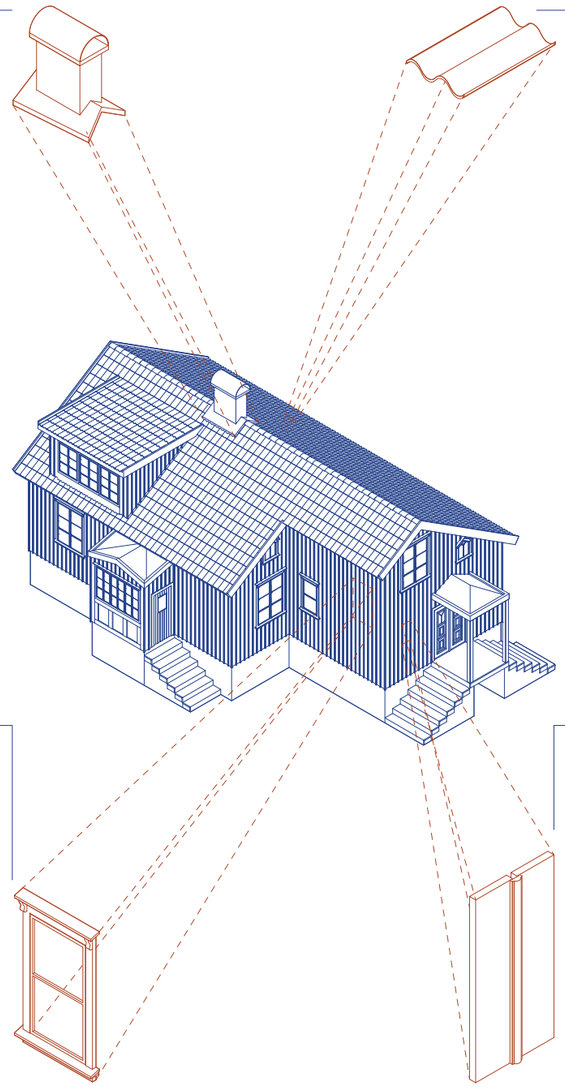
Expected service life:
40 - 100 years (average 70)

Leftover share:
5 %

Municipal turnover quantity:
80 400 pcs / year

Municipal leftover quantity:
4000 pcs / year

Scale 1:20 (A4)



Uninstalled window

Approximate quantity:
1 pcs/unit

Expected service life:
40 years

Leftover share:
100 %

Municipal turnover quantity:
94 pcs / year

Municipal leftover quantity:
5 pcs / year

Scale 1:20 (A4)

Wooden panels

Approximate quantity:
4.5 m2

Expected service life:
40 years

Leftover share:
5 %

Municipal turnover quantity:
420 m2 / year

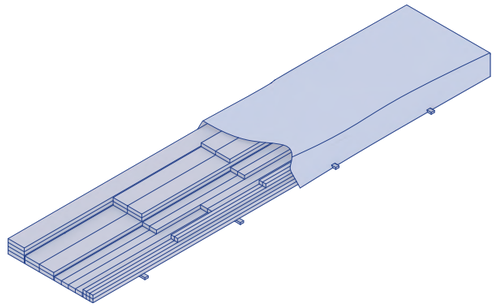
Municipal leftover quantity:
21 m2 / year

Scale 1:20 (A4)

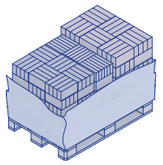
Figure 30:

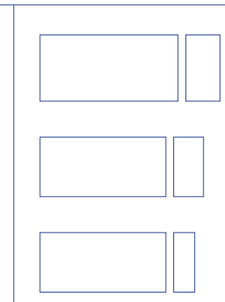
Leftover material analysis of Uleberg 2:102, a typical "fisherman cottage" typology common for Sotenäs municipality. The leftover quantities on municipal level is calculated according to SCB statistics of single family homes and vacation homes in Sotenäs 2022 (approx. 8000 units).

Data source: *SCB*
Boverket
Sotenäs Kommun
Graphics: *Author*

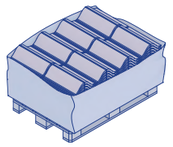


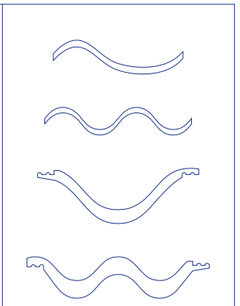
Material: *Wood*
Leftover share: *5%*
Dimensions (mm): *45 x 45/95/145*
22 x 70/95/120/145/170
22 x 45 (including profile)
23 x 36





Material: *Brick*
Leftover share: *5%*
Dimensions (mm): *250 x 120 x 62*
228 x 108 x 54
228 x 108 x 38



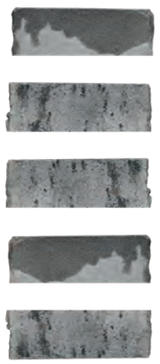


Material: *Roof tile*
Leftover share: *5%*
Dimensions (mm) *Clay 1:* *235 x 420 x 60*
Clay 2: *266 x 420 x 60*
Concrete 1: *292 x 420 x 96*
Concrete 2: *330 x 420 x 75*

Figure 31:

Materials chosen for further investigation in a design proposal.

Data source: *SCB*
Boverket
Graphics: *Author*



Volume analysis

By examining the building volume and consequently the building program, inspiration was taken from the vernacular tradition of supporting structures to the quarry. When operational, the Udden quarry hosted a number of sheds where stone was carved by quarry workers. Most significant was the large shed that existed in the later stage of the quarry, with its opening towards the Nordre Hoge hillside (see figure 20). Being of purely functional characteristic, the shed worked as a space definer where the hillside itself served as a second wall. The space in between became a sort of “inner yard”, creating a protected space from the forces of nature.

