CIRCULAR DESIGN ATLAS

K.118 KOPFBAU HALLE 118

Architect(s):
baubüro in situ

Year:
2021

Location:
Winterthur, Switzerland

More info:
https://www.insitu.ch/

Scales:
Buildings

Resources:
Reclaimed Materials

Design Approaches:
Regenerative Design

R-Strategies:
Reduce, reuse, repair, remanufacture, repurpose

Aspects:
Design, Resource Flows

TU Delft
BK Bouwkunde

1. Credits | Design: baubüro in situ | Photo: © Martin Zeller

The K.118 project has emerged in response to the pressing global concern of climate change. It is driven by a set of innovative strategies, including the utilization of reused locally sourced materials, biomaterials, the repurposing of architectural elements from old buildings and the adaptable nature of its shearing layers. This culminated in the creation of a lightweight structure placed atop an existing industrial warehouse which harmonizes seamlessly with its surroundings. As a pioneering architectural endeavor, the K.118 project proposes new tools for circular building design with lowered carbon footprint.

Layers Of Change And Lifecycle Duration

Located in Winterthur, Switzerland, this project represents an extension of an existing brick warehouse. The structure of the existing building underwent reinforcement to accommodate the extension, effectively extending its lifespan and enabling it to serve a new purpose.

The extension's structural framework primarily consists of reused steel beams, with some encased in concrete to enhance strength and meet the new building's structural demands. The typical lifespan of steel elements ranges from 50 to 100 years, but this can be extended through proper maintenance and design. The use of composite elements ensures a durable and long-lasting structure, reducing the need for frequent modifications and minimizing disruptions to the other shearing layers of the building.

For the floor finish, wooden panels reclaimed from other buildings in the city were used. The lifespan of wooden flooring varies depending on the type, with hardwood floors typically lasting between 50 and 100 years. By utilizing wood for flooring and maintaining it properly over its lifetime, the interior gains a durable and resilient material.

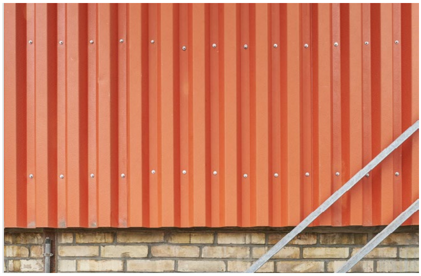
The building extension is characterized by visually distinctive red corrugated aluminium panels, repurposed from other local construction projects. These panels serve as protective cladding against the elements, particularly moisture. External aluminium coverings generally endure for approximately 37 years.

All building services are openly exposed and suspended from the ceiling, facilitating maintenance without causing disruptions to other shearing layers. For instance, electric cables have a lifespan typically lasting between 20 and 30 years, making non-destructive replacement or maintenance crucial for the preservation of other shearing layers.

Reused porcelain sinks and toilets were incorporated into the project, with an expected lifespan of around 25 to 30 years before requiring refinishing.

Site
Eternal

Skin
± 20 years



Structure
30-300 years

Services
7-15 years

Space plan
3-30 years

Stuff
Various

2. Credits | Design: baubüro in situ | Photos: © Martin Zeller

Carbon Footprint of Materials

The façade is an essential element in the design of the project, as it must not only insulate against low temperatures, but also seek to be as light as possible, since it, together with the structure of the project itself, will be embedded in an existing building that will support its loads. The façade of the K.118 is made up of different layers of materials that enable it to fulfil these two objectives.

In addition, these materials were selected and collected in a responsible manner in order to cause the least possible environmental impact. It should be noted that, although, after having generated the calculation of CO2 produced by the materials needed for the façade, this process might not highlight with certainty the low environmental impact of this project. All the materials, with the exception of the straw, were collected from other buildings in the region. The carbon footprint, then, decreases considerably as the process of extraction of the raw material and the production of the elements are removed from the sum. The extraction of parts from old buildings, the transfer to the project site and the assembly/ modification of each element are the factors to be taken into account.
As a result, K.118 turns out to be a building with a conscience for the reuse of materials and proof that materials have the potential to live more than one life before fulfilling their ultimate purpose.

