SILENT MATERIAL – RECLAIMING THE UNSEEN

MASTER THESIS
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Context

The act of isolating buildings is a primordial and instinctive search for strategies to enhance our ability to endure thermal conditions that fall outside our ideal temperature range. This ranges from the use of clothing to the design and construction of buildings.

Around 1870 the first specifically manufactured isolation materials enter the market. Amongst them stone wool, a product that remains widely utilized to this day.

Stone wool has demonstrated its crucial role in enhancing energy efficiency and heat storage, especially following the oil and energy crisis of the 1970s, which spurred the widespread adoption of insulation. Since that pivotal period, the thickness of the insulation layer has risen significantly, growing from 4 to 30 centimeters up to the present day. Consequently, Switzerland annually utilizes around 400,000 tonnes of insulation materials, with stone wool representing 43% of the market.

There is in Switzerland a sole producer of Stone Wool, namely Flumroc. It manufactures this insulation product since 1950. Currently, Flumroc produces approximately 60,000 tonnes of stone wool each year for the market.

The resource for stone wool is a combination of three stones, Diabase, Dolomite, and Amphiboilite which are extracted the Grisons Mountains. At Flumroc, they undergo a process where they are fused at 1500 °C to create liquid stone. This molten stone is then spun into fibers and subsequently crafted into a fiber carpet. Through this method, one cubic meter of stone (with a density of 3000 kg/m³) is transformed into 100 cubic meters of stone wool, with a density ranging from 60 to 200 kg/m³.

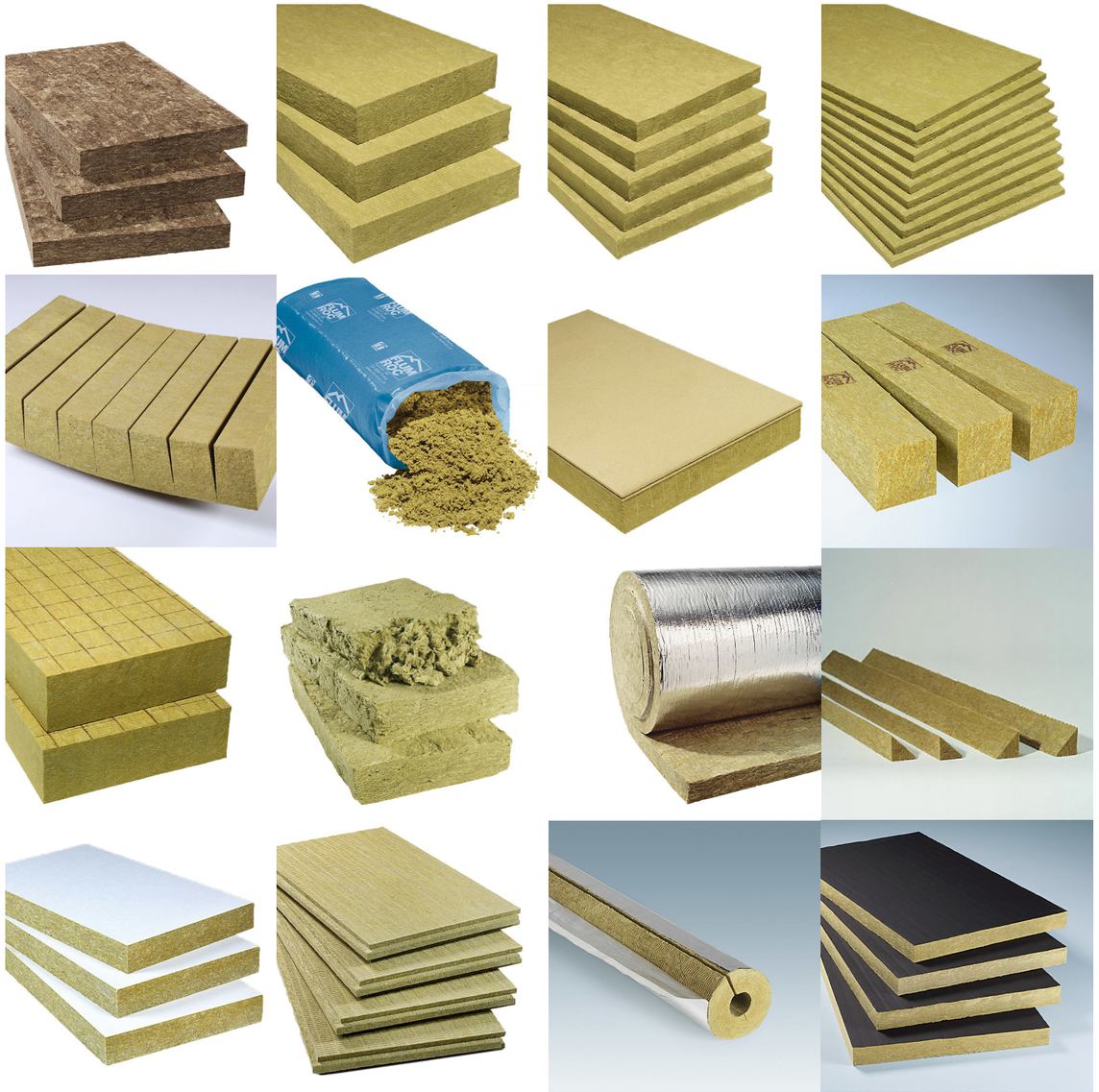
Following 40 years of installation, the material requires replacement. The deconstructed stone wool insulation is subsequently either directly transported to a landfill or shredded, blended with other waste, and incinerated in a waste incineration plant. Ultimately, the burned waste also finds its way to the landfill as slag.

Only a very small percentage is recycled today even though stone wool possesses the potential for 100% recyclability as it can be remeleted together with the primary resources. Also, stone wool waste recovered from buildings without moisture damage shows properties corresponding to newly manufactured stone wool and could potentially be reused.

The reason for the common, non-circular disposal approach stems from low landfilling prices and the heightened transportation costs involved in returning the stone wool to the production facility, which exceed the expenses associated with direct landfill disposal. These factors contribute to a lack of economic viability for recycling the material.