With this in mind, the inner yard and the Nordre Hoge hillside makes up important spatial features when proposing a building volume. This would create a sort of interior and exterior atmosphere, where the walls facing outwards would be materialised out of leftover granite artefacts, referencing Parika Castle (see figure 8) and the walls facing the inner yard would be a experimental palette of leftover materials, similar to the Muuratsalo Experimental House by Aalto (See figure 9).

Udden, dominated by the Nordre Hoge hill, has impacted the town extent. North of the hill there are homes that will have their ocean view obstructed by anything built in front. Thus, the proposal for Stenens Hus in this thesis will be, in contrast to the existing conceptual study by Sauders (2018), pushed towards the south in front of the former quarry. This decision will put emphasis on the preservation of any industrial heritage at the site, which will be made by incorporating leftover granite into the building exterior wall as leftover “spolia”, such in the case with San Clemente’s colonnade (see figure 7).

When consulting the program, the proposal by Todd Sauders (2018) was first examined. As Sauders proposal consists of a quite extensive program of more than 2000 square meters, the aim is to reduce the program to its most essential parts. In the conceptual pilot study for Stenens Hus (Andrezon et al. 2020), the programmatic request reads as follows:

- *Exhibition hall for basic exhibition and various thematic exhibitions.*
- *Black Box for e.g. film, theatre, music and temporary exhibitions.*
- *Administration with hygiene areas.*
- *Cafe/restaurant with a focus on regional cuisine.*
- *Room for archives and workshops where research can be conducted in collaboration with local actors such as stone industry companies and local associations.*
- *Marketing window for local actors with an emphasis on stone.*

Anderzon et al. (2020). Translated by author.

For this reason, three volumes are proposed where these functions are collected. The volumes will consist of the following:

- Exhibition with storage space for art pieces.
- Restaurant and workshop, including a residence for artists working with stone.
- Black Box, together with administrative functions and office.

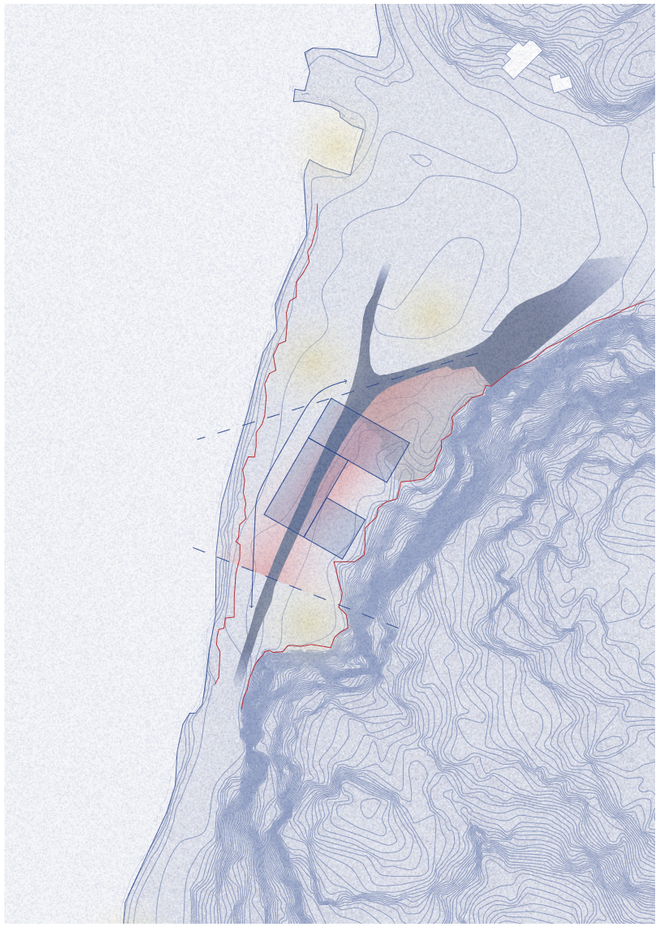


Figure 32:

Border of flat terrain
Areas of interest / not to build
Area of discarded quarry stone
Border of shared view from affected houses
Best area for proposal
Proposed footprint of volumes

N

Scale: *1 : 2000 (A4)*
Graphics: *Author*


33.


34.


35.

Figure 33 - 35:

Areal perspective of proposed volumes (33). The study consisted of testing two different alternatives for the roof, either a symmetrical lower pitched roof (34) or an asymmetrical pitched roof (35). The goal was to keep the profile of the building low, as regards was taken to affected views (see figure 28).

Photography: *Author*


36.


37.


38.

Figure 36 - 38:

Top perspective of proposed volumes (36). The symmetrical roof (37) offers a slimmer profile and a more rational building setup. However, the asymmetrical roof (38) offers a more varied interior spatial configuration. Furthermore, it resembles the original production sheds at site more closely.

Photography: *Author*

Tectonic prototype

As part of the design exploration, in relation to the material concept and typological approximations earlier examined, a tectonic prototype is envisioned to address the assembly of various elements, with a building width set at 15 meters and a symmetrical pitched roof selected as the roof type (see figure 39). Drawing inspiration from the prototyping method conducted in Jubileumsparken in Gothenburg (see Theory - Temporary permanence), the solutions explored are highly preliminary and have obviously not been tested at full scale. However, the outcome can be regarded as an embodiment exercise, where materials are assessed for their aesthetic combinations.

The prototype focuses on four main leftover elements: roof tiles, wooden latches, bricks, and tiles. A simple wooden stud wall, lined with combinations of leftover materials, is envisioned as a structure. Given that the standard length of wooden latches offered at Swedish building supply stores is a maximum of 5400 mm, this dimension is established as the wall height.

