CIRCULAR
DESIGN
ATLAS

BUITENPLAATS BRIENENOORD

Architect(s):
Superuse Studios

Year:
2020

Location:
Rotterdam, The Netherlands

More info:
https://www.superuse-studios.com/projectplus/buitenplaats-brienenoord/

Scales:
Buildings

Resources:
Technical

Design Approaches:
Design for adaptability

R-Strategies:
Reuse, Refurbish, Repurpose

Aspects:
Design, Resource flows

TU Delft
BK Bouwkunde

Figure 1. Buitenplaats Brienenoord | Image © Superuse Studios

Buitenplaats Brienenoord, located on Brienenoord Island in Rotterdam, is a small-scale redevelopment project of a former camp building into a space for social and cultural programs. The former structure was dismantled, and 90% of the building materials were reused on-site. Combined with materials sourced from nearby sites (through the initiative of the ‘Oogstkaart’, or ‘Harvest Map’), 95% of all materials used are reclaimed. The construction process was primarily carried out by volunteers, with occasional professional input from specialists.

The space hosts a broad variety of social, cultural, culinary, artistic, and educational programs with the goal of creating an active community interested in the future of Rotterdam and beyond.

Layers of Change and Lifecycle Duration

The site is located on Brienenoord Island in the Nieuwe Maas river in Rotterdam. A derelict camp building situated on the site was designated by the municipality to be replaced with a new building.

Superuse Studios employed the strategy of ‘Material Driven Design’, where available reusable materials are reconfigured and repurposed for their original use or other high-quality applications. The architects reused the foundation, steel trusses, and wooden beams from the old building. The trusses, worn from previous use, were recalculated for their new load-bearing function. When necessary, they were reinforced with wood or welded parts. New steel consoles were used to assemble the structure. The shape of the new building’s structure resulted from careful reconsideration of load-bearing capacities and dimensions of the reused structural components.

To allow for desired large spans, the load-bearing structure supports only the roof and a skin built from lightweight materials. The steel connecting components used to assemble the structure are deliberately dry-mounted, allowing the structural elements to be demounted from the foundation and reused without damage. We estimate the structure to last another 50 years.

The skin is made from reused window frames from the former building and harvested materials from around. Sandwich panels, polycarbonate panels, trespass panels, steel profiles, and construction boards; two large windows were obtained from sites relatively close to Rotterdam. Moreover, 1200 ceiling panels were repurposed in a composition of five layers as floor insulation. Due to careful consideration and reconfiguration of these materials and the ambition presented in the architect’s philosophy, we estimate the building’s skin to also last another 50 years. The specific irregular structure makes future reuse of the skin material difficult.

The interior is zoned based on the desired climate – not all spaces are heated. This influences the distribution of the reused heaters and the placement of insulation. To supply energy, solar panels are installed on the roof. The installations are not hidden in the construction, allowing for future redevelopment.

The large spans and generous rooms allow for diverse use of the space plan. The installations are clustered, which allows flexibility in spatial reconfiguration for future users. The expected use, therefore, extends as long as the durability of the structure and skin will allow.

Site
Eternal

Skin
± 20 years

Structure
30-300 years

Services
7-15 years

Space plan
3-30 years

Stuff
Various

Figure 2. Images © Superuse Studios

Carbon Footprint of Materials

The part of the facade selected for this analysis is located on the south side of the construction. The cladding and structural elements are representative of the overall building.

The calculation using the material pyramid suggests a carbon emission of 48.1 kg CO2 per square meter of the façade. However, it should be taken into account that all materials, except the double-glazed window panes on the south facade, have been harvested from demolished buildings. Therefore, it would be sensible to consider the carbon emissions originating from transportation, rather than material production.

Based on calculations by the International Council on Clean Transportation, a regional delivery (RD) truck emits an average of 197 grams of carbon dioxide per kilometer. Considering the materials in the facade detail, the transportation emissions of those elements (see chapter: building material origin; materials collected on site – i.e. the distance being zero kilometers – are not considered here) for the *whole building* add up to 34.9 kg CO2.

