The demolition of Vityaz Movie Theatre, Moscow, Russia, 2019.

Urban mining potential in demolition and design for innovative material reuse within a circular model

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Abstract: A significant Soviet-era building from the 1970s in Moscow was demolished in 2019 after being excluded from the heritage list and left abandoned for an extended period. Constructed with bricks, precast slab panels, and a steel roof, the building underwent rapid destruction by machinery. The metals were sent to a recycling facility, while the concrete-brick mixture was transported to a dumping site, where it was partially stored and landfilled. The demolition process was monitored daily and documented through photographs, forming the initial phase of the current research. This research focused on creating an urban mining strategy to enhance the circularity of materials within an innovative architectural design. Detailed observations were made regarding the unit types and bonding style, the characteristics of the precast panels and jointing technique, the materials and fabrication of the trusses. This information was used to identify potential end-of-life applications for the materials within a circular model from around the world. The research identified a strategy that prioritized deconstruction and reuse, which included cutting and reshaping walls into new load-bearing blocks, slicing slab panels and reassembling them into perforated facades, and converting the trusses into cross-braced columns. Using 3D modelling, each stage of the proposed scenario—including the state of the components and their transformation into new architectural materials—was digitally visualized. Additionally, the necessary tools and processes for this transformation in a real-world context were determined. Finally, the innovative architectural appearance created from these repurposed materials, showcasing their rich composition and textures, was presented. The benefits of the proposed management strategy were highlighted, emphasizing the intrinsic and architectural value of the materials, as well as their positive environmental and social aspect.

Keywords: Deconstruction, demolition, design for reuse, circularity, material cycle.

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1. Introduction

Urbanization and population growth not only hasten the construction of new structures but also have additional effects on the built environment, such as a drastic increase in the number of demolitions worldwide. Researchers from a variety of fields, including architecture, concentrate on finding solutions to reduce this problem because the ongoing accumulation of demolition waste triggers environmental threads.

Russia also faces a comparable issue regarding the rate of urbanization and the management of old, abandoned buildings. The research material for this study is one of those, an old movie theatre building of Moscow, and its demolition process.

The state of the art with waste disposal strategies in a circular economy, especially innovative solutions with architectural potentials, are presented in the literature survey section of this report to set the stage for a worldwide backdrop. The brick, precast concrete, and steel that were the three main materials heavily utilized in the inspected building were the focus of the literature search.

First, a general overview of common strategies was given, followed by a closer examination of one unique reuse example for each material, complete with data and images of real applications.

The architectural characteristics of the examined building are then presented in the research material section using historical records and first-hand observations made during the demolition. The research method section provides a design idea and uses 3D visualization to demonstrate how the generated waste can creatively be transformed into new building materials. A sample architectural space formed with a newly produced set of materials is shown in the report's results section. The discussion part demonstrates the quality of the final product, and the applicability of the suggested approach compared to the examples from the literature review. The significance of this study and the lessons learned that can assist future researchers in the field are finally listed in the conclusion.

2. Literature Survey

In circular economic systems, product chains are interconnected from the extraction of raw materials to final disposal, emphasizing the efficient management of waste as a critical component (Potting et al., 2017). These connections minimize the use of natural resources and reintegrate waste into production processes, significantly benefiting the environment. Various circularity strategies are employed, such as energy recovery through incineration or transitioning to innovative, environmentally friendly product designs. Importantly, solutions differ in their level of circularity, with low-energy approaches proving more sustainable and effective than energy-intensive alternatives (Potting et al., 2017).

Accordingly, reuse offers less environmental impact compared to recycling and therefore, prioritizing it is vital, particularly in sectors with substantial waste production, such as construction. Similarly, the significant rise in deconstruction and demolition activities worldwide has brought increased attention to the critical issue of excess waste.

The Life Cycle Assessment (LCA) approach is a vital tool for assessing the effectiveness of circularity strategies and determining the most appropriate waste handling methods (Ghisellini et al., 2018). It offers a comprehensive analysis and quantitative comparison of the environmental, economic, and social impacts of different options across a product's entire lifecycle, including end-of-life scenarios.

Literature shows that LCA studies on construction and demolition waste gained prominence emphasizing their critical role in advancing the transition to a circular economy (Ginga et al., 2020 and Üçer Erduran et al., 2020).

A significant opportunity lies in identifying material stocks within the built environment—through urban mining—that are likely to undergo deconstruction or demolition. This practice allows for the recovery of secondary materials before they become waste (Ergun & Gorgolewski, 2015).

Research indicates that urban mining can reduce the extraction of new materials from the earth significantly and help clear potential waste from landfills (Lederer et al., 2020 and Verhagen et al., 2021). Additionally, it supports the dynamic recording of existing buildings, focusing on available materials, material flows throughout their lifecycle, and opportunities for reuse and transfer (Yang et al., 2022). Urban mining also preserves the historical significance of production techniques, material properties, and architectural styles, offering a unique opportunity to integrate these elements into new constructions (Ergun & Gorgolewski, 2015).