For the roof truss, the beam structure from the case study is combined with various pieces of wooden latches. The Roman truss technique, known for its historical prevalence in European buildings dating back to medieval times, was chosen for its proven solidity across various building types. However, this approach is later abandoned as it was found to exert pressure on the roof tile beam structure, making it ineffective (D. Norell, personal communication, March 13, 2024).

Drawing on Aalto's Muuratsalo House (see figure 9), the organization of leftover materials adopts a method of combining small quantities of similar products to create uniform elements for both the brick wall and the floor tiles. As the materials are intended for ad hoc use, there is no initial plan for material placement. However, as with the Muuratsalo House, materials are organised as individual blocks that collectively form the wall element. This approach also suggest the possibility to replace certain material categories according to their technical service life (see figure 30). Standard measurements for both bricks and tiles were sourced from building supply stores, ensuring consistency and ease of procurement.

Upon reflection on the exploration, certain elements will be incorporated into the final design, such as the organization of the brick wall and the dimensional aspects of standard materials. However, the truss technique is considered impractical. This realisation raises concern regarding the thesis topic, as it criticises the use of leftover outside of their intended use, as initially stipulated in the main research question. Thus, this exploration signifies a shift where leftover materials will serve more as visual markers in the climactic shell rather than being accountable for the tectonic structure.

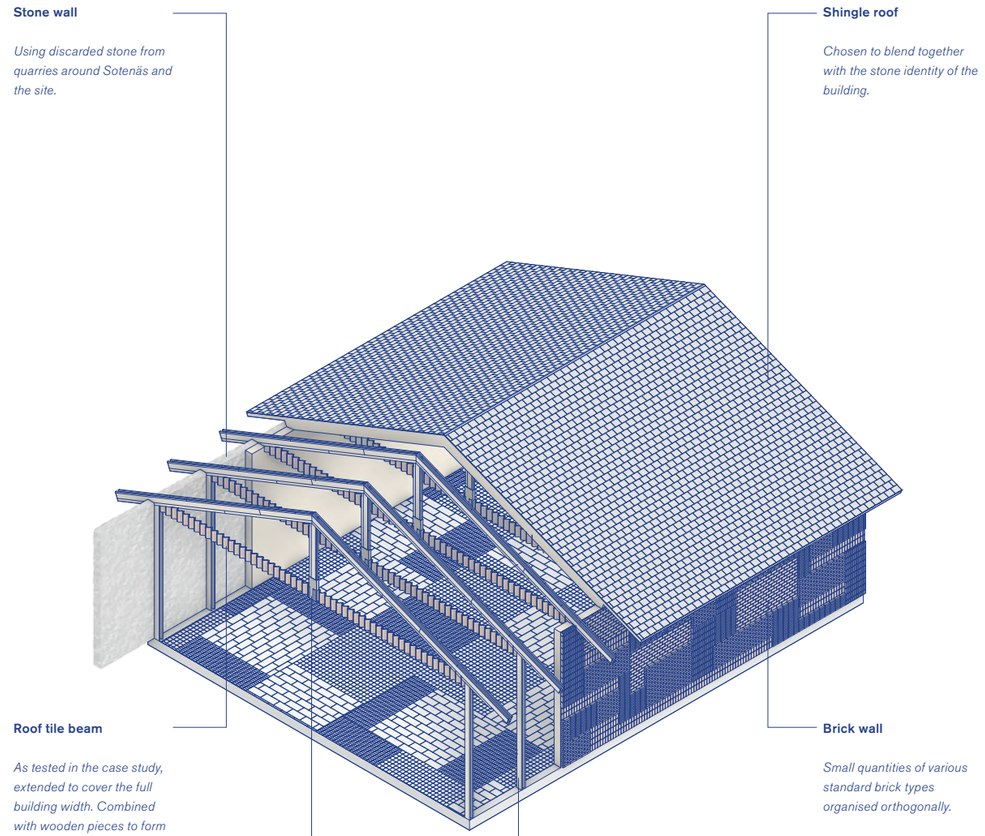


Figure 39:

Tectonic prototype in axonometric perspective. Some of the explored tectonics will be taken into the final design of Stenens Hus, however the roof truss renders ineffective for the use of this building width.

Scale: *1 : 200 (A4)*
Graphics: *Author*

Stenens Hus

Expanding upon the analysed volume proposal and tectonic prototype (see figure 39), the building is defined utilising a spatial grid layout to visualise there the actual strain points will be located. Given the systematic nature of Swedish standards, as many parts of the building will use leftover materials of these dimensions, the grid spacing is established at 1200x1200 mm, a widely employed centre-to-centre measurement in construction. By adjusting the grid to closely align with the predefined volumes of 15 meters in width, precise placements can be determined for further spatial development. The final building footprint is shown in figure 40.

As the grid allows for the alignment of exterior walls, this is also where the concept of adjusting the volumes for intermediate spaces between the buildings takes shape. To enhance the existing spacing between the volumes (see Embodiment - Volume analysis) and align them more closely with the interior planning, a series of walkways are being employed in front of the volumes at three designated spots. As the unified roof continues to follow the extents of the grid, these walkways will form a set of colonnades under the roof and connect to the existing intermediate spaces to form a unified outdoor path through the complex. Referencing the San Clemente colonnade and the Parika Castle wall (see figure 7 - 8), the pillars, as well as the exterior walls facing outwards, are being constructed of discarded quarry stone found on-site. Specifically, the existing cylindrical paper rolls lying right next to the site will serve as well-defined elements for the pillars.

As the colonnades define the exterior form, they give way for a more transparent wall type behind the raster. These glazed elements, building upon the defined leftover material pool (see Translation - material concept), are constructed with stacked leftover windows fixed between structural steel beams, another common construction material prone to be left over. This concept will summarise the three different exterior wall types employed:

- Solid wall: consisting of leftover materials and discarded granite artefacts.
- Colonnades: defining the exterior form as a raster typology, relieves structural strain points and provides passage through the building complex.
- Transparent: elements constructed from leftover windows, mounted between structural steel beams at strain points.