The design of the façade as well as the availability of materials in disused buildings or buildings that will be renovated at a later date are two essential characteristics for such a process of circularity of materials to be possible.

<u>Aluminum Sheet</u>
-Group: Metal
-Area: 1m^2
-Thickness: 20mm
-Result: 564.80kgCO^2

<u>Glass Pane, Double-Glazed</u>
-Group: Components
-Area: 0.8m^2
-Thickness: 100mm
-Result: 21.30kgCO^2

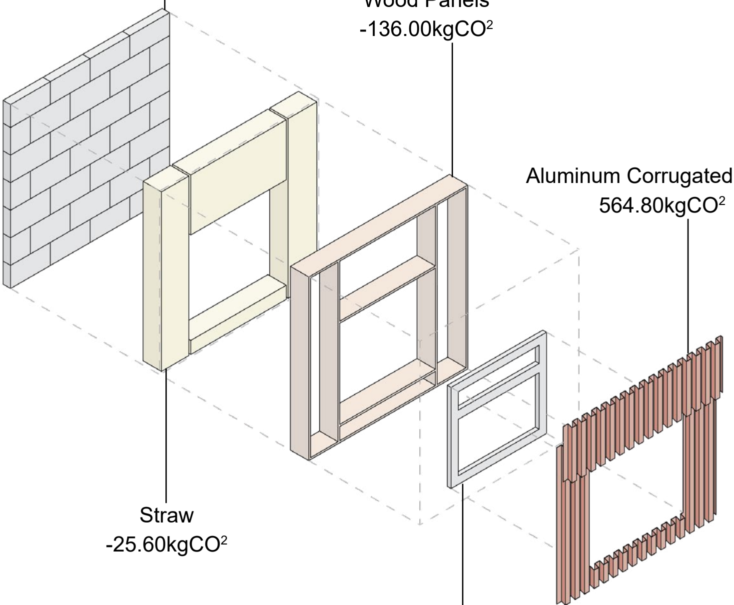
<u>Construction Timber</u>
-Group: Tree
-Area: 1m^2
-Thickness: 200mm
-Result: -136.00kgCO^2

<u>Straw</u>
-Group: Biobased
-Area: 1m^2
-Thickness: 200mm
-Result: -25.60kgCO^2

<u>Interior Finishing</u>
-Group: Mineral
-Area: 1m^2
-Thickness: 20mm
-Result: 4.90kgCO^2

<u>Total=429.40kgCO</u>^{2}

Based on the CINARK Construction Material Pyramid



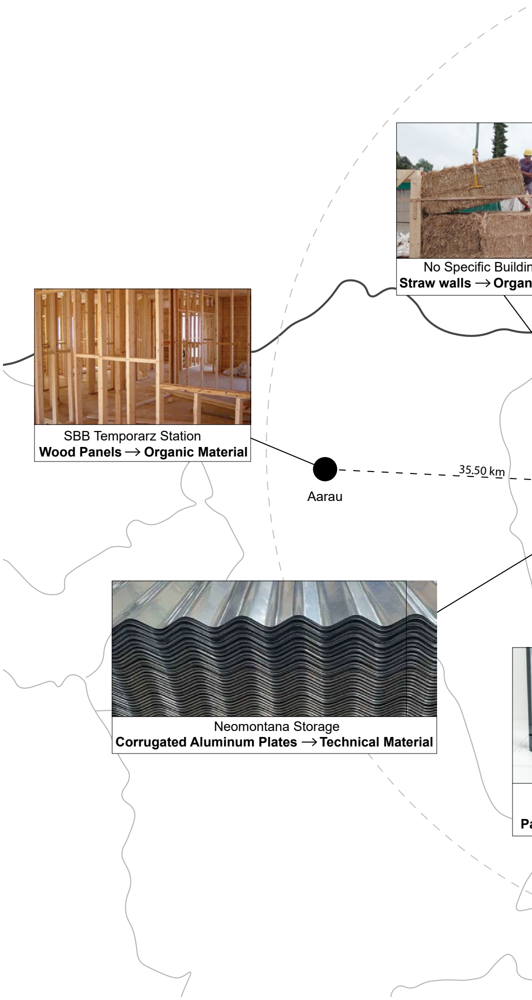
Axonometric Façade 1m² Credits | Alejandro Mendiola De la Peña