Regulations in many countries are also adapting to environmentally friendly strategies, including state laws that limit the production of demolition waste and mandate the reuse of materials instead of their disposal (Aslam et al., 2020). Similarly, the establishment and growth of specialized businesses that recycle waste material through various methods provided substitute solutions to the issue (Devi et al., 2021 and Volpe et al., 2023). As a result, it is now practically the most prevalent practice to recycle metals quickly, especially steel and aluminium, after buildings reach the end of their useful lives (Koutamanis et al., 2018). Parallel to this, specialty businesses have already made it quick and simple to obtain and repurpose building materials, such as claddings and finishes, particularly PVC and wooden components (Elias-Ozkan, 2014).

Modern buildings are often subjected to demolition and are central to debates about waste management and material conservation, primarily because heritage is typically associated with antique and medieval structures (Guillet, 2007 and Gültekin, 2019). This limited perspective hinders the recognition of modern buildings as heritage assets, making it difficult for them to gain official protection. As a result, these structures are increasingly at risk, particularly in rapidly changing contexts (Guillet, 2007).

Despite this, the post-war building boom led to the creation of numerous modern structures—ranging from iconic architectural landmarks to ordinary buildings—that hold significant cultural and architectural importance. These structures often feature innovative construction techniques and materials that are now obsolete or rarely used (Gültekin, 2019). Such structures house invaluable records and deserve greater recognition and preservation efforts (Guillet, 2007 and Gültekin, 2019).

Even when demolition cannot be avoided, finding creative ways to reuse the waste can lead to remarkable results and the creation of distinctive final products. These goods aid in the imaginative reinterpretation process that transforms a lost building's historical character into a new one in a new format (Gorgolewski, 2017, Kalakoski & Huuhka, 2018 and Plevoets, 2022). Additionally, the combination of diverse materials from different backgrounds gives architects a plethora of creative design possibilities for the new architectural spaces (Plevoets, 2022). Rather than being entirely recycled, these materials are classified as secondary because they have undergone a significant transformation into a new form while maintaining some of their original characteristics (Hebel et al., 2014).

To provide a clear foundation for the scope of the current research, the state-of-the-art documentation on the inventive use of secondary materials was restricted to three specific cases in the following text: brick, precast concrete, and steel.

2.1 Innovative Reuse of Brick Waste

Crushing brick waste into smaller pieces and adding it as aggregate to new cement mixtures is an alternate method that is gaining popularity (Aliabdo et al., 2014). Yet, the application is being questioned due to the energy-intensive crushing procedure and the mixture's lower ultimate mechanical strength in comparison to those with natural aggregate (Cachim, 2009).

Therefore, researchers focused on unit recovery for a possible reuse and according to the findings, the type of mortar used has a significant impact on how easily the units are separated (Arlotta, 2018). Lime mortar's greater flexibility allows for manual recovery and the achievement of clean elements, whereas cement mortar's extremely rigid feature prevents separation (Ergun & Gorgolewski, 2015). Therefore, walls built with cement mortar can be demolished, and the mixture can be used as a composite infill; if the mortar is lime-based, on the other hand, it makes more sense to separate the bricks for reuse to maximize energy efficiency and maintain the final appearance's quality (Ergun & Gorgolewski, 2015). In addition, designers can transfer all assigned values—such as colour tones and textures—into a new application when units are removed neatly, preserving the distinctive remnants of the production facility and time (Arlotta, 2018).

Recovery of wall materials has gained another crucial technique with the development of better machinery, which involves slicing the old walls into sections using powerful saws (Gorgolewski, 2017). As seen in Figure 1, such components are skilfully assembled into a unique composition for the facades of a mass housing project in Copenhagen, Denmark (Lendager Architecture, 2020). Preserving the original wall's strength and applying it to a new construction with a potentially large surface area is one of the method's main benefits. It offers the advantage of using the already-acquired rigidity between units and mortar as an intact masonry body, in contrast to the salvaging method of brick separation. In addition to the physical characteristics of components, the method also transfers the unique bonding workmanship, as another layer of historical information.

Finally, the patchwork style gives new building a unique appearance in addition to serving as a memorial for the previous lives of gathered members.