With these elements in mind, the aim for the spatial organisation is to create rooms tailored to the specific functions situated behind the predetermined exterior walls. Considering the programmatic definition for each volume (see Embodiment - Volume analysis), particular emphasis is placed on creating the right interior atmospheres for the primary functions, namely exhibition, restaurant, and black box. This process results in the final spatial layout illustrated in figures 40-41.

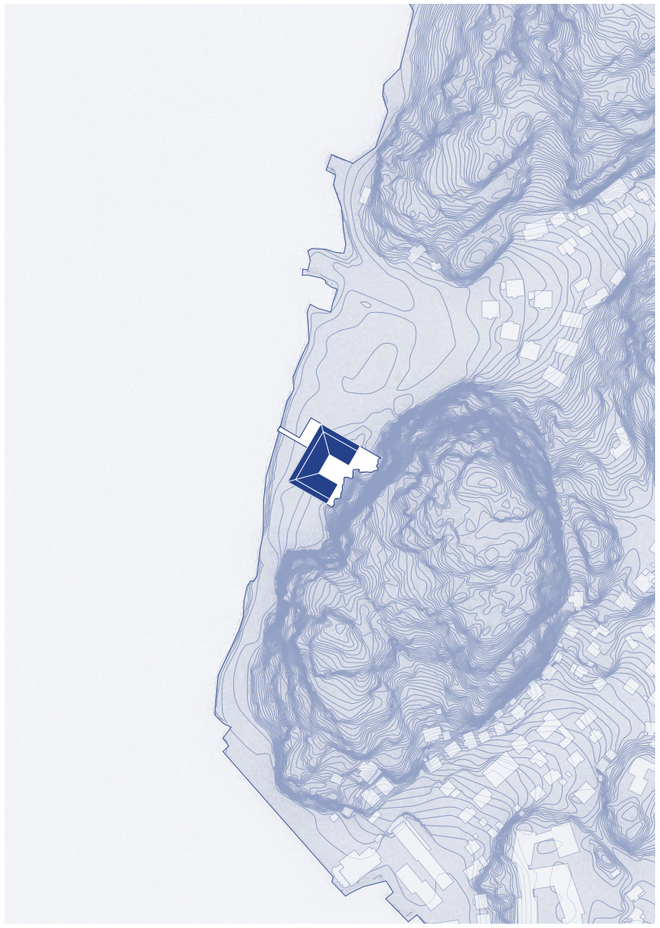


Figure 40: *Site plan. As a defining feature, a jetty is added in the extension of the intermediate space facing the ocean. This jetty allures to the vernacular tradition of the region, as well as creating a viewpoint along the walkway passing the building.*

N

Scale: *1 : 4000 (A4)*
Graphics: *Author*

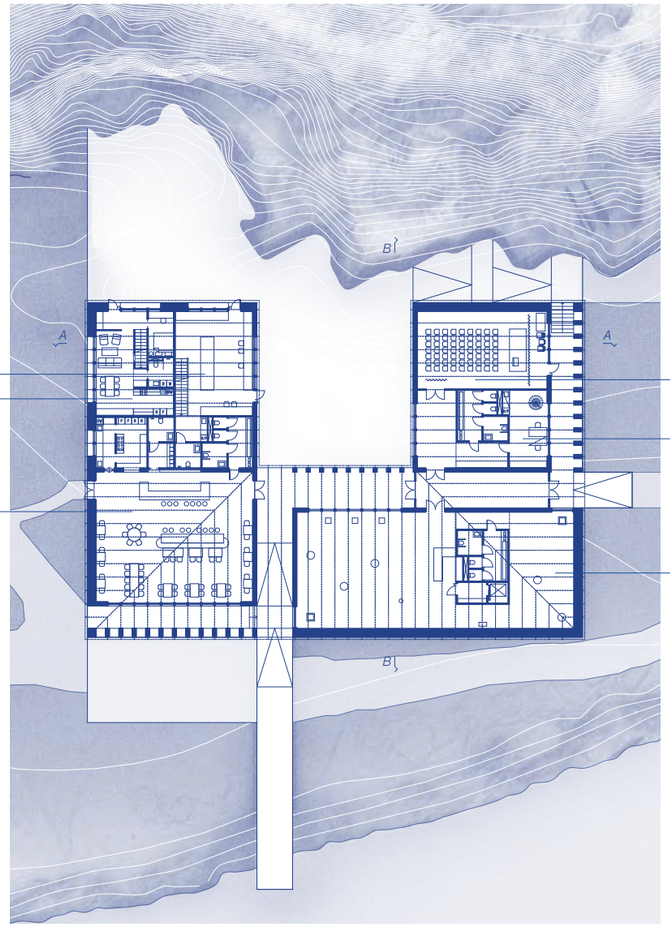


Figure 41: *First floor*

1. *Workshop*
2. *Artist residence* *(for up to 8 people)*
3. *Restaurant and bar*
4. *Black box* *(70 seats)*
5. *Staff office*
6. *Exhibition halls*