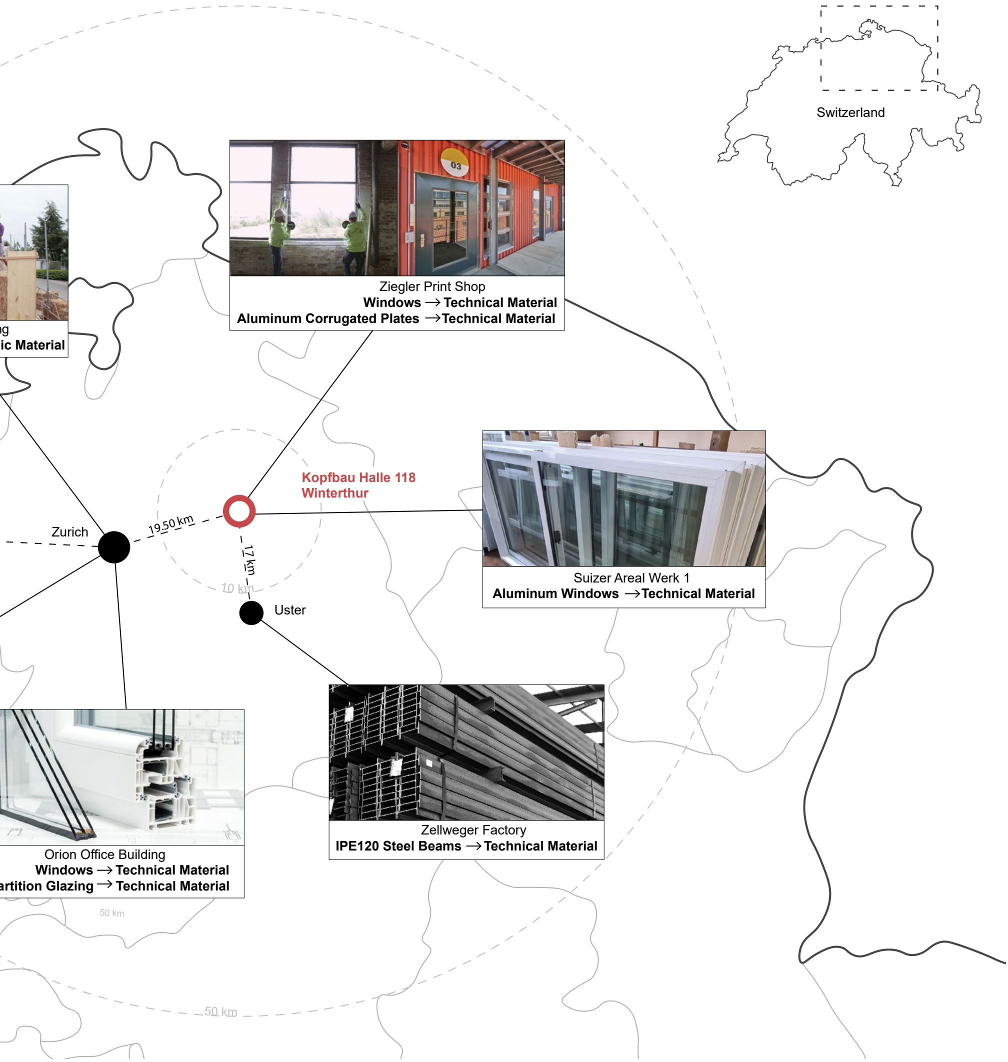
Building Material Origin

The great virtue of the origin of the K.118 construction materials is their proximity to the building site, the most remote being only 50km away from it. It should be noted that to provide a closer explanation regarding the materiality of K.118, the collection was made, not of materials, but of elements previously manufactured and used in other buildings in the region; the elements used for this project were given a second life.

It is worth mentioning that within all these collected construction pieces, none of them is part of the critical material group, while all, with the exception of the wooden panels, are classified as technical materials. Only the straw, a biological material that allows the insulation of the interiors in a sustainable and easy to replace way, was directly extracted as raw material and transported to the site.