	Kg CO2/m3	m3	kg CO2
Structural steel	8831.2	0.0026	23
Contruction timber	-680	0.03	-20.4
Wood frame window	474.1	0.012	5.7
Glass pane, double - glazed	266.1	0.00092	0.2
Steel panel	26578	0.00077	20.5
Vinyl (PVC) - Billboards	4095.5	0.0034	13.7
Stone Wool	70.4	0.077	5.4
			48.1 kg CO2

Table 1: CO2 emissions per material - numbers based on Materialepyramiden.dk

	km from site	g CO2
Timber beams	80 km	15760
Sandwich panels	80 km	15760
Construction billboards	17 km	3349
		34.869 kg CO2

Table 2: CO2 emissions material transportation - numbers based on ICCT

Buitenplaats Brienenoord
Façade detail - Exploded

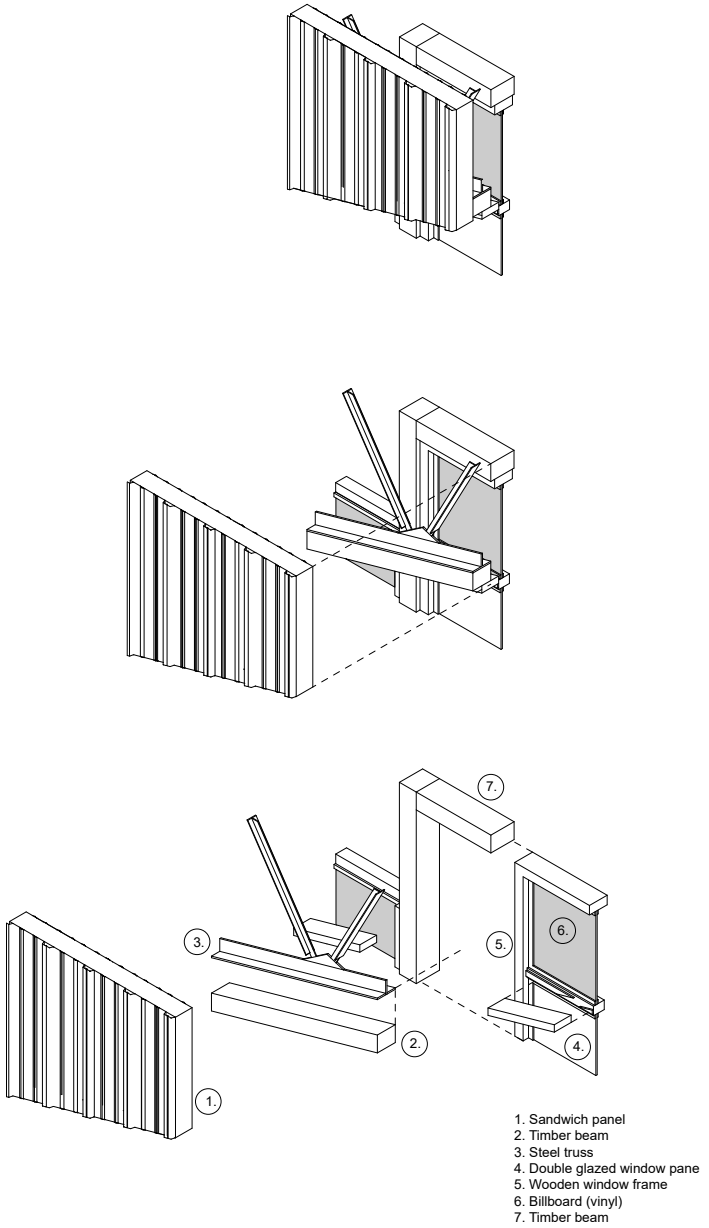


Figure 3. Façade detail | Diagram: Richard Múdry, Annika Goedkoop, Sacha Oberski

Building Material Origin

The studied facade fragment on page 6 consists primarily of 6 elements (technical materials): (1) Sandwich panel, (2) Timber beam, (3) Steel truss, (4) Wooden window frame + Glazing, (5) Billboard, and (6) Timber beam.

The strategy for the building material origin was to reuse the material from the demolished object on the site and the rest to harvest or from the immediate surroundings of the site. As a result, in total, 90% of the old building has been reused, and only fixing material, 5 wooden trusses, column foundation, and the glazing in the window on the south facade are not harvested from different buildings.