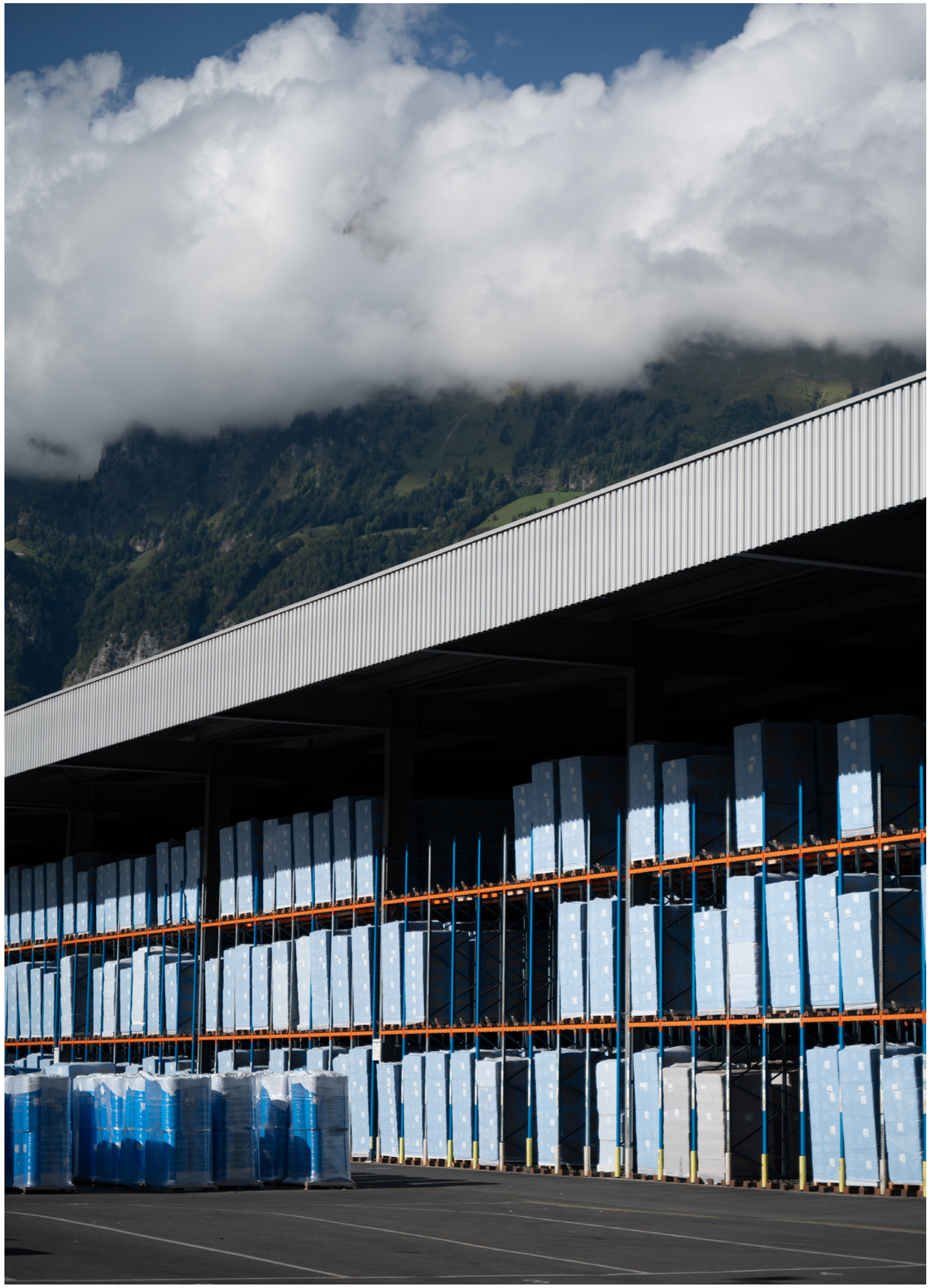
The challenge lies in identifying suitable locations for collecting the materials. Ideally, these storage locations should be strategically situated in urban contexts, where most of the waste is generated. These logistical hubs should also align closely with the current transport routes to facilitate a seamless transition from the existing logistical routes.

To ensure that a smaller amount of the still usable material ends up in landfill it is necessary to reevaluate the disposal practices and investigating how the material can be reused without remelting, considering economic viability and environmental sustainability.



Stone Wool Products

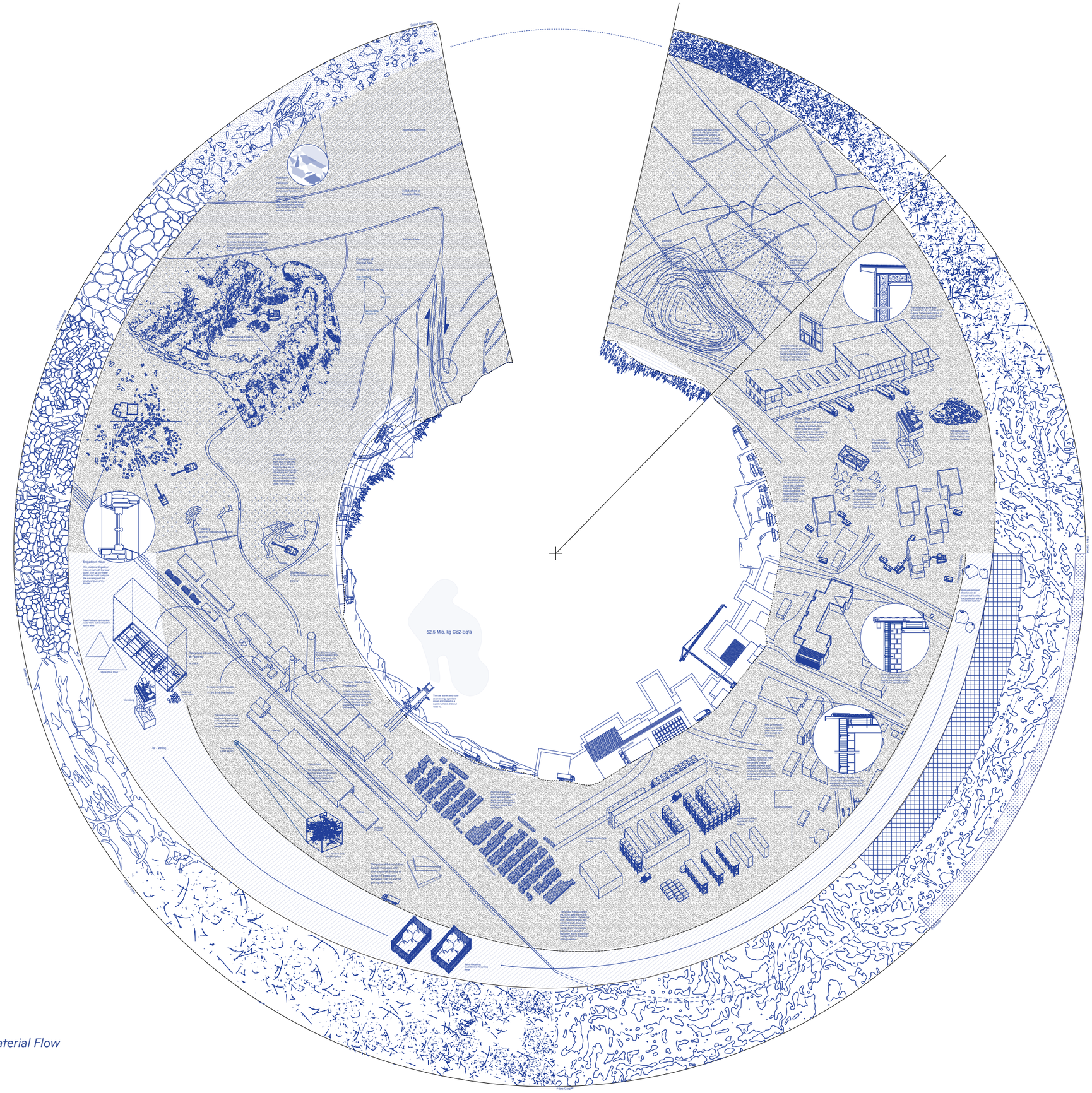
Production Process



Product Storage

Waste Material

Stone Wool at Landfill Site



Mapping of Material Flow

Reclaiming Stone Wool

Reclaimed stone wool has the same physical properties as newly produced stone wool. This potential would make it possible to produce new insulation products from the harvested waste material and revaluing the material itself, by treating the waste as a resource.