K.118 uses the reclamation of materials and elements as a tool for the search of sustainable project design with added value in terms of its circularity. The elements harvested for its construction constitute a second life. The building is designed in a way in which the materials could also be disassembled for future reuse.





Harvest Map Credits | baubüro in situ / modified by Alejandro Mendiola De la Peña

R-Strategies

Further examining the current circular potential of the fragment.

SMARTER USE & MANUFACTURING:
Reduce
The studio appears to have thoroughly addressed the selection of construction materials and components that cannot be obtained from disassembling existing structures. Generally, except for certain instances where concrete is essential for purposes like soundproofing, fire safety, or structural stability, the primary emphasis is on the utilization of environmentally friendly building materials such as wood, clay, and straw.

EXTENDING LIFESPAN OF PRODUCT AND ITS PARTS:
Reuse
Throughout the project, numerous components were sourced from nearby locations. For instance, the steel framework constituting the main structure of K.118 was obtained from the distribution center situated on the Lysbüchel site in Basel. Similarly, the granite facades were repurposed from the Lysbüchel distribution center, subsequently transformed into slabs for kitchen and restroom surfaces, while also serving as the new walkway surface on the balcony pergolas. Furthermore, a significant portion of the insulated aluminum windows were reclaimed from the Orion Building, and the sectional aluminium sheeting utilized as cladding was procured from Winterthur itself.

Repair
By minimizing unnecessary building materials like foils and focusing on the essential ones, it's likely that expensive repair work won't be needed. Given that most installations are visible when mounted, it seems easy to repair and replace components. Since the primary component of the wall consists of solid wooden panels, replacing items like straw appears relatively straightforward.

Remanufacture
The example of the reused steel skeleton illustrates that, while architects may sometimes prefer to extensively work on elements for both aesthetic and functional reasons, this can be challenging from a structural and practical standpoint. Initially, the architects intended to maintain the building's original shape by extending it uniformly. However, a change in plans came about due to the identification of the building's underlying support structure and the input from the civil engineers. As a consequence they decided to keep the steel skeleton in its original square shape. Therefore starting from the fourth floor, the building extends outward.
The design also involves the remanufacture of windows primarily sourced from other buildings, which are then

repurposed for their original function within the new structure but in a different configuration. The architects tackled geometric issues of the used windows by mixing them with flexible materials: The gaps around the reused windows are filled with eco-friendly materials, like insulation made from straw bales that adjust to the windows' irregualar shapes without loss of material. They adopted a comparable strategy when dealing with the reused doors, opting for wood as the primary material. Wooden interior walls were constructed to incorporate both the reused doors and triple-layer panels from stage construction. Wood, due to its flexibility and ease of workability, is instrumental in enabling this adaptability.

Repurpose

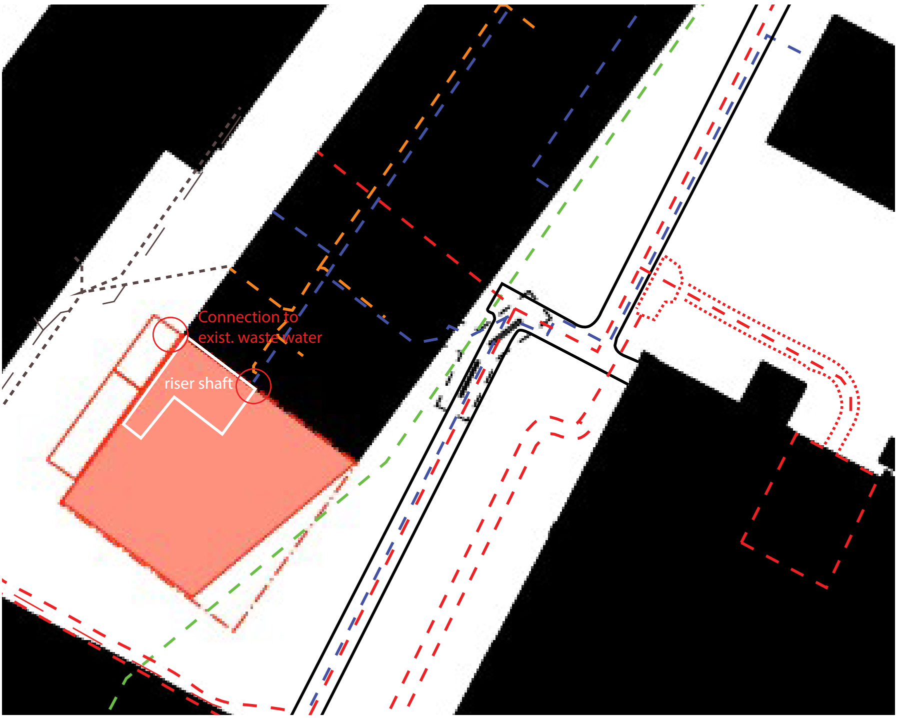
As a result of the irregular shapes and sizes of the reused materials, the facade components have been divided into distinct layers based on their intended roles. This division facilitates the future disassembly of these elements without damaging the fragments. It becomes evident that many of the previously already reused materials possess enduring potential for a second or third life and continued future reuse.