N

Scale: *1 : 550 (A4)*
Graphics: *Author*

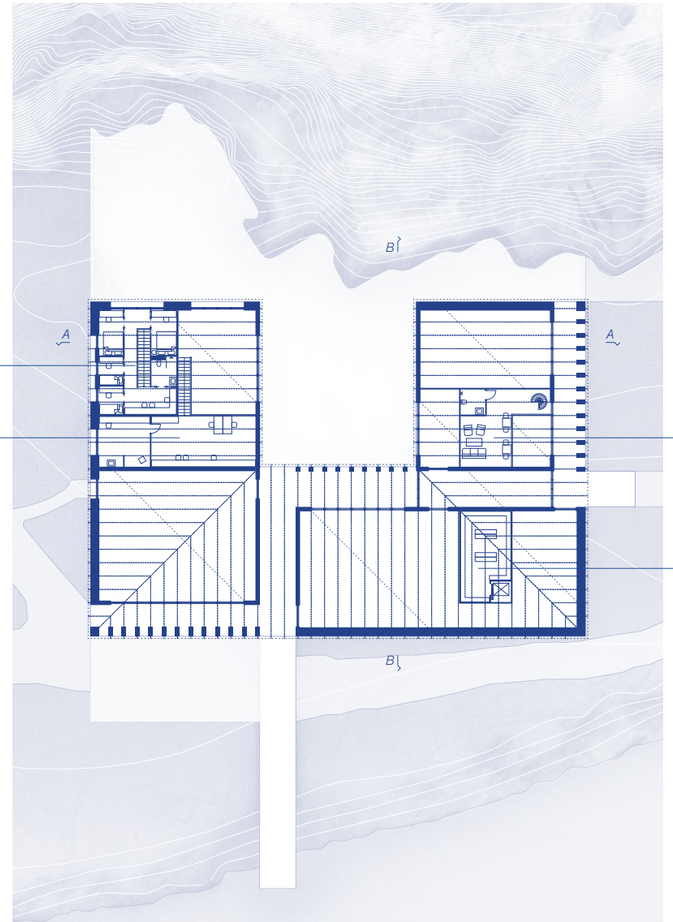


Figure 42: *Second floor*

1. *Artist residence* *(upper level)*
2. *Workshop* *(upper level)*
3. *Lounge*
4. *Storage*

N

Scale: *1 : 550 (A4)*
Graphics: *Author*

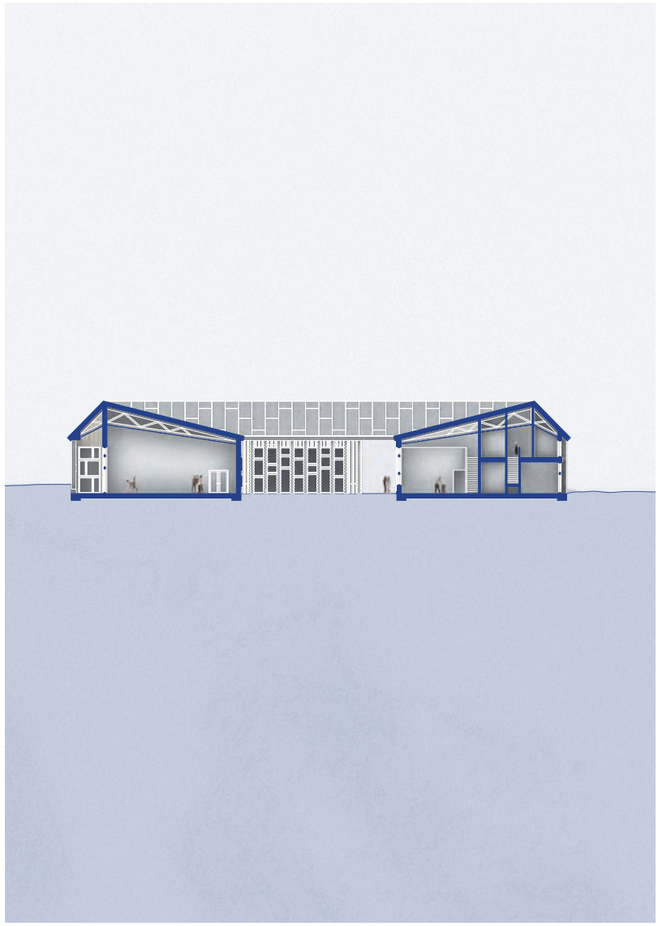


Figure 43: *Section A - A*

Scale: *1 : 550 (A4)*
Graphics: *Author*

Figure 44: *Section B - B*

Scale: *1 : 550 (A4)*
Graphics: *Author*

Figure 45: *Elevation of facade facing west. As the exhibition volume requires a more controllable light source, it is not as dependant on natural light as the restaurant volume is. Thus, wall typologies are chosen accordingly.*

Scale: *1 : 550 (A4)*
Graphics: *Author*

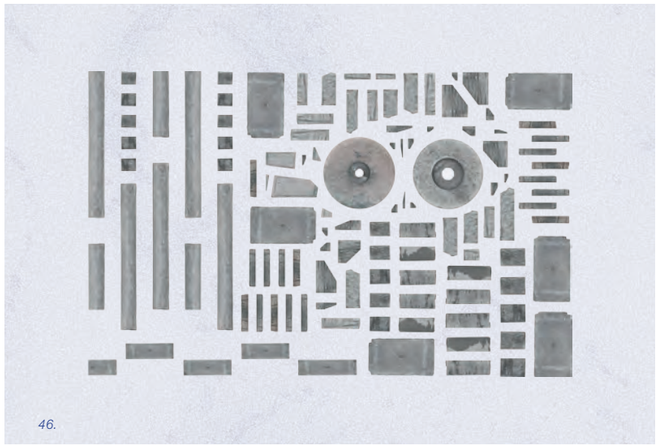


Figure 46 - 47: *Collection of granite artefacts (44) when isolated from the section elevation of facade facing west (45). Every artefact illustrated exists at the site, however they have been duplicated to form the wall element for the simplicity of this thesis.*