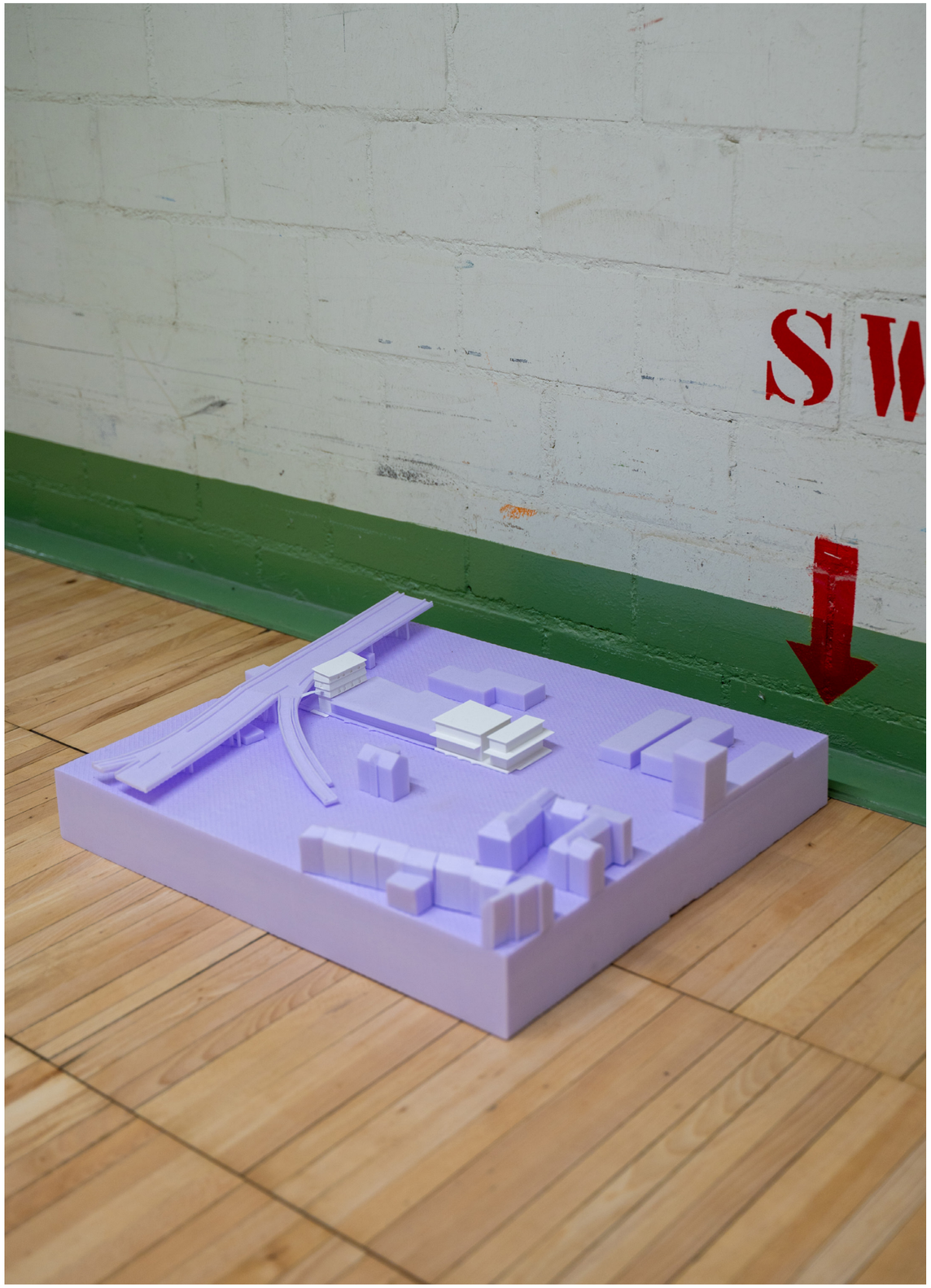
In the reclamation process the stone wool undergoes sorting, cleaning and shredding before the resulting granulate can be converted into various new insulation products.

The reclamation infrastructure is located at Hardbrücke, where the largely demolished Güterbahnhof is being restored to its original logistical purpose. The existing structure of Güterbahnhof is connected with an extension on the east facade to accommodate the necessary spatial requirements to reprocess the stone wool.

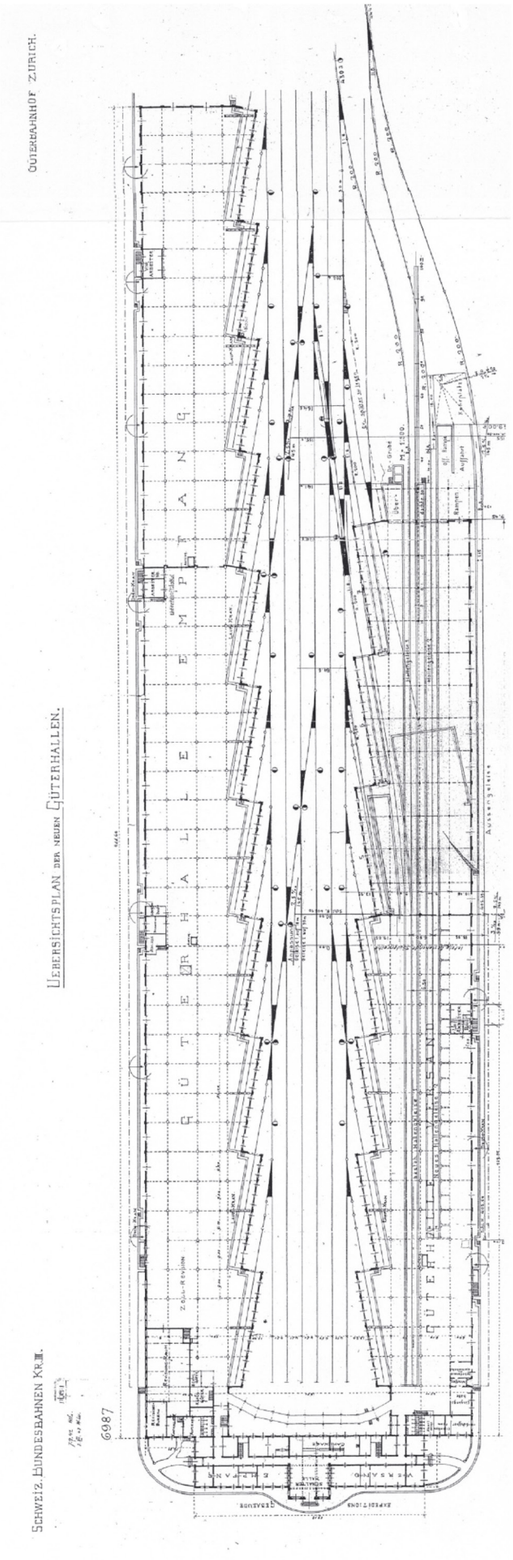
The intervention activates the underutilized recycling potential of stone wool by implementing an infrastructure for recovering stone wool waste in the heart of Zurich, where the biggest quantity of waste is generated within Switzerland.

Furthermore, the Güterbahnhof provides a direct link to the railway network, enabling the interception of larger volumes of waste.

Within the facade of the adminstrative building, the insulation assumes a dual identity, functioning not just as a protective layer but as a deliberate ornament, a rediscovered design piece, carefully integrated into the appearance of the building, resembling the placement of a marble plate. This integration not only respects functionality but also positions stone wool as a material embedded within the urban environment.