Although this technique of slicing thick masonry walls demands a high energy density, it is far less than crushing them into aggregate scale. Therefore, in terms

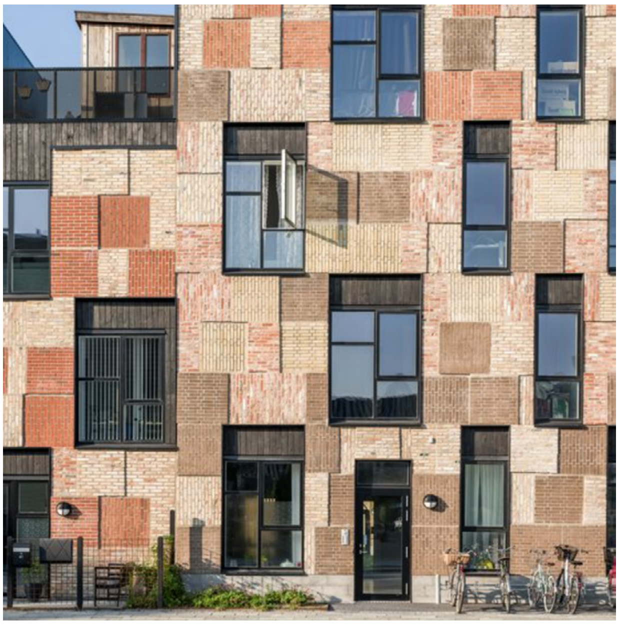


Figure 1 | Reused brick wall pieces for a new façade (Lendager Architecture, 2020).

of energy requirements, this way of repurposing offers a more environmentally friendly option than overall recycling (Üçer Erduran et al., 2020).

2.2 Innovative Reuse of Concrete Waste

Recovering aggregate from concrete and using it in a new cement mixture is becoming a preferred method (Reis et al., 2021). It requires crushing, careful separation, and an additional dust removal procedure (Tam et al., 2021). Even though waste is effectively recycled in this way to create a useful ingredient, each step takes a lot of energy (Martínez-Lage et al., 2020). Additionally, concrete containing recycled aggregate may lose about 15% of its strength when compared to those with regular aggregate (Ikeda et al., 2023).

As a result of these shortcomings, research is underway to find viable salvage alternatives for concrete sections. Rearranging the parts in a creative and practical way after cutting or breaking them into manageable pieces is an alternative approach (Küpfer et al., 2023). Despite requiring more energy, the approach is also implemented on larger scales with the assistance of cranes (Küpfer et al., 2023).

Precast concrete, as opposed to that cast in situ, provides a simpler method of separation because of its mechanical jointing (Huuhka et al., 2015 and Bertolazzi et al., 2023). As a reversal of the assembly process, breaking apart the joints releases the components and permits disassembling them (Huuhka et al., 2015).

The technique was offered as a significant opportunity for many precast concrete housing blocks built in Russia, Finland, Germany, and many other countries during the post-war or rapid industrialization periods (Hebel et al., 2014; Hrabovszky-Horváth & Szalay, 2014; Huuhka et al., 2015 and Üçer Erduran, 2020). These buildings have further deteriorated over the preceding decades in addition to the inferior materials that were used to construct them.

Therefore, salvaging them appeared as an inevitable intervention where the process of repurposing disassembled precast bodies allowed for innovative ideas to be explored.

By reshaping and rearranging these parts, designers were able to come up with creative solutions, like a Copenhagen based Danish company's decision to slice the hollow core slab panels into new perforated walling units, as shown in Figure 2 (Vandkunsten Architects, 2017). By expressing circular voids and corroded reinforcement steel as design elements and in a rhythmic manner, the architects' proposal offered a completely new viewpoint on old and decaying waste material.

2.3 Innovative Reuse of Steel Waste

Nowadays, it's already common practice to collect metals and get them ready for recycling when buildings reach the end of their useful lives (Cha et al., 2020). Since the process does not require a gentle separation of elements, it seems like a straightforward solution in the chaotic atmosphere of demolition. Various types, amounts, and shapes of metals from cables, claddings, pipes, and structural members can efficiently be melted down to create new raw material sources (Ram et al., 2020). Despite the process's high energy consumption, the overall economic profitability makes the approach highly preferable (Purchase et al., 2021).

On the other hand, disassembly and reuse of metals require less energy than recycling and therefore they remain more environmentally friendly. Additionally, the possibility of accurate and quick disassembly is increased by general mechanical connections used for metals, i.e. bolts and nuts (Broniewicz & Dec, 2022).

Demounted parts present a wealth of opportunity for creative repurposing through reshaping and reassembling.

Figure 2 | Precast concrete slabs modified for repurposing as façade elements (Vandkunsten Architects, 2017).