(1) Sandwich panels

The sandwich panels creating the outer layer of the facade were reused from a site located in Ede, 80 km from Rotterdam;

(2),(6) Timber beams

The timber beams in the facade fragment have been harvested from a site in Zeewolde, 80 km from Rotterdam;

(3) Steel trusses

The structure is mainly composed of steel trusses from the old building. These trusses were recalculated for the new loads, and if necessary, they have been reinforced with wood or welded parts without compromising their characteristic appearance;

(4) Wooden window frame + Window with double glazing

The window frames were reused from the demolished old building, while the double-paned windows were newly produced. The location of the production is unknown;

(5) Billboard

The billboard panel fabric is used as an infill for some of the window frames. The material originates from the outskirts of Rotterdam, 17 km from the site.

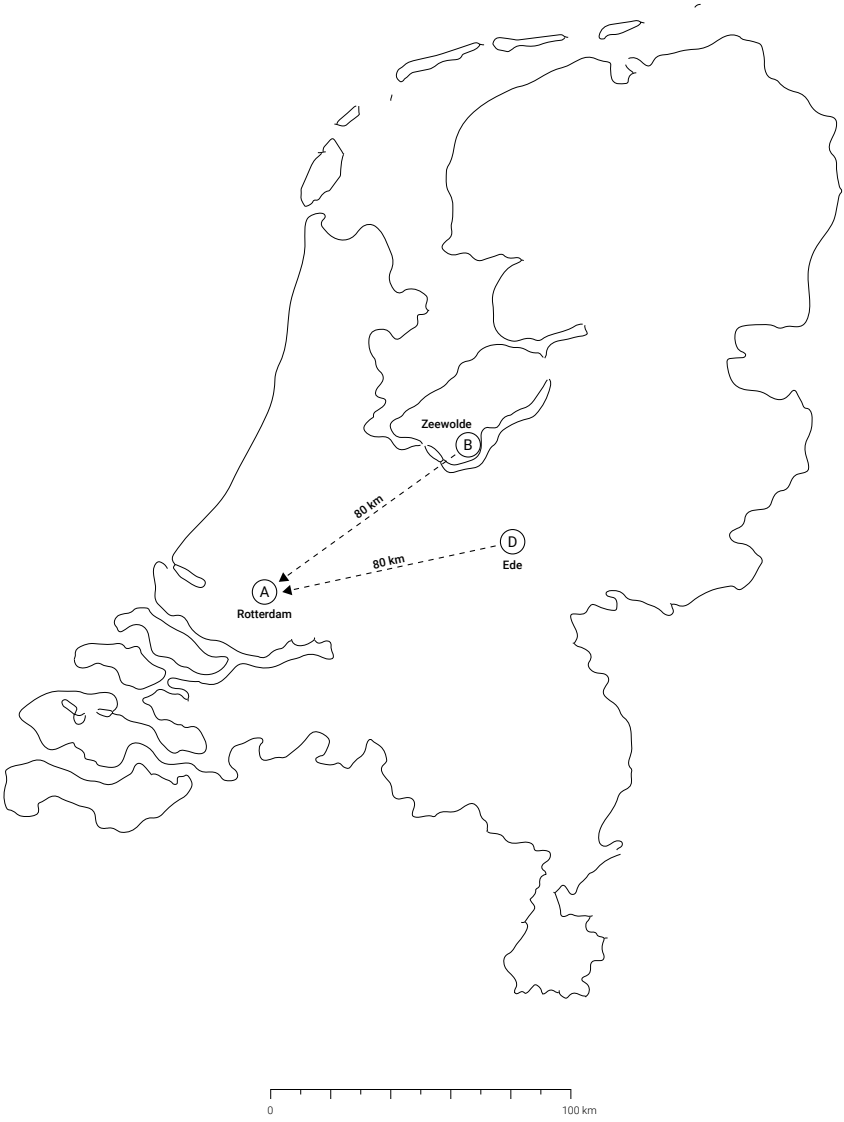


Figure 4. Harvest map | Diagram: Richard Múdry, Annika Goedkoop, Sacha Oberski

R-Strategies

Considering the fact that ninety percent of the project is based on reused, refurbished, and repurposed materials, the availability of construction elements has significantly influenced the building process. As a consequence, the assembly of the facade underwent multiple alterations during construction. In fact, the architects consider the building as ‘forever unfinished’ to underline its continuous development and potential to be easily and sustainably adaptable to change.