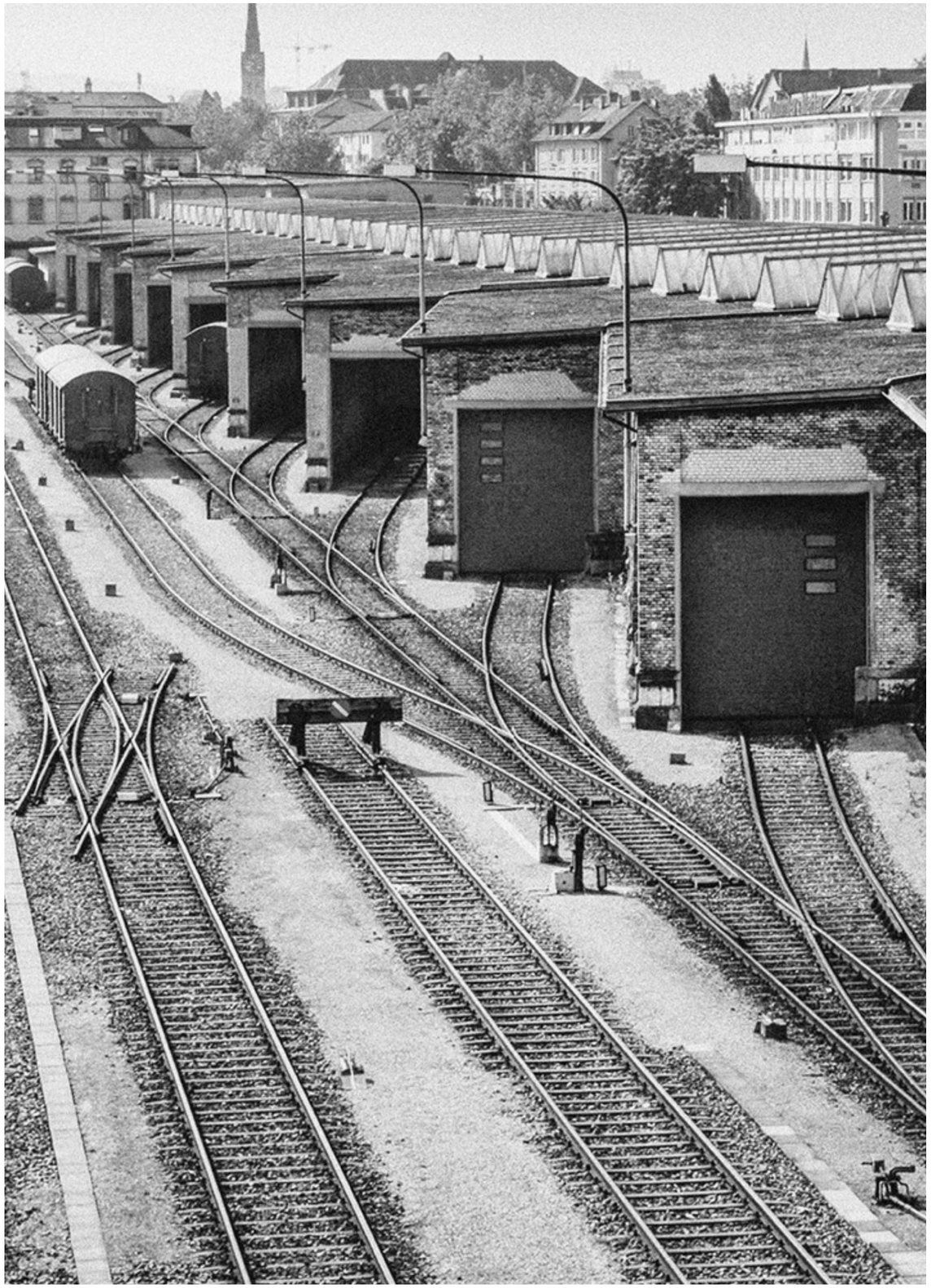


Site Model

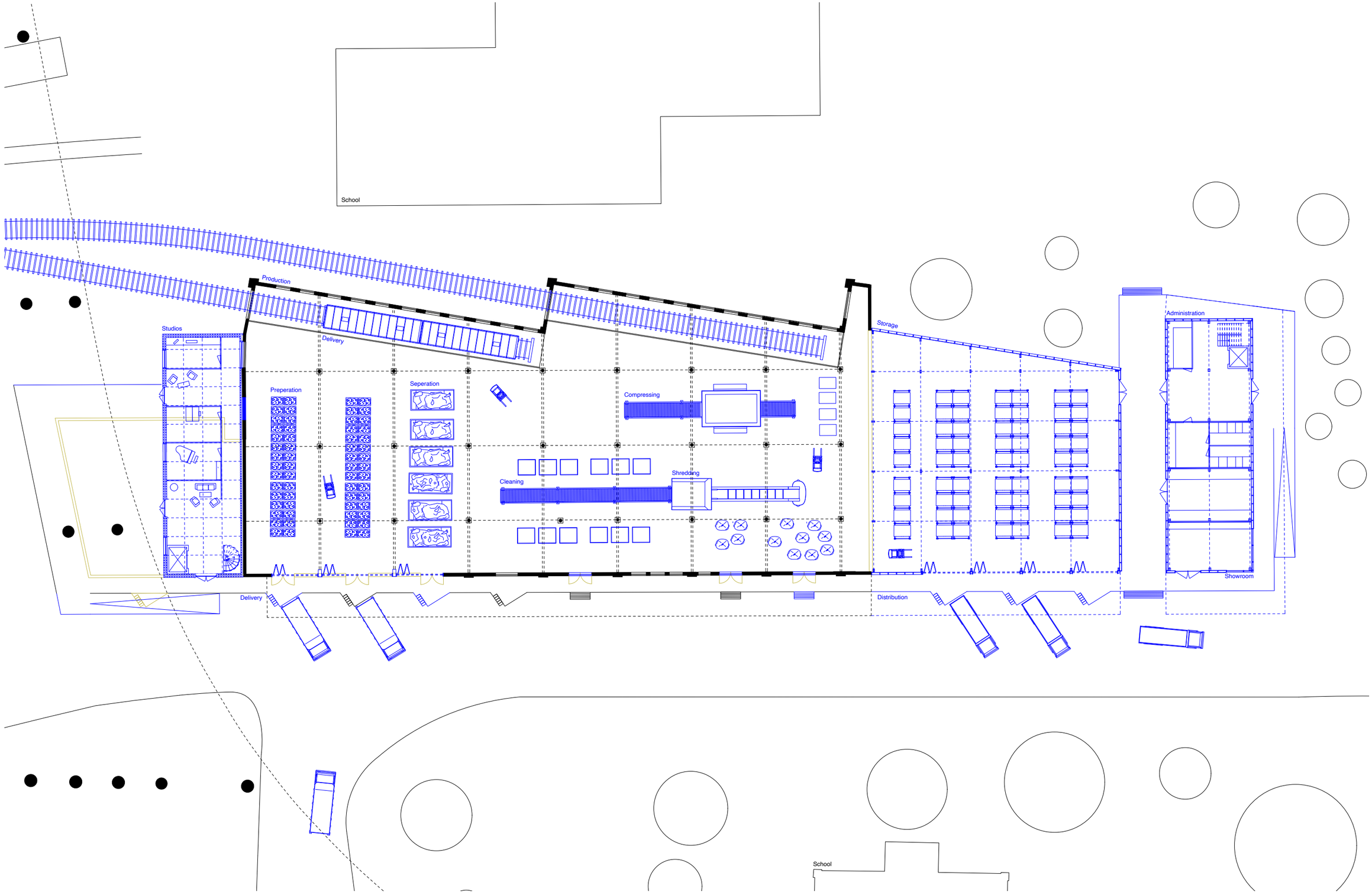


Güterbahnhof und Güterverwaltung, Grundriss Erdgeschoss (Infothek SBB Historic Bern, Archiv)

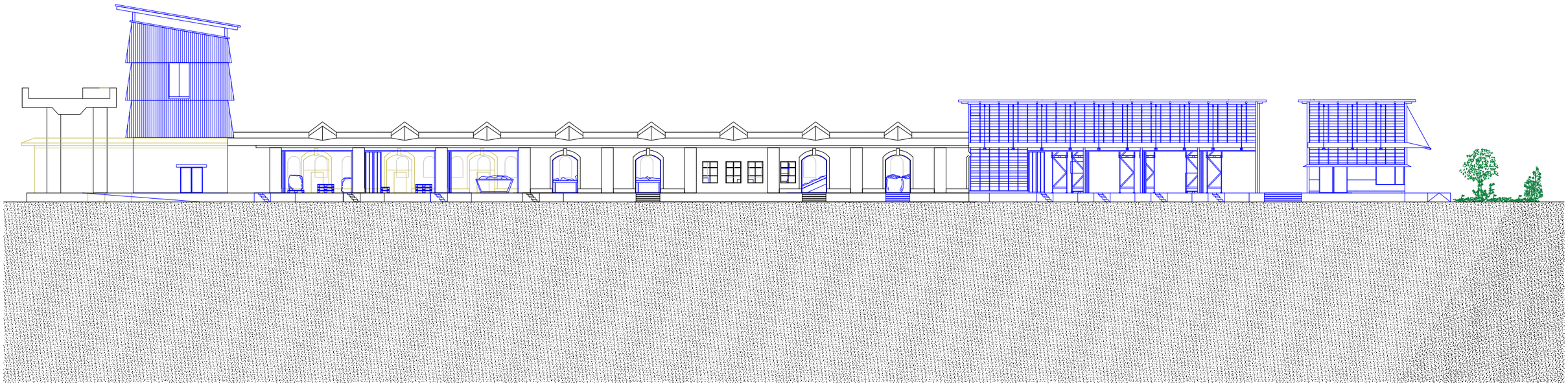
Former Güterbahnhof Plan



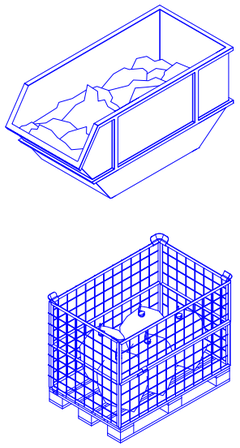
Former Güterbahnhof Photo


School
Production
Delivery
Studios
Preperation
Seperation
Compressing
Cleaning
Shredding
Storage
Administration
Showroom
Delivery
Distribution
School