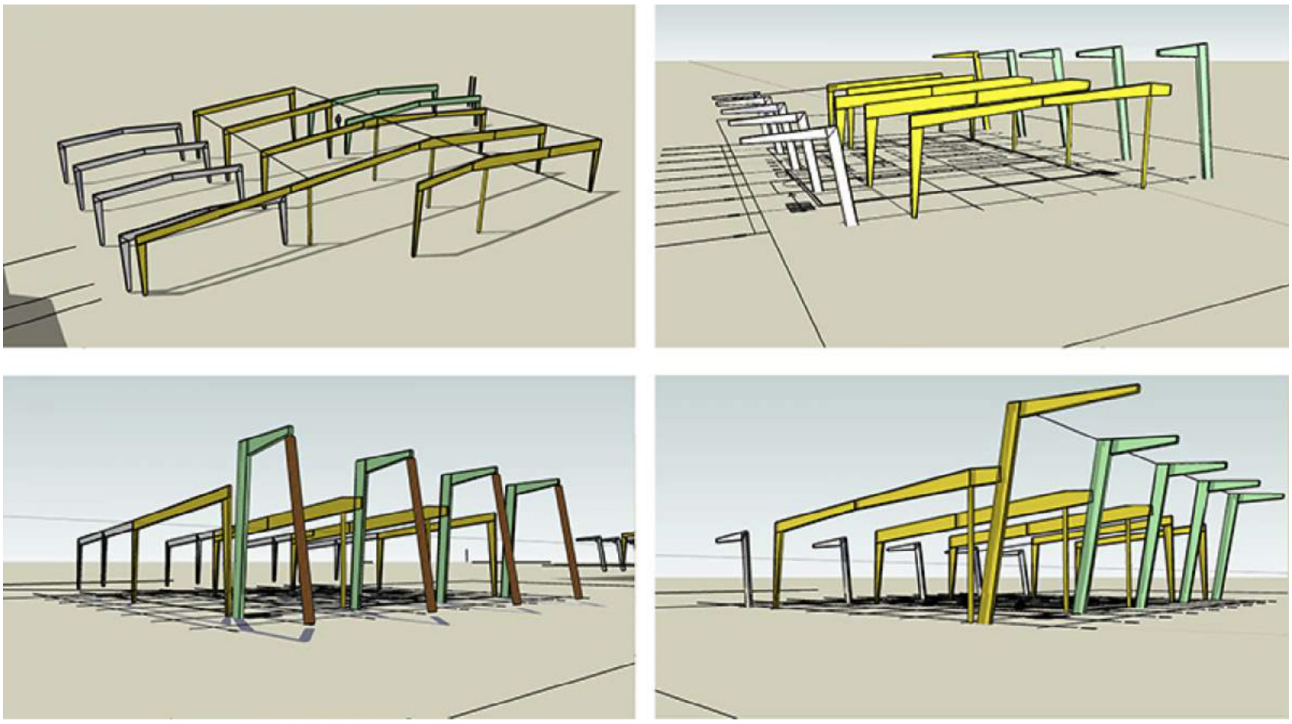


Figure 3 | Design options for repurposing readily available steel components (Monteyne Architecture, 2011).

In 2011, Monteyne Architecture, Manitoba based Canadian company, implemented a design procedure integrating existing steel elements for a large-scale shelter project that housed facilities for food preparation and serving during a festival. In contrast to the typical start from scratch procedure, the company initially looked for nearby steel buildings that would soon be deconstructed (Monteyne Architecture, 2011). To optimize the architectural spaces and minimize the energy required to reshape and connect the obtained steel elements, four alternative assemblies were created for the new project, as illustrated in Figure 3.

The original surface degradation and fading colours of the repurposed elements were skilfully incorporated into the building's new state through the application of a proper design option, as shown in Figure 4. Additionally, the application's uniqueness was enhanced using transparent panels and salvaged corrugated metal cladding from several buildings.

3. Material and Methods

The research material for this study is derived from the Vityaz Movie Theatre (Kino Vityaz), which operated in Moscow for several decades.

The building's construction began in the 1970s and it hosted numerous movie screenings before being demolished in 2019. Since its inception in the early 1900s, movie screenings have played a significant role in Russian city life (Anisimov, 2019). This role was reinforced by the fast-paced political climate of the 1920s, when politics' outlook encouraged the construction of movie theatre structures (Taylor and Christie, 1994). There were changes in the following decades, including a decline in movie attendance due to the widespread use of televisions during the 1970s (Taylor and Christie, 1994). When movie halls were added to recently built shopping mall complexes, these older buildings faced abandonment (Centre: Strategic Development Agency, 2015). At that point, the government and the heritage conservation committee determined whether to preserve them as cultural assets (Mraz, 2018). Finally, the decision to demolish Vityaz

Figure 4 | The building constructed with salvaged steel (Monteyne Architecture, 2011).

Movie Theatre was made much like other typical 1970s projects (Mraz, 2018). Nevertheless, community protests against the unjust fate of this important building began even though the decision could not be overturned (Chernykh, 2018).