This strategy necessitates a high level of flexibility in the assembly of the construction. Therefore, the architects opted for simple and straightforward construction principles, such as dry assembly, to allow easy access to both the structure and the skin layer (see picture). The facade can be considered as having only two layers: the sandwich panelled envelope and an apparent structure on the inside. This is particularly advantageous for repair or replacement works.

Regarding the materials harvested from other buildings, they can be disassembled to be remounted in a different configuration. Only the steel trusses were repurposed to withstand the new working load, which simultaneously demonstrates their adaptability. To facilitate these reuse procedures, the architect keeps track of all elements in a ‘material passport’, documenting life cycle stages and supporting decision-making in case of replacement.

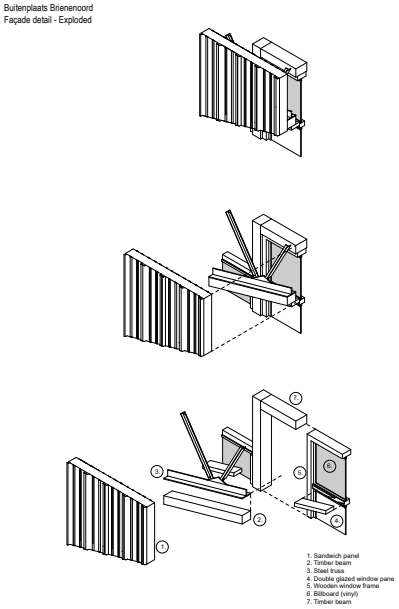


Figure 5. Façade detail | Diagram: Richard Múdry, Annika Goedkoop, Sacha Oberski

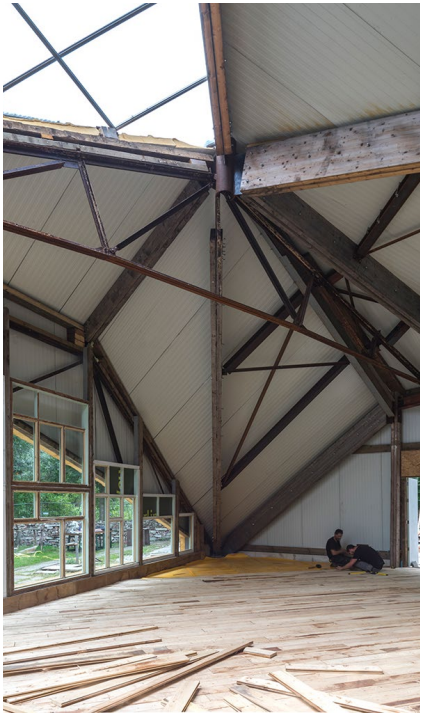


Figure 6. Image © Superuse Studios

The NEW Nexus

The location of the project Buitenplaats Brienenoord is the island Brienenoord in the Nieuwe Maas river crossing Rotterdam. The island spans 21 hectares and was created at the beginning of the 19th century through the siltation of a sandbar. Nowadays, its nature and role within the city's ecosystem are intentionally intensified.

Designers can influence the nexus of nutrients, energy, and water at the micro-scale when considering urban resource flows. By managing with a circular approach and utilizing waste flows of water and food, loops are closed. With this circular approach, the need for resources is lowered, and the energy required to transport and process waste is reduced. Renewable energy production also reduces the need to import energy from afar, and thermal insulation of buildings can decrease energy demands overall.

Buitenplaats Brienenoord achieves this by utilizing rainwater and composting food waste. The building has a geothermal heat pump, and the climate facade on the south facade functions as a heat buffer. Renewable energy is generated from solar panels installed on the roof.