Plan

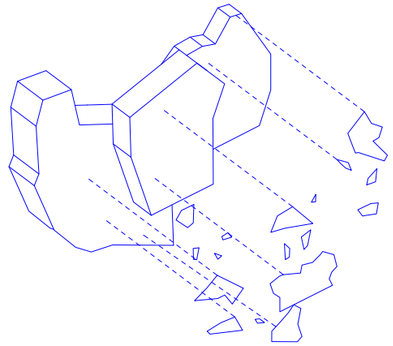


Elevation



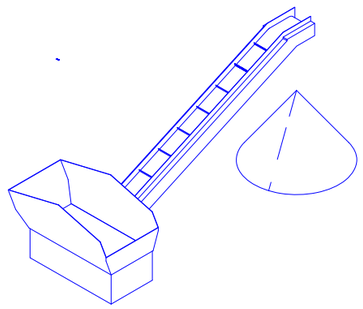
Waste

Waste Material is reclaimed either from buildings that are being demolished or from offcuts from the construction site. Demolition waste is usually more heavily soiled than offcuts.



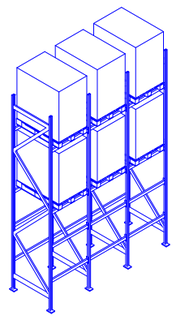
Cleaning

Contaminated stone wool must be cleaned of foreign matter before shredding. The soiling is usually only superficial.



Shredding

The stone wool is reduced to a uniform size by the shredder, which facilitates further processing of the material. The result is a homogeneous granulate.

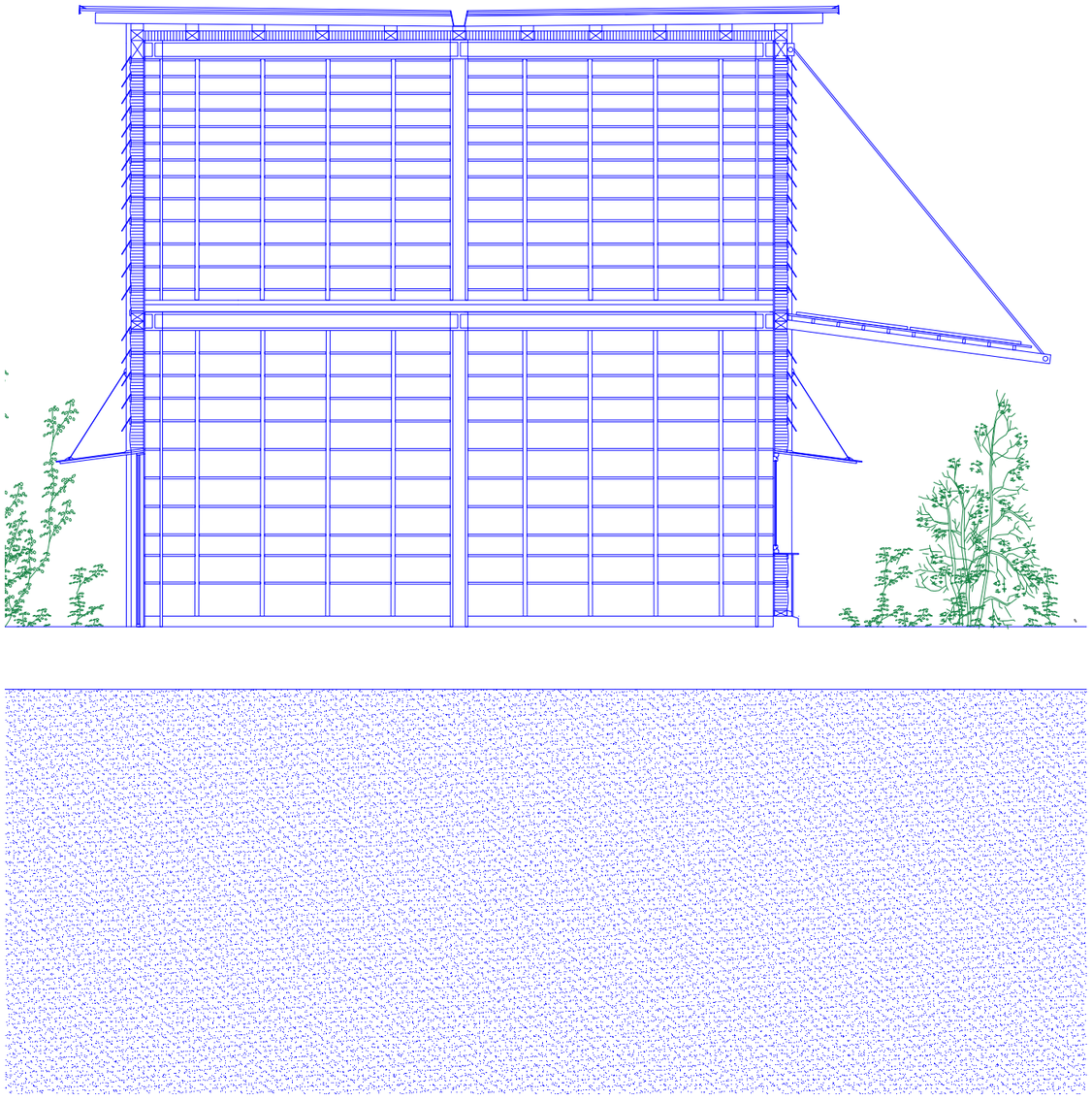


Storage

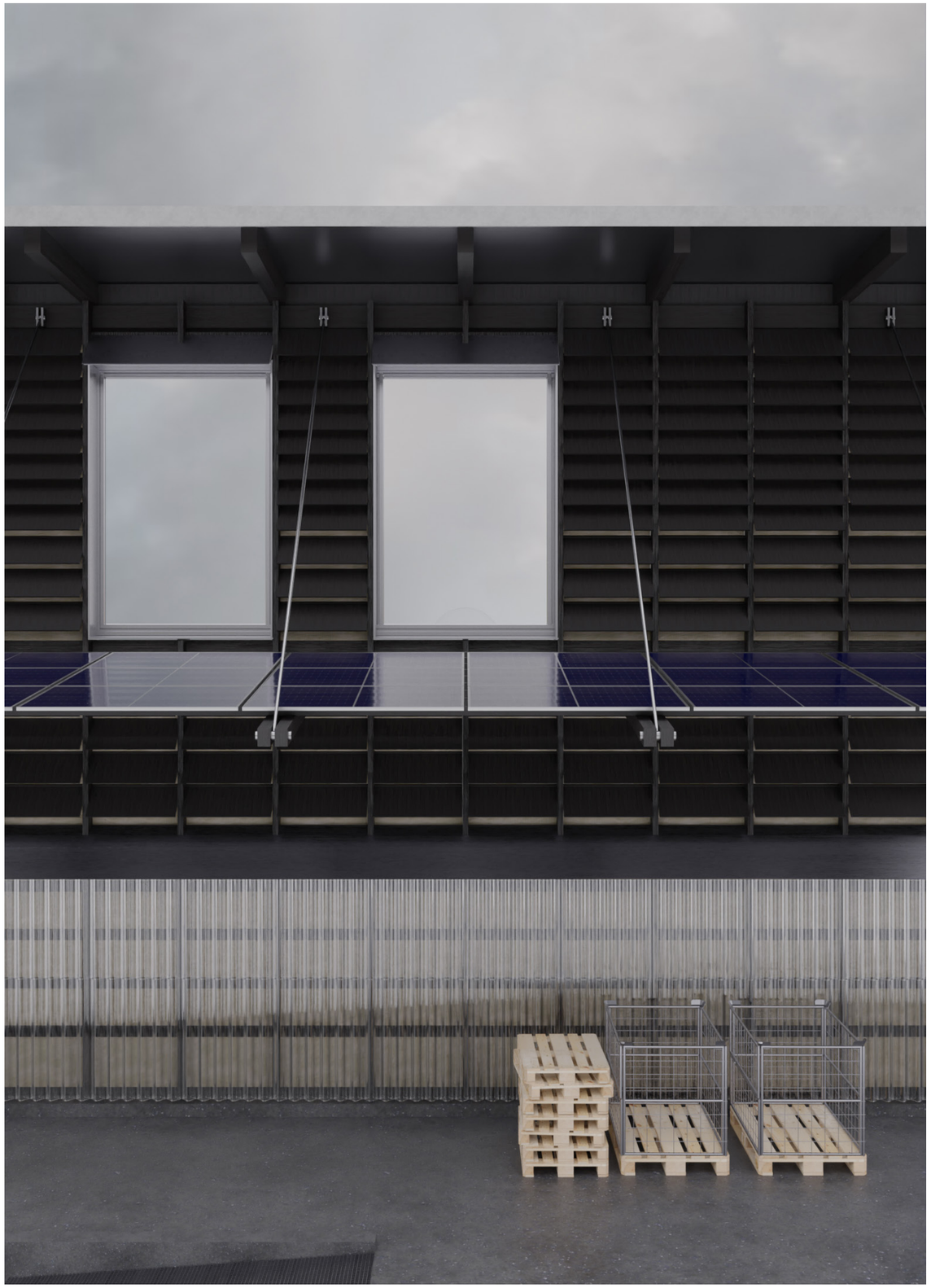
After shredding, the granulate is compressed into compact packets. This saves storage space and transport costs. The material can then be reused in the same way as newly produced stone wool.