The current study tracked the building's demolition via first-hand observations and photographic documentation. Information of materials used and related workmanship details were obtained by this process since original design and construction files were not available. This record was used to assess the actual end-of-life applications that were carried out and to offer a better alternative scenario that would have allowed for the preservation of more materials from the waste in an improved manner. Accordingly, the building's urban mining potential was assessed, highlighting an approach that could have been implemented before demolition began. This evaluation served as a case study to explore enhanced secondary uses for three key materials—brick, steel, and precast concrete—in new construction projects. Due to the frequent use of these materials, the insights gained from this case study have the potential for wide-ranging application.

Additionally, the scenario was designed for creating a chance to repurpose remnants of these historical materials for the benefit of public memory.

The building was a consistent representative of common architectural tastes from the 1970s, including typical materials and craftsmanship. As seen in Figure 5, the structure had a single, wedge-shaped main hall with thick walls positioned above a glass-fronted foyer where brick, concrete, glass, and metals were visible from the exterior.

Even with the glass facades of the foyer still in place, the building started to be demolished, as Figure 6a illustrates. The remaining materials experienced a similar degree of harshness during the application, which had a substantial impact on the materials' actual potential, as shown in Figure 6a,6b,6c.

When the movie hall's corner was broken, the lightweight steel applications used for the envelope were revealed, as seen in Figure 6a. Subsequent moves demonstrated that the heavy walls were load bearing and the entire cross section was created using a single type of brick and mortar, as shown in Figure 6b. Deep steel roof trusses were fully visible during the later stages of demolition, and finally, pieces of precast slab panels were plainly seen, as Figures 6b and 6c show.

The varied debris of materials created a mound towards the end of the demolition process, as illustrated in Figure 6c. Finally, classification and separation in accordance with the required final disposal was accomplished. All kinds of metals are gathered and delivered to a recycling facility located in the city's industrial zone. This mix was the most profitable of composite debris, so it was transported right away. The remainder, which included broken units and pieces of concrete bodies, was gathered and transported to a landfill area outside the city. Since these materials are

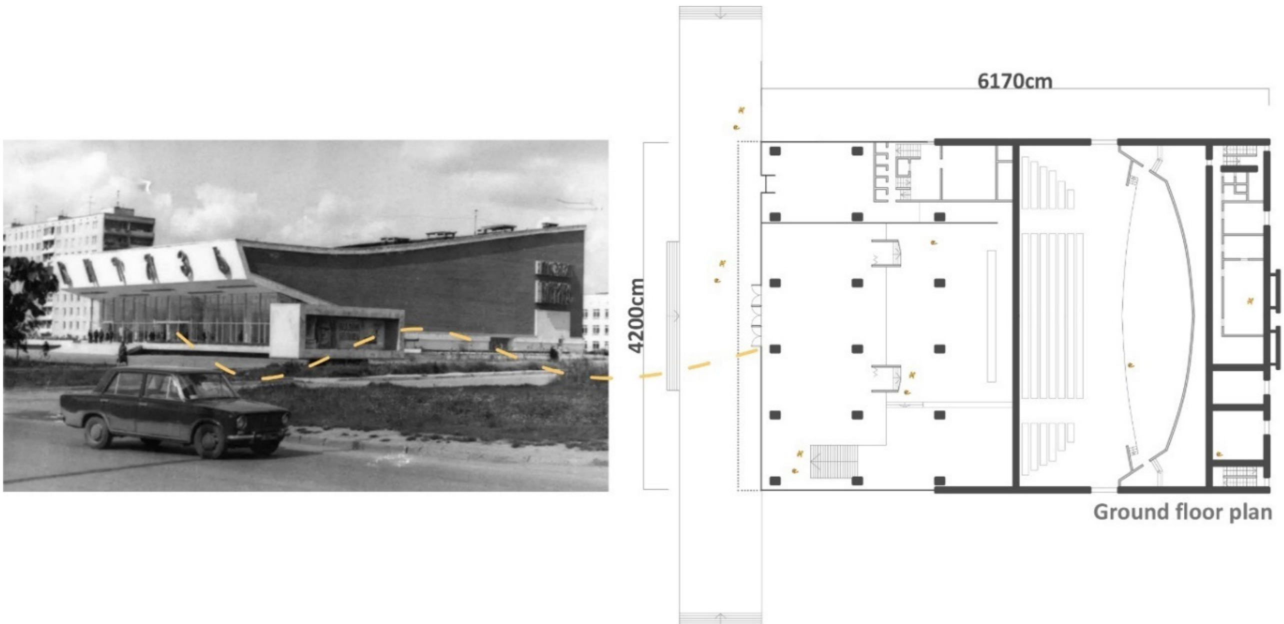


Figure 5 | A 1973 picture of the Vityaz Movie Theatre (Lavrov, 1973). Author-produced plan drawing adapted from Ermolaev, 2020.