3. Credits | Design: baubüro in situ | Photo: © baubüro in situ

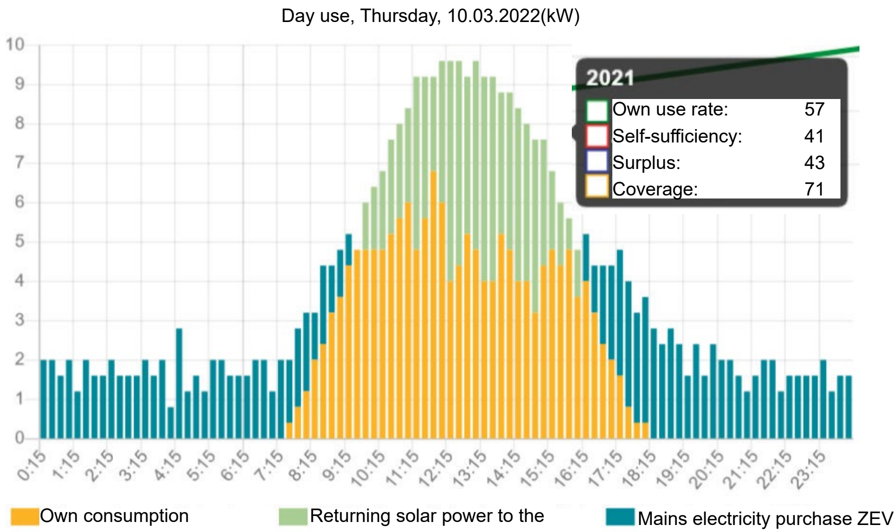
The NEW Nexus

Since project K.118 involves an extension to an existing building, the relationship of this mentioned existing building to its surroundings must first be examined with regard to the flowing resources. The project K.118 is an addition to the Hall 118, hence the name. The entire existing building was originally constructed as a machine factory for the Sulzer company, which initially had its own heating plant. After the company left the site, the area was later connected to the district heating network of the city of Winterthur.

Through the site utility network dating back to the industrial era, external supply tunnels bring in district heating pipes, electrical supply, and chilled water horizontally into the building. (See graphic 2) Due to the optimal use of natural light, the technical center and the utility shaft are located on the ground floor, next to the elevator. This communal used area, which also includes the



Credits | Design: baubüro in situ, drawing modified by insertion of information provided by the architects



4. Credits | Design: baubüro in situ| Photo: © baubüro in situ, translation by Alix von Knebel

sanitary cores, is located on each floor and provides access to the three separate units.

Solar Energy

Although newer solar installations now have higher area efficiency, the office has decided to continue reusing less efficient installations that were available. They justify this by pointing out that despite having been in use for about 25 years, the installation still maintains a 90% performance and functions without any issues. Photovoltaic installations have a significant embodied energy content and must run for approximately 15 years to offset the carbon dioxide emissions produced during their manufacturing. Therefore from their point of view, as long as the installation continues to operate, it should be used further. The graph illustrates that the building’s energy demand is met from 8 AM to 6 PM, and the installation even generates significantly more energy than the building itself consumes. This demonstrates that the continued use of less area-efficient installations is both legitimate and worthwhile.