Figure 7. Buitenplaats Brienenoord's direct surroundings | Photo: Google Maps, edited by Richard Múdry, Annika Goedkoop, Sacha Oberski

Figure 8. Buitenplaats Brienenoord, siteplan | Image © Superuse Studios

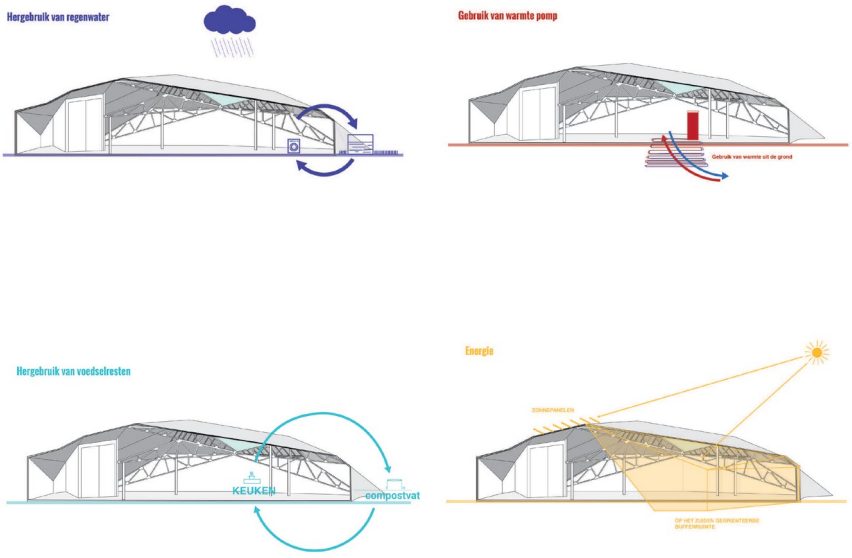


Figure 9. Buitenplaats Brienenoord, climate sections | Images © Superuse Studios

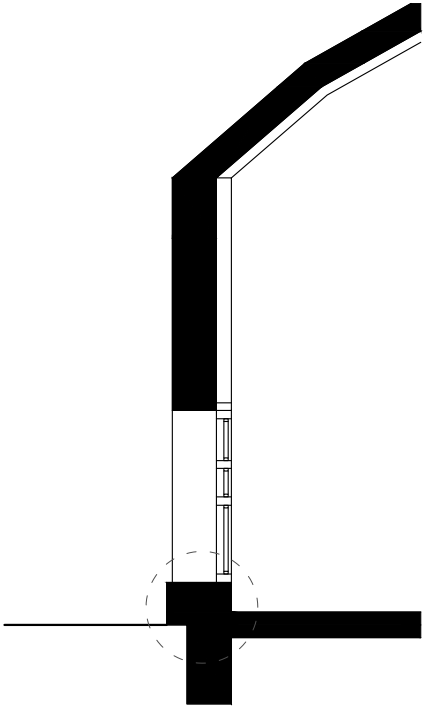
Design Approaches

The architect's approach focuses on working with what is already present. Building materials found on-site are refurbished, repurposed, and reused. Looking beyond the expectations of the newly built, principles of designing for disassembly were adopted.

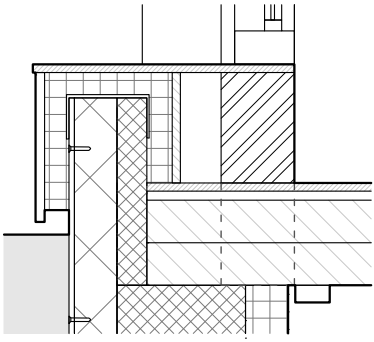
The reused foundations are fixed to the vertical load-bearing structure using a dry process to enable future disassembly without causing damage to the materials.

Facade assembly follows the same principles accompanied by a simple build-up. Sandwich panels, creating the envelope, are attached with screws to the structure, allowing for low-effort maintenance during the lifespan of the building. However, the horizontal structure, made from repurposed and adapted steel trusses, presents a challenge for potential future use, as the single elements are all unique and optimized for their exact positions within the structure.

Moreover, to plan for the future life cycles of the building, a 'material passport' was created, documenting the material used throughout the entire building. Precise documentation of the building material supports the concept of a 'forever unfinished' building and establishes a groundwork for future adaptations and changes.