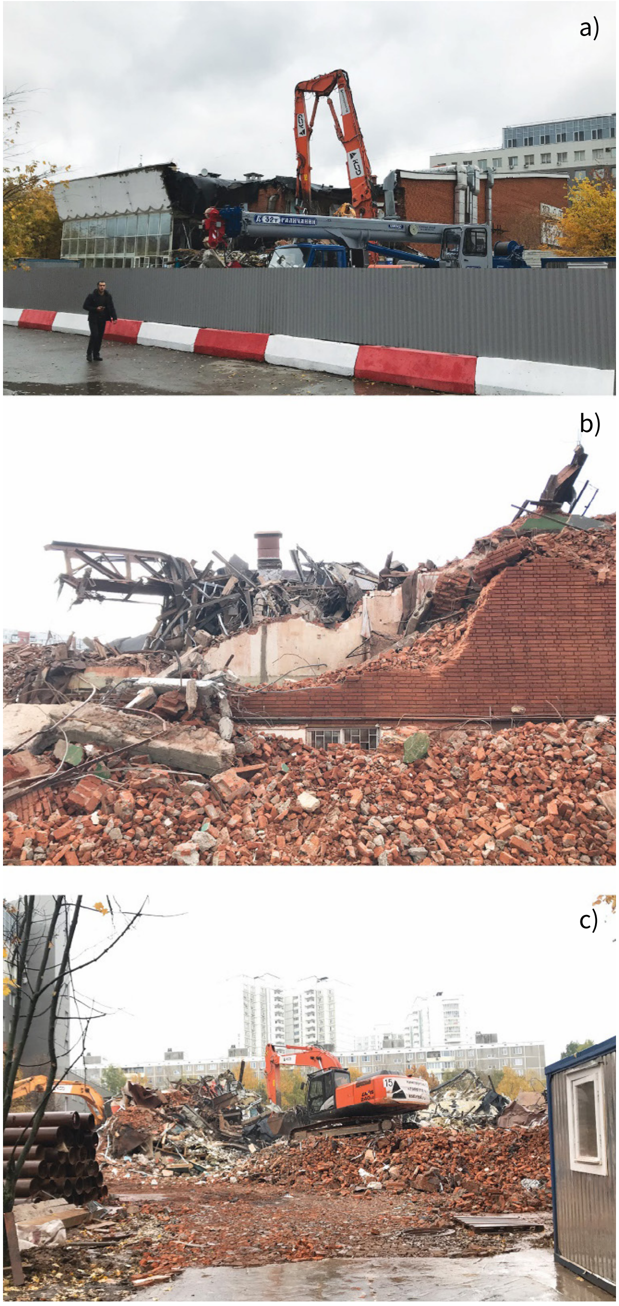


Figure 6a | Initial stage and glass façade destruction (Author, 2019).
Figure 6b | Demolition of roof trusses and masonry walls (Author, 2019).
Figure 6c | Mixed debris and final classification (Author, 2019).

classified as inert waste—that is not reactive and poses no risk of leaking to the soil—they were stored in a landfill until they are required for a possible application. The utilization of this type for levelling in landscape organizations, infill in infrastructure constructions, and repair in torn-out road sections is encouraged by national regulations (Russian Federation Council, 2002).

However, after carefully examining the states of these three primary materials of the building, it became evident that, rather than being recycled and disposed of, they could have all been utilized once more in proper architectural arrangements. Therefore, an alternate hypothetical scenario was created in which deconstruction occurred instead of demolition and these materials were preserved rather than ultimately ending up lost in the waste stream.

The building's walls appeared to be made of sturdy, fired clay bricks joined together with cement mortar. Since the entire wall section was built identically using standard bricks, there was no low-quality infill throughout the entire 55 cm thickness of wall, as shown in Table 1. A successful production was indicated by the uniform colour tone and the relatively neat surface quality of the units, which suggested the production of wire-cut and extruded solid units.

The bonding pattern, a variation of Flemish bond, was delicate, with bedding and header surfaces placed alternately. Despite the rigorous demolition process resulting in significant cracks and disintegrations, it was evident from the visual inspection that the wall's original strength was of high quality.

The slabs of the structure appeared to be regular precast concrete panels with hollow cores and steel reinforcement, measuring 22 cm deep and 9 m long, as given in Table 1.

The 45-meter-long, 2-meter-deep, slender trusses were made by neat, precise welding of the high-quality steel plates. The web and flange portions of the components were made of L profiles in the two predominant sizes.

Superior qualities observed through analysis of building components illuminate appropriate interventions to extract secondary materials from them.

4. Results

Because of the sufficient mechanical strength, solid masonry walls were first and foremost a significant asset to preserve and repurpose in a new structure. Furthermore, since these walls had their original, intricate bonding, this feature deserve to be preserved and transferred as well. Slicing them into new masonry blocks and integrating into a new wall suggests a reasonable scenario where two decisions are combined.