Reclaiming Process

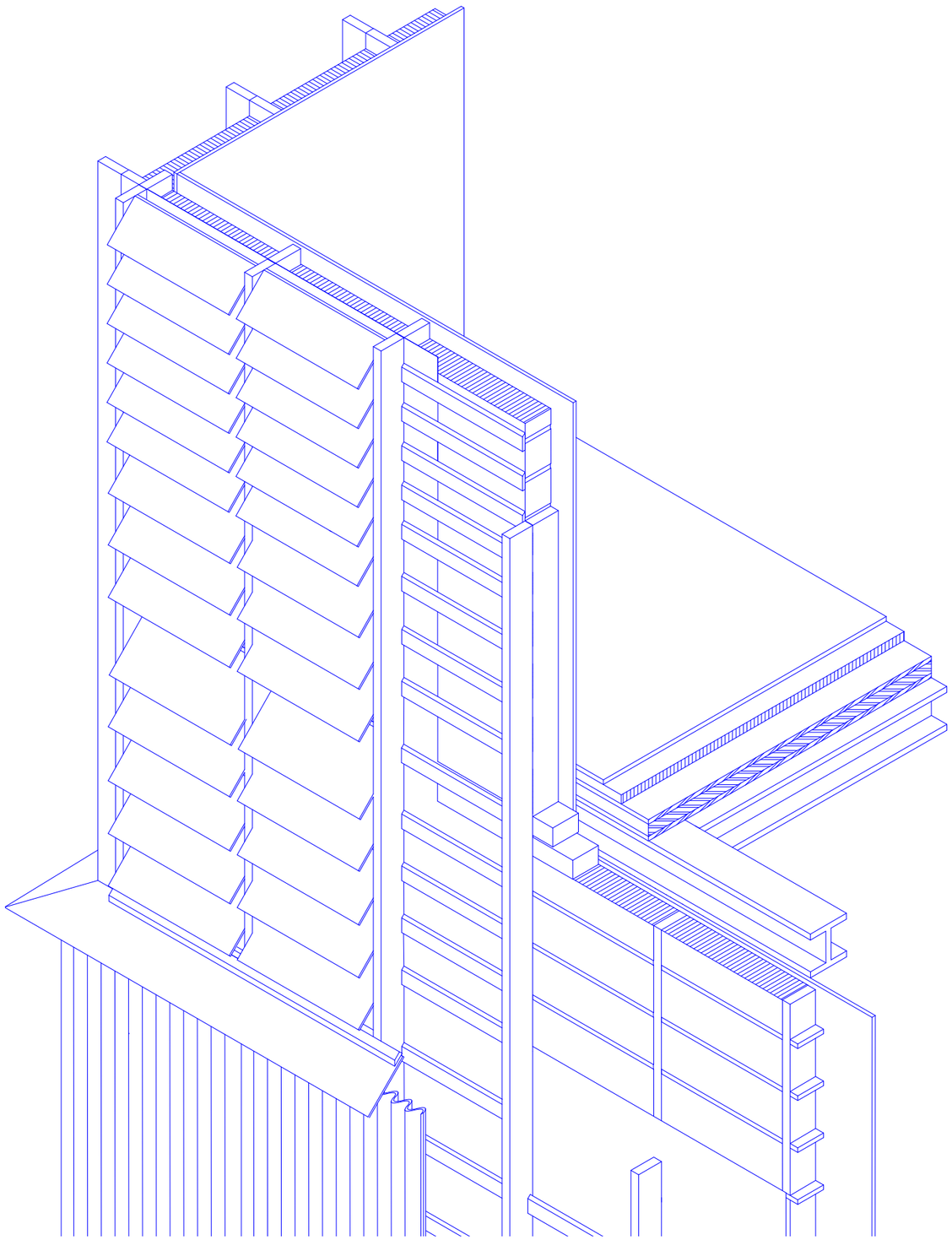
View along Warehouse



Section of Administrative Building



Facade of Administrative Building



Envelope Axonometric

Envelope Model

Granulate Application

By reintroducing the material after it has been deconstructed, the stone wool can gain a new valuation, transitioning from a purely technical product to become a vital architectural element.

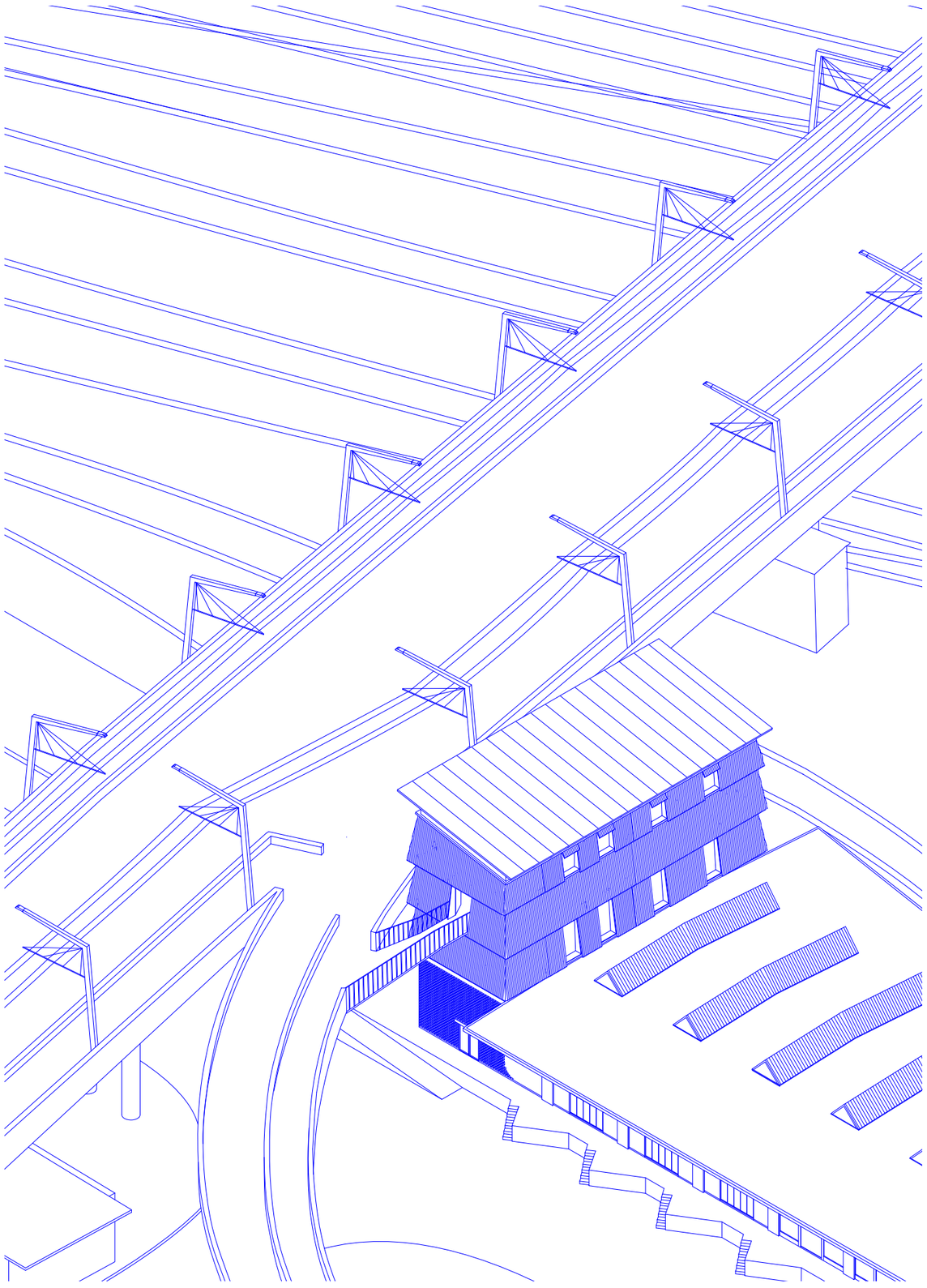
This potential is realised in the second intervention in a four story building conected to Hardbrücke. It contains music studios, rooms for the community of Hard and an event and exhibition space. These uses can harness the advantages of the presence of stone wool.