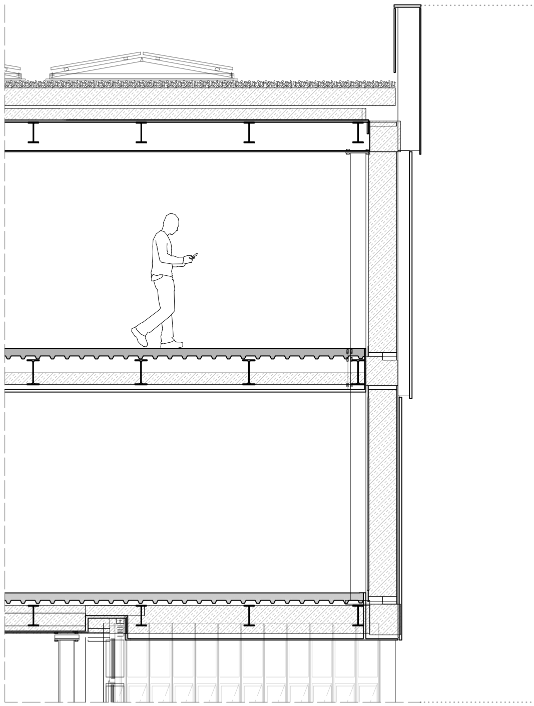
The office explains that maintainability and adaptability is a crucial factor for them in the context of circular designing. They pay attention to the varying lifespan of elements within the building. For this reason, they do not bury the utility lines but lay them additively in pathways. This allows for repairs or replacement without the need to break open the walls.

Design Approaches

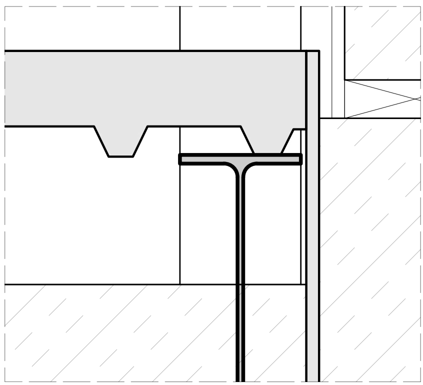
Reuse of disassembled materials was the primary circular approach for the architects. The structure can be separated into three different components. There is first the existing structure of the old warehouse. This structure was reinforced, and the second structural component of the building, the extension, was built above it using repurposed steel and concrete. The third structural component is the external staircase which acts independently to the rest of the building. It was entirely repurposed from a previous building, and the floor levels of its landings determined the floor levels of the extension.

The skin is made of both reused materials and biomaterials which consider waste disposal at their end-of-life. It is designed as a distinct element from the structure and can therefore be changed depending on the needs of the users without affecting the main building structure. The corrugated metal sheets create a waterproof surface, while the triple glazed windows and straw insulation ensure internal thermal comfort.

The building's services are exposed and hang from the ceilings. This is an approach which allows for easy adaptability,