section 1:200



detail 1:20

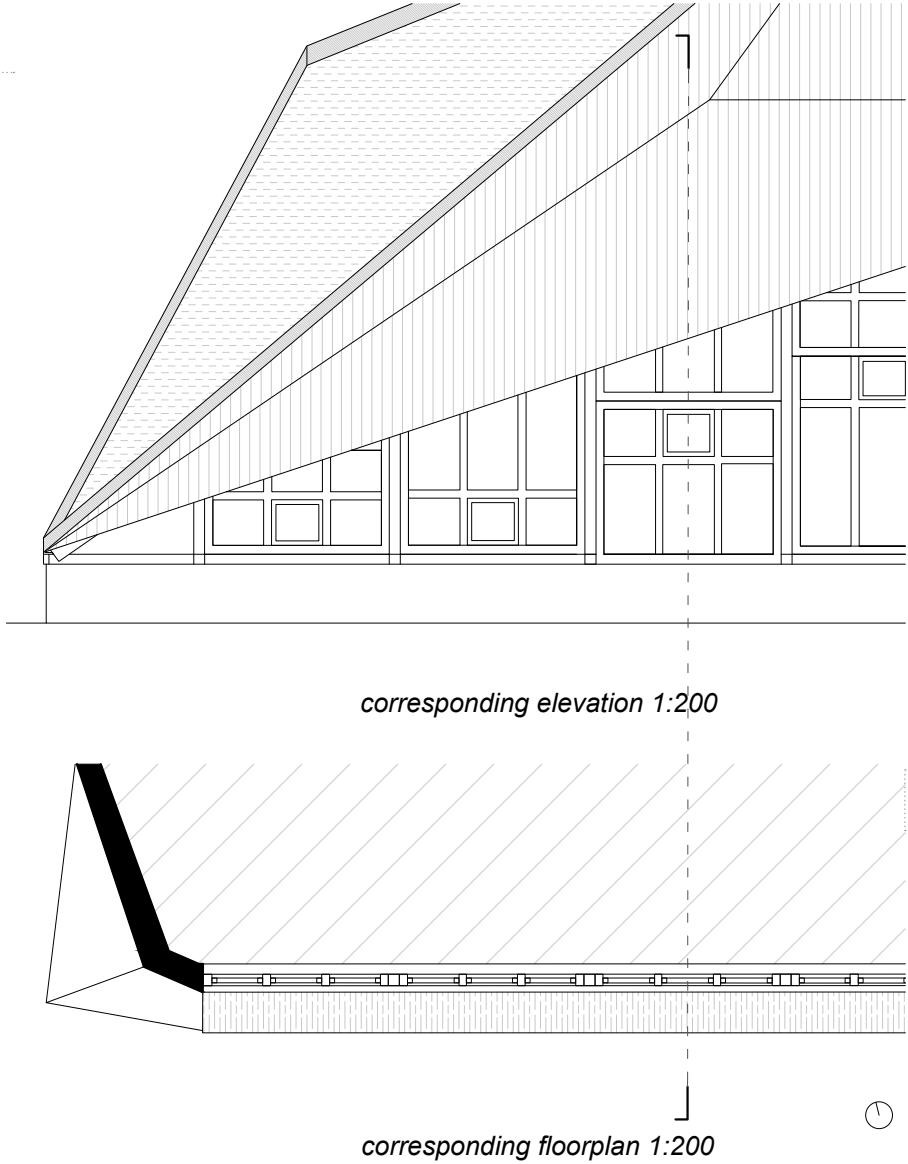


Figure 10. Detail, section and floorplan drawings, Superuse Studios | Edited by Richard Múdry, Annika Goedkoop, Sacha Oberski

Stakeholders & Value Chain

Stichting Grondvesten manages Buitenplaats Brienenoord and creates a program around the themes of “future thinking and future acting.” This non-profit organization approached Superuse Studios to realize a new camp building on the Island of Brienenoord in Rotterdam, Buitenplaats Brienenoord. The brief included:
- ‘social return on investment’: creating employment for people at a distance from the labor market, with a ratio of 10:1;
- minimal ecological footprint;
- the limitation of the old bridge to the island (carriage capacity of maximum 15,000 kg);
- a limited budget.

Architect Floris Schiferli explains in an interview with Cirkelstad how the concept of building Buitenplaats Brienenoord started with a municipal budget of 40,000 euros to demolish the old camp building. Superuse Studios proposed using this budget not only to demolish the old building but also to demount and reuse its elements for the construction of a new building.