Within the music studios the stone wool creates soundproofing as well as good acoustic conditions. In the event space the ceiling insulation transforms into an acoustic ceiling.

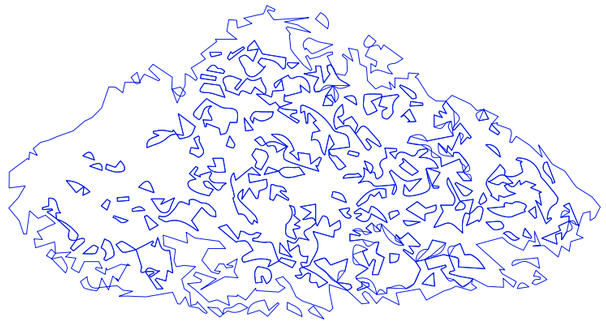
The value of stone wool is no longer solely dependent on its technical performance but is rather determined by the time, knowledge, and care invested in the integration of the material in the design process.

The invisible thermal barrier might even transform into a visible architectural element on walls and ceilings, consciously avoiding its concealment beneath other materials.

The intervention functions as a prototype as the reclaimed stone wool has versatile applications for reuse in the construction industry. With 60% of stone wool employed in timber constructions in todays industry, this sector presents the most significant potential. The granulated material can be either blown into or inserted into the gaps within the timber framework. Establishing a viable and environmentally sustainable reintroduction into the construction cycle.



Plug-In at Hardbrücke

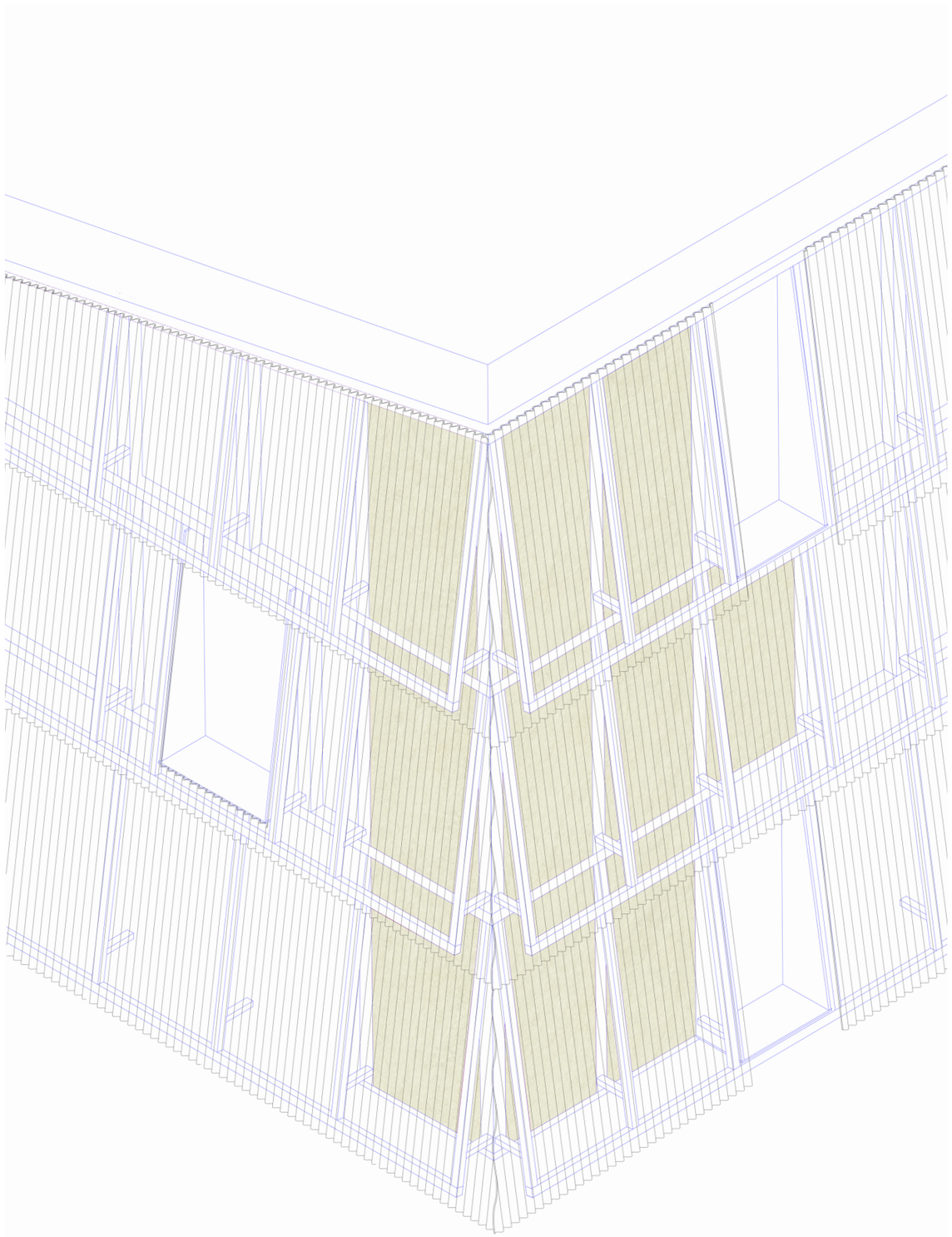


Physikalische Materialkennwerte	Beschreibung / Messwert	Einheit
Rohdichte	90-110	kg/m³
Wärmeleitfähigkeit	0.038	W/mK
Wärmekapazität	870	J/kgK
Diffusionswiderstand	1	–
Brandverhalten	A1	Euroklasse
Branherverhaltensgruppe	RF1	
Maximale Anwendungstemperatur	250	°C
Schmelzpunkt	> 1000	°C
Wasseraufnahme	< 1	kg/m²
Lieferform	Lose in Säcke, oder Säcke auf Paletten	

The granulate that has been reclaimed possesses the mentioned physical characteristics, a fact confirmed by Flumroc. Flumroc expresses interest in the recovery process; however, they point out that the associated tasks, such as dismantling, involving the careful handling of material, and ensuring separation to maintain its integrity, incur a significant time and cost burden that no demolition company is currently willing to bear. Nevertheless, construction company In Situ has already undertaken efforts, conducting tests with stone wool granulate in timber frame construction. According to the SIA standard, the reclaimed granulate would be categorized as an unsupervised building material, necessitating a 20% increase in material usage to meet the standard, despite its equivalent performance to new insulation material.