Scale: *1 : 150 (A4)*
Graphics: *Author*

Figure 48: *View of courtyard*

Graphics: *Author*

Figure 49: *View of exhibition hall*

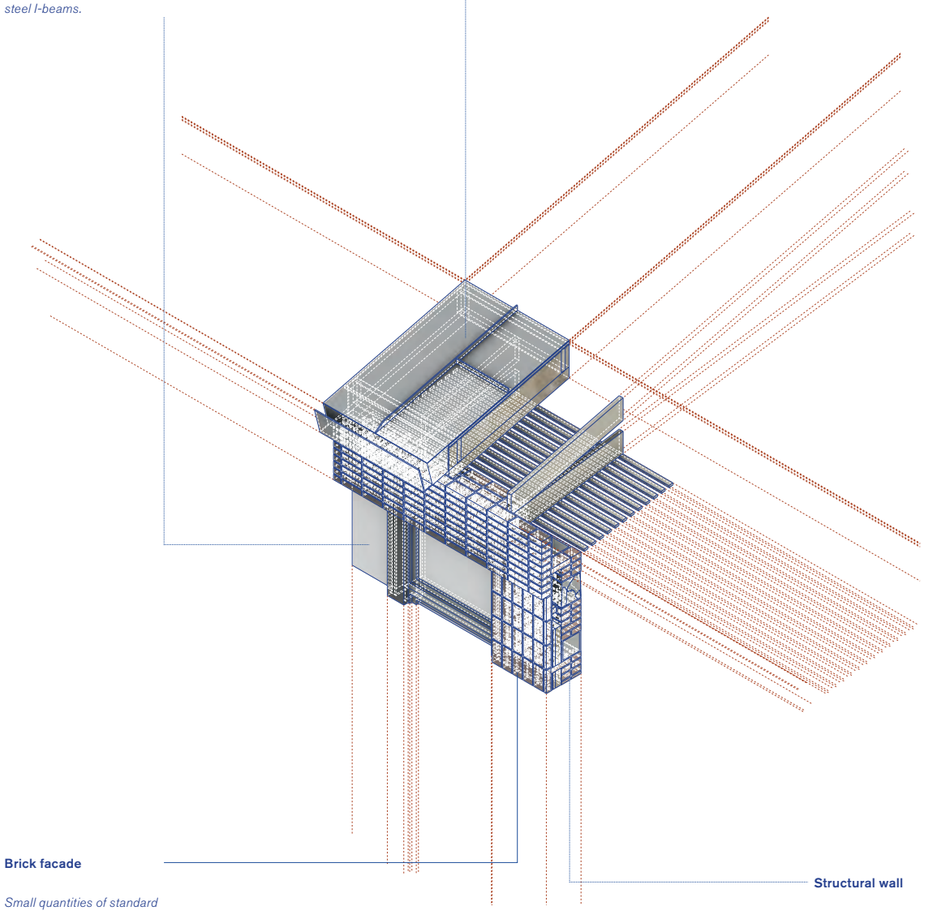
Graphics: *Author*

Unused windows

Leftover windows of standard measurement are assembled between leftover steel I-beams.

Leftover tin roof

Leftover metal sheets are merged together to form a tin roof.



Brick facade

Small quantities of standard measurement leftover bricks arranged together to form the outer layer of an insulated brick wall.

Structural wall

Leftover bricks and leca blocks are stacked together to form the structural part of the brick wall.

Figure 50:

Sectioned axonometry of a wall-to-roof meeting where assembled new leftover bricks are used, present in the walls surrounding the courtyard.

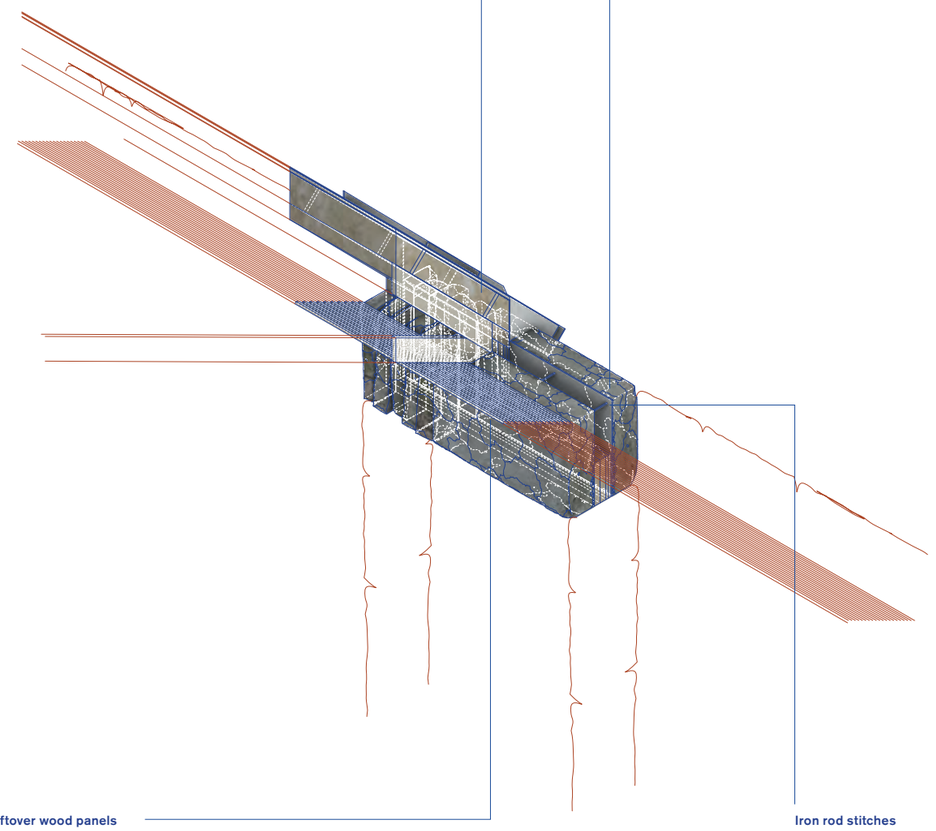
Scale: *1 : 50 (A4)*
Graphics: *Author*

Leftover insulation

Glass wool insulation of different widths are arranged together to form the insulation of walls and roof.