Figure 11. Images © Superuse Studios

The architects practiced ‘material-driven design,’ which means a design inspired and guided by available reusable materials. High-quality reuse is assumed: the material will be used again in its original function or a higher one without much processing. This involves another sequence in the design process. The main shape of the new building can only be decided upon once there is a clear overview of the available materials, which was only possible after the building was demounted on-site.

While it was evident that this building would be used by many parties, all were invited to collaborate on the spatial design in stakeholder sessions. To provide insight, the inventory of all demounted elements was scaled and 3D printed. This construction kit was used by all involved collaborators to make spatial propositions. Many ideas were integrated into the final design, including routing, relation to the outside, un-climatized rooms on the south side of the building, and the built-in flexibility to change the building layout during use.

The architects of Superuse Studios translated the free explorations into architecture. In addition to locally reused materials from the old building, residual materials from nearby were collected and reused. This led to the fact that only the thereafter missing components - mostly those for fastening purposes - were new building materials (5% share of the total of used materials).
Only after this profound inventory, a final design could be completed, while a possibility to modify the design right up to the final phase was necessary. This required good cooperation between the architect, contractor, and client.

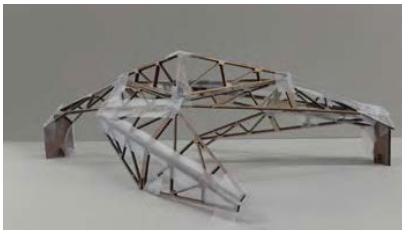


Figure 12. Images Superuse Studios

The building process was intended to educate people at a the distance to the labor market. The actual construction team included people who were long-term unemployed, people with burnout, refugees, among others. This method included unconventional workflows and solutions too.

Superuse Studios mentions that currently, few suppliers offer guarantees on reused materials. This requires shared responsibility and enough expertise to approve used materials within the building team of the architect, contractor, and client. The application can also be assessed by an external party. For materials that are sensitive to wear and tear, it can be useful to plan for a small stock of spare parts.

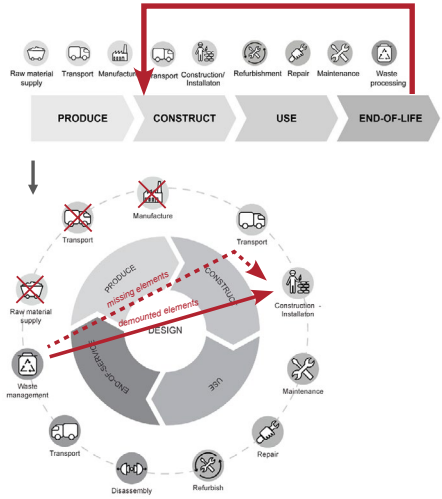


Figure 13. Design strategies, TU Delft | edited by Richard Múdry, Annika Goedkoop, Sacha Oberski

Lessons Learned

Buitenplaats Brienenoord exemplifies how to effectively utilize existing resources. It demonstrated that 90% of the materials from the old building, originally slated for demolition, could be demounted and reused. These materials accounted for 65% of the materials used in the new building. Additionally, locally sourced residual materials contributed another 30%, resulting in a total share of 95% of the building's materials being reused. The dry-mounted construction method, along with independently assembled services, consider the differences in the life spans of the building layers, enabling future dismantling and reuse, which aligns positively with the circular concept of the project.

The project offers a new perspective on the design process. Instead of presenting an uninformed design proposal, the architect initially evaluated and reconfigured available materials from the site and its surroundings, leading to a reduction in the amount of needed materials. This approach requires thorough incentivization and calculation, resulting in a final design that can be adjusted and modified right up to the final phase (referred to as a 'Dynamic Definitive Design'), and thus necessitates good cooperation between the architect, contractor, and client.

Colophon

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Tutor(s):
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Image credits:

Figure 1, 2, 6 :
- Buitenplaats Brienenoord 7. From “Flickr.com,” by Superuse Studios, 2019. (https://www.flickr.com/photos/superuse-studios/48753531811/in/album-72157710893585598/)

Figure 8, 9, 11, 12:
- Buitenplaats Brienenoord. From “superuse-studios.com”, 2019. (https://projects.superuse-studios.com/projects/buitenplaats-brienenoord/)

Figure 13:
- BES Lecture Series on Circularity, lecture 1: Introduction to circularity at building scale by Olga Ioannou, September 2023

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