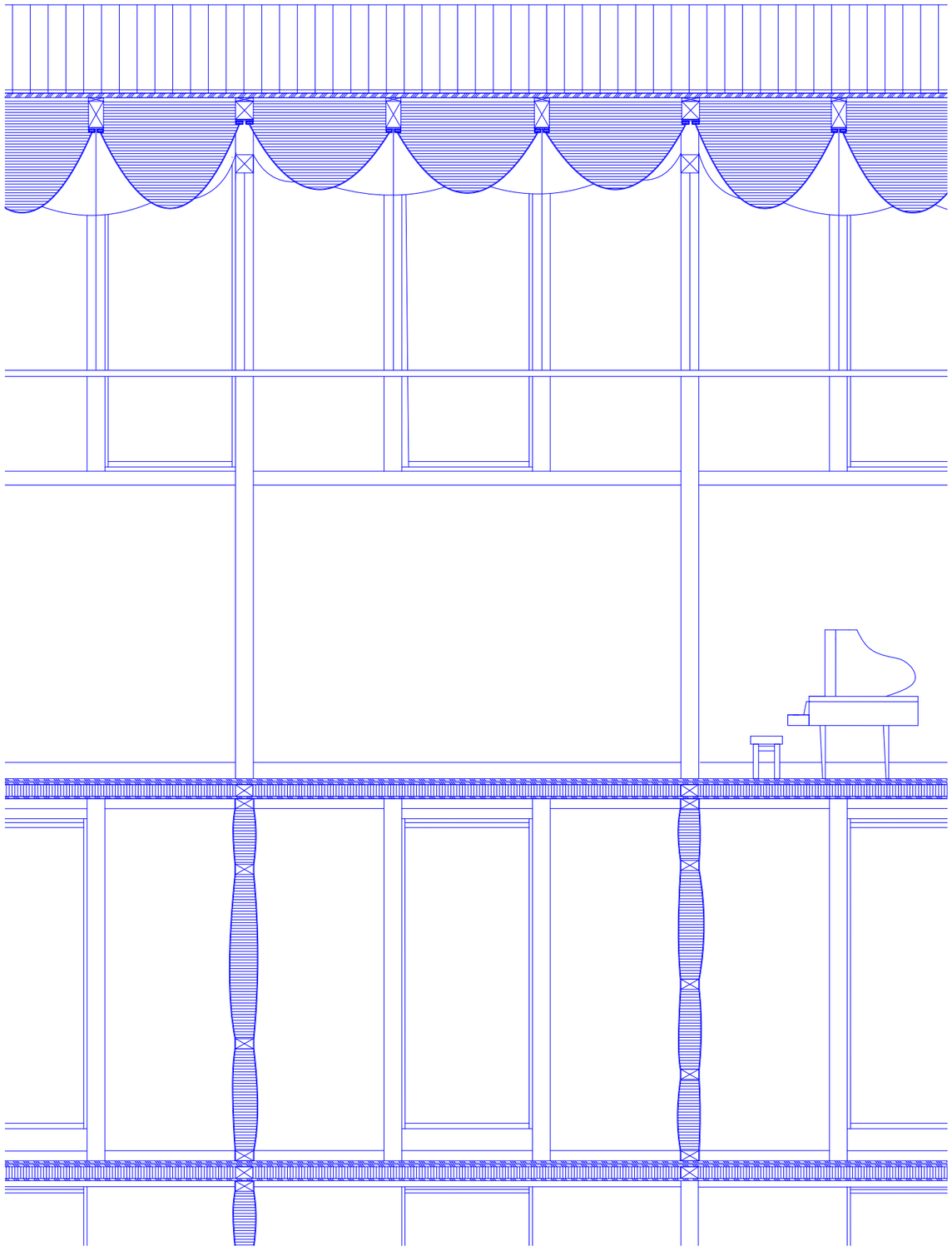
Physical Properties of Granulate

Reclaimed Stone Wool

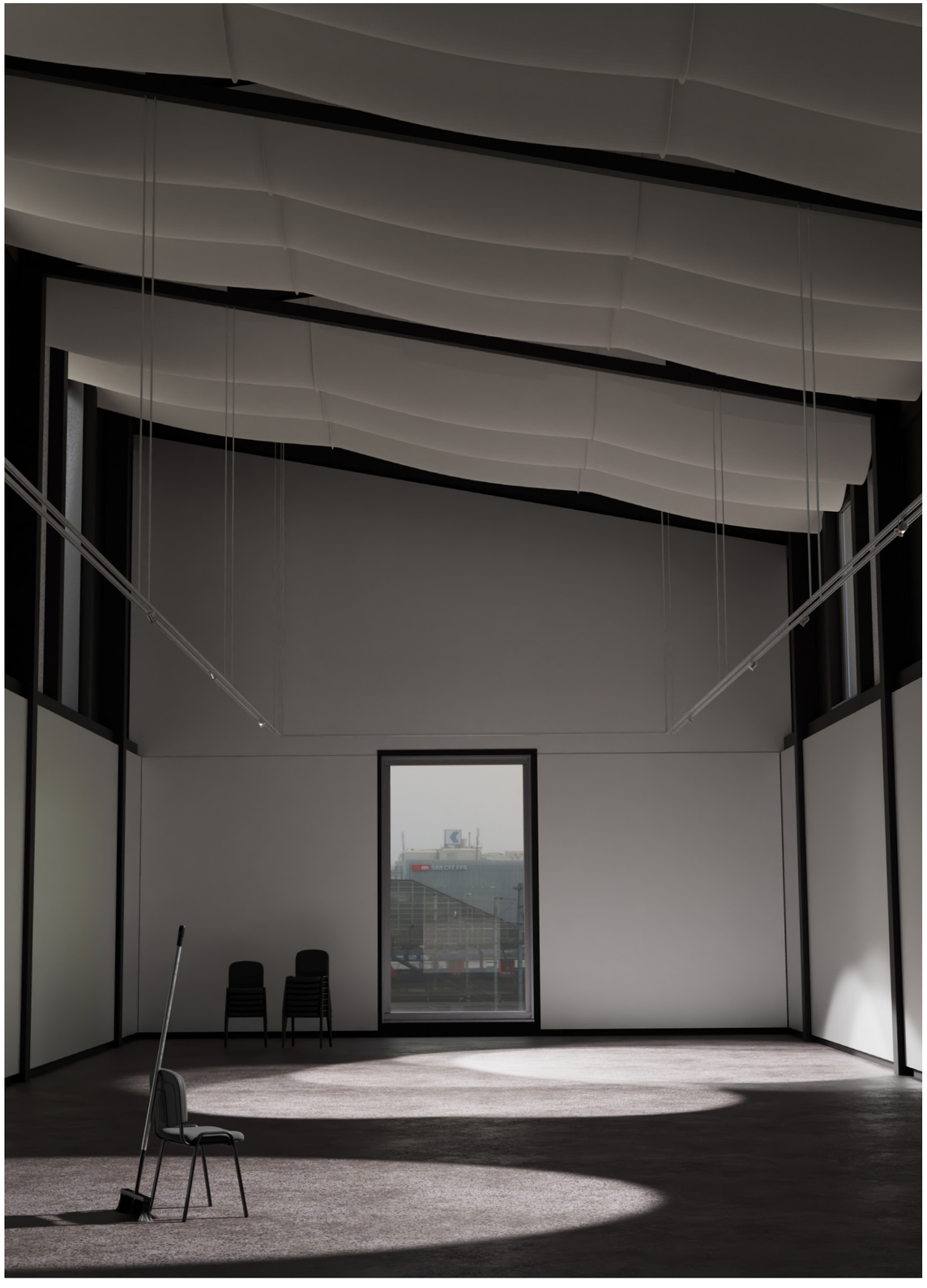


Envelope Axonometric

View along Hardbrücke



Section of Acoustic Ceiling



View of the Event Space on Hardbrücke