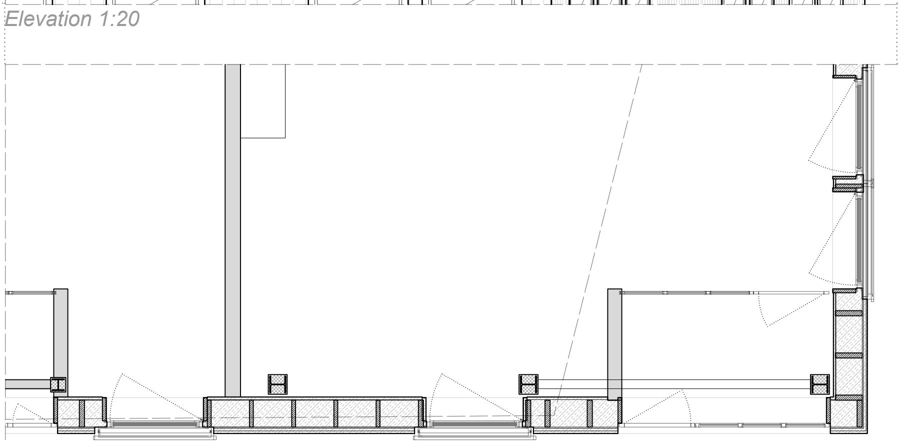


Section 1:20



Section 1:5

Elevation 1:20

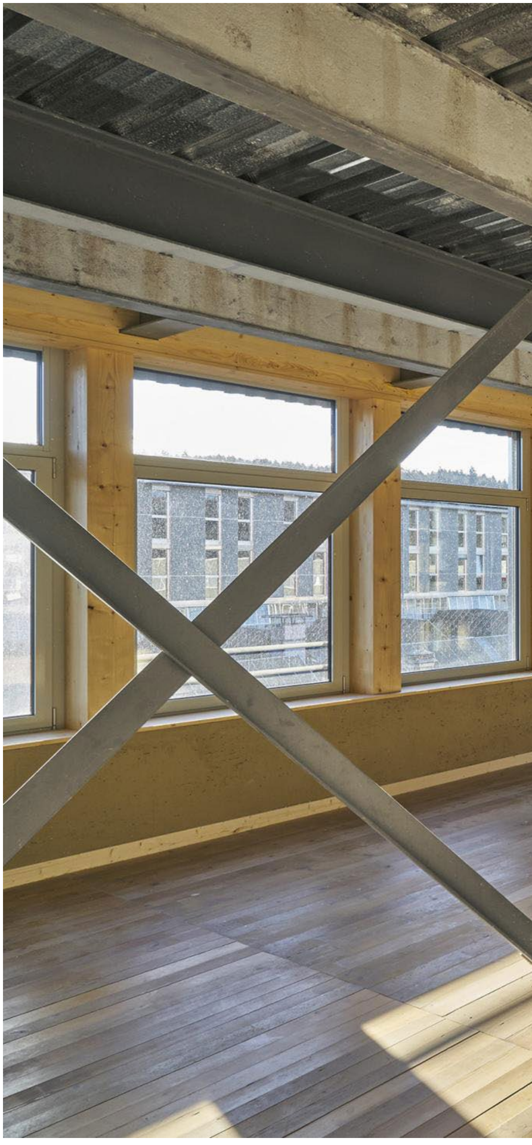


Plan 1:20 Credits | baubüro in situ / modified by Mark Caruana

Design Approaches

making it convenient to replace or change the building's services. without adversely affecting the other shearing layers of the building. Re-used PVC panels were installed on the roof to generate electricity for the building and thus improve its energy efficiency.

The internal floor build-up consists of galvanized steel sheets, recycled concrete, sound insulation and wood flooring, while the internal walls are built out of wood. The internal walls allow for a degree of adaptability since they are separate from the skin and structure, however the possible configurations of the interior are somewhat limited since the structure is not modular and the floor-to-ceiling heights are relatively restricted.



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Stakeholders & Value Chain

Designing in a more circular way can significantly influence and challenge the role of an architect within a building's development process.

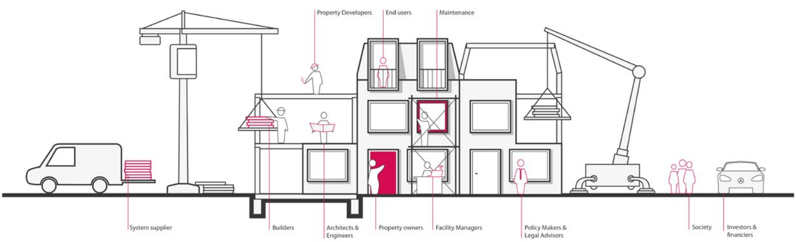
Architects need to consider the lifecycle of materials, their recyclability, and their ability to be repurposed. This may require architects to source alternative materials and collaborate more closely with suppliers who provide eco-friendly options.

As seen in this project, starting with available building components, the planning process takes a different approach. It may include an intensive research of materials that are locally available or even locally reusable.