Only a lengthwise cut should be made during the transformation process to preserve the walls' current strength. It's also important to consider the bonding pattern that was used, which consisted of two bedders and one header

Table 1 | Main Materials of Vityaz Movie Theatre (Human scale for the estimation of actual sizes).

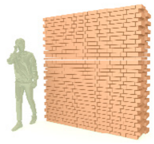
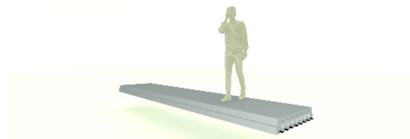
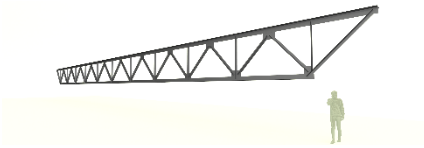
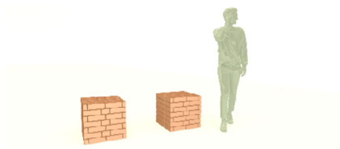
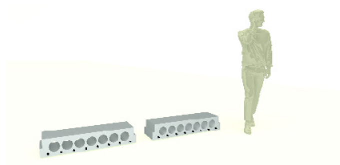
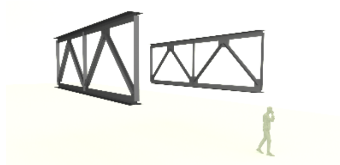
ID	Demolition Phase	Properties	Dimensions	Original form
Wall		Solid, fired clay brick. Cement mortar.	55 cm thick wall. Standard bricks, 1 cm mortar thickness.	
Slab		Precast, hollow core, reinforced concrete slab panel.	22 cm thick panel, standard production.	
Beam		Welded L profiles, steel truss.	Larger profiles for flanges. Fine welding. 45 meters length.	

Table 2 | The process of transforming components.

ID	Shaping tools	Requirements	New Component	Final form
Masonry wall	Twin diamond blade circular saw.	Skilled worker, electricity.	Masonry cubes. 55cm edges.	
Precast slab	Diamond blade circular saw.	Skilled worker, electricity.	Sun-shading façade units. 30 cm thickness.	
Steel truss beam	Diamond blade circular saw.	Skilled worker, electricity.	Cross bracings. 7.5m length.	

arranged in alternating layers. Consequently, it is appropriate to make a 55 cm length and height cut, which results in masonry cubes being the new components that respects to the module generated by the original bonding and that allows for the creation of new blocks without wastage, as shown in Table 2.

Prior experience and conducted LCA studies in a similar context indicated that an electrical twin-blade diamond saw operated by a skilled professional is required to cut through these kinds of walls due to their extreme toughness and thickness (Üçer Erduran et al., 2020). If the precast slab panels are divided into sections, the voids in them present a valuable opportunity to produce perforated components. The original slabs' shallow depth and additional reduced thickness from the internal voids make processing easier and allow for the use of a standard diamond blade circular saw.

Identical triangle-based steel trusses allow for modular division during a potential transformation. These beams, which are 45 meters long, can be divided into sections that are 7.5 meters long, making them easier to handle for transportation and new assembly, as shown in Table 2.

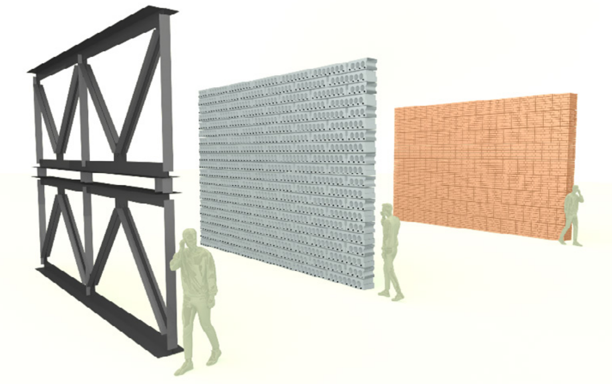


Figure 7 | The final configuration of the transformed components.

The original beams' thin plates and slender components made of welding together facilitate the process of cutting and separating using standard tools used by construction workers.

Modified materials can be put together using conventional methods to create a unique collage of textures, as shown in Figure 7.

A final appearance that combines the original and new bonding styles together can be achieved by joining the obtained masonry blocks with an appropriate cement mortar and leaving them bare.

Similar bonding is appropriate for the salvaged sun-shading elements, where steel bars and now-visible voids provide additional visual components.

Transformed trusses can be used as cross braced structural elements by connecting the two halves of the beams by flipping one half. The completed form not only provides significant structural rigidity under combined gravitational and lateral loads, but it also improves the appearance of the architectural space.