Leftover quarry granite

Processed granite are used outside of their intended purpose to form an insulated wall.



Leftover wood panels

Wood of standard measurement arranged to form an inner roof.

Iron rod stitches

Granite blocks are merged together by leftover iron rods.

Figure 51:

Sectioned axonometry of a wall-to-roof meeting where assembled leftover quarry granite artefacts are used, present in the walls facing outwards.

Scale: *1 : 50 (A4)*
Graphics: *Author*

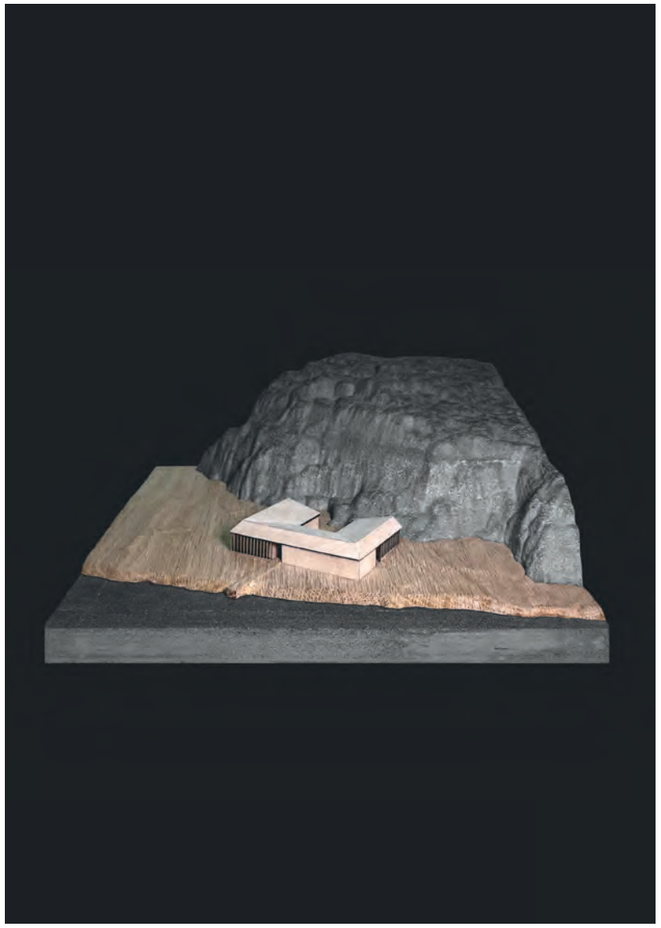
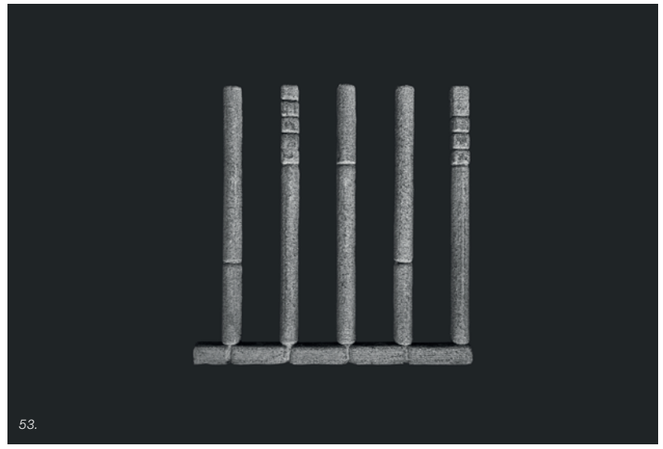
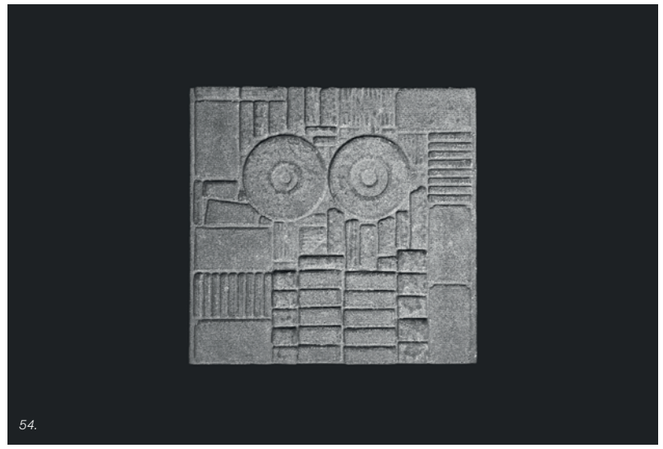


Figure 52: *Site model. The Nordre Hoge hill is represented by concrete and the flat plane in front by oak. It illustrates the main thee volumes in relation to its context.*

Model scale: *1 : 500*
Photography: *Author*



53.



54.

Figure 53 - 54: *Models of assembled wall elements in facade facing west (see figure 45). The elements are cast in styrofoam molds made by a CNC-mill. As the concrete is homogeneous, these models represent the unity in which arranged artefacts will form when assembled.*

Model scale: *1 : 20*
Photography: *Author*

Discussion

Reflecting on the main research question of finding methods to use and combine leftover materials outside of their conformity, the principal outcome emerged as proposed architectural compositions incorporating small quantities of potential and definitive leftover materials as the climactic shell of a public building proposal. As for combinations, the various materials have conversely been arranged within their respective material category. This design choice is made primarily due to enhanced articulation. Upon comparing the proposal with the presented method references, the assembled compositions bear a closer resemblance to Alvar Aaltos Muuratsalo House than to Andrew Kovacs' Wall Assembly (See Method - Method references). Regarding the assemblages of quarried granite documented on-site, they represent a form of spoilation despite the pieces lacking architectural origins. The approach suggest that the artefacts in question, in this case, granite, possesses constructive potential beyond their original functional purpose.