As a result, architects must return to familiarize themselves with the project's surroundings. This also includes observing existing buildings and recent developments, like house demolitions or other possible harvest sources.

In other respects, too, the architect's focus seems to be shifting in the circular design process.

Reusing materials and the further processing that comes with it like disassembly, repair, and adaptation is potentially really time intense and require specific knowledge about the materials and their field of application. The office "in situ" states that their practice of reusing materials generated local employment opportunities and created new job files such as „material collector" and „component expert" *1. Also the following process of cataloging this found material requires a lot of organization skills. Furthermore, the use of new technologies and different programs could prove useful in this process and may change the focus of the architects' tasks and skills.



Based on a diagram by the CBE Hub, BK TU Delft

The role of the architect in circular design processes may also require increased persuasive skills, driven by various factors.

On one hand it might be challenging at times to estimate the costs as it's not always clear initially which materials are available and the extent to which they require additional processing. These uncertainties regarding project costs can significantly influence the design, as evidenced in the K.118 project. The core design principle was maximizing the utilization of reused building components and locally sourced materials from deconstruction sites. However, the ultimate selection of materials was largely contingent on cost considerations. The project aimed to incorporate secondary building materials to the greatest extent possible, all within the confines of the available budget. Although additional reusing options were conceivable, they would have incurred progressively higher expenses. The "Stiftung Abendrot" granted their approval with the condition that the construction using recycled materials would not surpass the cost of a traditional building constructed with new materials.

As a result, the expenses align with those of a comparable new construction project. However, the financial resources have been reallocated and are being used to support the local economy and knowledge development rather than buying new materials.

Circular construction not only brings with it a number of technical

There are for example additional uncertainties that may initially discourage both builders and investors, such as concerns related to the guarantee of reused building materials. This may include that the history of the material's previous usage is often unclear, requiring potential research into its treatment, including exposure to potentially toxic substances.

As the design approach to work increasingly with stock materials is quite novel many regulations have yet to be worked out. In the case of this project, the architecture office is still in conversation with the insurance company "AXA" in order to to find a solution for warranties and obtain more certainty here.[*1] This could encourage future clients to be more willing to use reused building materials.

As seen in the last paragraphs, there are several reasons why the role of an Architect changes in the circular building's development process.

Lessons Learned

K.118 serves as an excellent example of material reuse as a central circular design principle in building construction. It is an experimental and pioneering project where material reuse was applied across each shearing layer of the building, from the primary structure to various interior elements such as toilets and radiators. The architects' commitment to reusing materials from local sources ultimately resulted in a 60% reduction in the construction carbon footprint when compared to similar conventionally constructed buildings.

The traditional linear construction value chain was rethought in a circular manner, and materials which would have otherwise been discarded were given new life, thus preventing the further generation of waste by the construction industry. This alternative approach to design and construction necessitates a changing role for architects. They must engage in closer collaboration with suppliers and contractors, while simultaneously immersing themselves in the local context, all the while thinking creatively to blend reused materials into a cohesive building.

However, this innovative approach comes with its share of challenges. Beyond the aesthetic constraints placed on architects, functional limitations also emerge. The availability of building materials depends on the time and location of a construction project, requiring bespoke solutions for each project of this type. Additionally, reusing structural elements can constrain the configurational possibilities of the building, impacting its adaptability for future users. For instance, the relatively low floor-to-ceiling heights in K.118 impose limitations on potential internal space modifications. Nonetheless, the architects ensured a level of adaptability by segregating the shearing layers, enabling maintenance and changes in one layer without disrupting others.

In the end, K.118 stands as a thoughtfully designed building that excels in both aesthetic and technical aspects. Despite the challenges inherent in material reuse in construction, K.118 successfully integrates with its surroundings, makes a powerful aesthetic statement, and delivers a high-performing building for its users.

6. Credits | Design: baubüro in situ | Photo: © Martin Zeller

Colophon

Student(s):
Mark Caruana
Alejandro Mendiola De la Peña
Alix von Knebel Doeberitz

Studio:
Complex Projects

Tutor(s):
Oliver Ebben

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