5. Discussion

The transition from a linear to a circular economy has been emphasized by experts for its substantial environmental benefits. Demolitions generating large amounts of waste underscore the need for adopting a circular approach in construction and demolition practices.

In this context, the Vityaz Movie Theatre underwent a predominantly linear process, with its demolition leading to the landfilling of materials like concrete and brick. Only minimal circularity was achieved, as limited recycling was applied to the building's metal components.

Moreover, like the common application highlighted in the literature, the Vityaz Movie Theatre Building faced inadequate end-of-life management, as it was not recognized as a modern heritage asset and excluded from the heritage list. Despite its considerable cultural significance as a central hub for Moscow's movie-going culture dating back to the early 1900s and its role as a gathering place for the surrounding community for decades, the building was subjected to downcycling and landfilling.

Furthermore, its demolition highlighted a missed opportunity for urban mining, which could have facilitated material reuse, offered environmental benefits, and enabled the partial preservation of the building's historical essence as a significant social value.

The walls and slabs were crushed together, creating a mixed debris that was obviously downcycled and lost its true strength as well as aesthetic appeal. These materials' next phase in their life cycle was either landfilling or being salvaged and used as infill, which is obviously undervaluing the materials given their true quality.

On the other hand, the proposed strategy in this study facilitates the preservation of partial architectural value, including elements like bonding craftsmanship and wall thickness, while reimagining them in a new form. It also carries significant social value by serving as a memory repository for the city and the local community. Furthermore, this approach ensures the retention of key intrinsic material properties, such as strength, texture, colour, and decay in time.

Similarly, truss's neat workmanship and distinctive quality was destroyed when steel components were recycled into raw materials.

While recycling offers significant potential for the next stage of a material's life cycle, the actual value of material is often underestimated. As demonstrated in the proposed scenario, an enhanced circularity approach—centred on reshaping and reusing materials—could have been effectively implemented before demolition, allowing for the simultaneous preservation of both the architectural and material properties of the finely crafted steel trusses from the Vityaz Movie Theatre Building.

In summary, the transformation scenario proposed in this study, incorporating enhanced urban mining parameters and a higher degree of circularity within a circular economic model, enables a more elaborate deconstruction process and more efficient material flow management. Thus, the recommended transformation of trusses into cross bracings, slabs into sun-shaders, and walls into new blocks transfers the superior qualities and historical memories of the materials to the following stage of their life cycles.

While suggested solutions improve the circularity of the materials, they also increase the energy and labour required for the transformation; the main ones involve the use of both conventional and advanced electrical saws for shaping. Prior experience with whole life cycle assessments showed that although energy consumption raises the embedded energy of secondary materials, they are typically still lower than those made from scratch with ground-based virgin resources (Üçer Erduran et al., 2020).

The offered scenario's applicability was reinforced by the examples that have already been established worldwide, as mentioned in the literature review section. The work of Lendager Architecture (2020), highlighted the potential that could be used by reshaping the heavy masonry walls and assembling them in an attractive way. Similarly, Vandkunsten Architects (2017) used a creative design approach to uncover a hidden value of precast panels, and this approach was also incorporated into the scenario that was tailored for this study.

The design strategy of Monteyne Architecture (2011), applied on a building that has already been built was included as a viable choice for the suggested transformation of the steel components for the building under investigation.

6. Conclusion

The primary importance of the study lies in documenting and disseminating the last phase of the life cycle of the Vityaz Movie Theatre Building, a noteworthy historic structure whose existence is scarcely mentioned in a few sources lately. It was regarded by the locals as a significant building that had shaped the neighbourhood's life for many years, despite not being included in the government's list of cultural heritage assets to be preserved. Therefore, the study highlighted the crucial importance of registering modern architectural buildings as heritage, revealing the potential losses that can occur when they are not registered, resulting in a significant gap in the architectural and historical record.

Additionally, the procedure that was followed disclosed the hidden materials and methods that were employed, adding new details to the body of knowledge regarding this significant building.

The study's second significance is its 3D visualization of the suggested deconstruction scenario, which aims to handle lost materials during demolition better. Even though the building was destroyed without any effective waste transformation, these images provided information about how those materials might have been recovered, providing insight into circumstances that are comparable. Since the materials in question are conventionally applied steel roof trusses, precast slabs, and brick—all common assets around the globe—the findings are appropriate to be interpreted for other contexts and cases.

The third importance of the research is the comprehensiveness of the recommendations on material transformations housing efficient use of basic properties and respecting original historic appearances. Finding the proper modularity while taking these two factors into account appeared as a crucial recommendation. Furthermore, identified shaping processes that reduce or eliminate material wastage completely through appropriate dimensioning expanded the scope of this recommendation.

Finally, the study underscores the considerable architectural potential that can be achieved through gentle deconstruction within a circular economic model, rather than through harsh machinery demolition in a linear model, thereby promoting better management of material cycles.

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