In a sense, the proposal of Stenens Hus presented in this thesis adopts a "bottom-up" approach to material integration, assembling site-specific fragments and potential leftover standard materials to create architectural elements. However, due to uncertainties about which materials might end up unused in Sotenäs, the presented proposal would prove the complexities of sporadic leftover use due to its uniformity. As the primary goal for the proposal was to find a functional solution as well as a holistic approach, the concept of three designated volumes under one roof was further developed into a spatial layout partly conceived independently from the material inventory. The functions were primarily decided upon client preferences, including inputs from the voluntary group and analysis of Todd Sauders' existing proposal. Thus, the ad hoc methodology of making architectural elements from various assemblage techniques, as firstly anticipated by researching the theory of Adhocism by Jencks & Silver (See Theory - Urgency and purpose) and conducting the assemblage case study of the leftover roof tiles, proved more challenging as materials were to be implemented in a broader picture.

This suggests a need for greater consideration of material perspectives which would mitigate the uncertain nature of material approximations regarding potential future surplus materials in Sotenäs Municipality. One such solution would be to adopt a phased construction layout wherein sections of the building are constructed according to the materials currently available. For example, one of the volumes could be built initially in order to define the site, such as in the approach with Jubileumsparken in Gothenburg (See Theory - Temporary permanence). Dividing a future construction in smaller phases would more closely resembles the scale of the bricolage, as seen in Gamper's and Raumlabor-Berlin's workshop extents (See Theory - The unexpected outcome). In addition, it is worth mentioning that the voluntary group behind the conceptual idea of Stenens Hus currently possesses limited funding options (See Translation - Site selection). A phased construction of the building, comprised of a leftover material pool, would possibly engage the local community to participate in the sourcing of materials and with local construction expertise. This could then be a way to lower the construction costs and possibly realise Stenens Hus with greater local support.

Returning to the topic at hand, it is clear that a de- optimisation of the current supply chain is necessary. In a reality where material are abundant, it is crucial to shift the mindset away from viewing them as endless resources of the commercial industry. By simply examining materials intended to be used but not utilised, or by identifying artefacts left unused on-site, there are opportunities to re-imagine our current approach to material planning.

Reflection

Regarding my personal perspective on this thesis, it has been an intriguing subject to uncover. The utilisation of leftover materials holds personal significance for me, however, I don't feel entirely satisfied with how the architectural compositions of leftover materials have been articulated. Initially, I aimed for a more spontaneous process, but I soon realised that materials cannot be haphazardly combined across categories. This realisation has made the project somewhat less experimental than first envisioned. Nevertheless, I perceive the building proposal of Stenens Hus as a fitting, well-articulated, and site-specific response to the Site. Given the ongoing uncertainty of the exact requirements of the future building, I believe that the scale and scope of the proposal present a realistic vision of what Stenens Hus could become.

As this thesis has progressed, the focal point has changed many times. During the initial planning and early explorations of the preparatory thesis course, I suspected the outcome to be a series of ornamental assemblages, possibly to be represented in full scale models. As it became clear that the thesis would result in a public building proposal of Stenens Hus, I dedicated a substantial part of the time to investigate more pragmatic matters such as the current material quantities of the Swedish building stock and analysis of site and typology. This resulted in scarce commitment for a more developed design proposal as the project deadline has come closer. This especially applies to the time spent on the embodiment of assembled elements in detail.

Furthermore, I dedicated considerable time on seeking relevant partners associated with the site, such as municipal official, industry stakeholders and enthusiasts, as it became clear that the thesis was to be situated within the context of Sotenäs. Upon reflection, I realize that the emphasis placed on personal communication did not significantly aid the design process as initially expected. In hindsight, I recognise the value of trusting my personal process more as the intention of this thesis is speculative in its nature. It is a reflection of material use rather than an attempt to influence the planning process of the actual Stenens Hus project.

In other words, this thesis did not adhere to the initial time plan laid out during the preparatory thesis course. Embracing an iterative design process, the structured weekly schedule gave way for a more adaptable approach, where tasks were adjusted based on what could be feasible to accomplish within the specific time frame. In retrospect, I acknowledge that this approach may not have been the most conducive to my well-being, as I consistently felt as though I was falling behind. I recognise that I should have allocated less time for each task in order to cultivate a broader range of designed elements. Nonetheless, this experience has afforded me a deeper understanding of the subject matter, and I can envision exploring similar topics in future projects.

As an aspiring architect, my hope is that this thesis can showcase my commitment to holistic and site-specific building designs, where materials are carefully considered in accordance with sustainable practices and long-term durability. Having spent significant time at the site, both during the project and prior to it, I truly grasp the significance of the quarrying heritage present in Sotenäs. While I recognize that an approach centred around the ad hoc utilisation of leftover standard materials may not be suitable for Stenens Hus, I strongly believe that employing leftover quarry stone is a highly relevant and cost-effective option for the exterior embodiment. It represents a perspective that I wish I had devoted more time to during this thesis.

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Figure 19 - 24: Hunnebostrands Bildarkiv. (n.d.). *Various images depicting Udden granite quarry.* Copyright 2024. Reprinted with permission. Obtained through personal communication.

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Figure 55: *In collaboration with a team of students, I designed and curated a water feature for the final exhibition of the AUSD studio. The idea was to let water fall onto pieces of preheated vacuum-pressed acrylic in order to capture the narrative of the exhibition. As the feature made use of leftover material from a former course, It was also the spark for this thesis subject.*

Photography: *Author*