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REPAIRS AND REINFORCEMENT OF HISTORIC BUILDING STRUCTURES USING BRUTT SAVER TECHNOLOGY

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Abstract

Modern conservation and revitalization of historic buildings require the use of advanced technologies that enable effective structural reinforcement while preserving the historical substance of the object. One of the innovative methods is the Brutt Saver system, which utilizes specialized connectors and techniques for strengthening masonry and structural elements. This article discusses the principles of the Brutt Saver technology, its advantages, and its application in the repair of historic buildings. The study analyzes cases of system implementation in various types of structures, taking into account technical aspects and compliance with conservation requirements. Special attention is given to the possibilities of stabilizing damaged walls, reinforcing masonry joints, and minimizing interference with the original building fabric. In conclusion, the article highlights the effectiveness of the Brutt Saver technology in the long-term protection of heritage buildings, as well as its potential to improve the durability and safety of historic structures. Recommendations for the practical application of this method are also presented, emphasizing the necessity of an individual approach to each building and close cooperation between engineers and conservation authorities.

Keywords: *Repairs and reinforcement; Conservation; Renovation; Brutt Saver technology*

Introduction

Historic structures constitute an integral part of the built environment, whether listed or unlisted, representing 30% of Europe's building stock [1]. Due to their historical, cultural, social, and economic value, they require special attention to ensure their preservation, use, and management over time in a sustainable manner. This necessitates modernization solutions that can improve indoor living and thermal conditions while reducing energy consumption and preserving heritage significance. However, the selection and implementation of modernization solutions in historic buildings is often constrained by socio-technical barriers (such as regulations, lack of knowledge about built heritage, economic feasibility, etc.).

The protection of cultural heritage resources is one of the key challenges of modern times. It involves not only preventing the ongoing degradation of monuments but also restoring them for reuse and safe operation [2]. Repairing and strengthening historic building structures is crucial for preserving historic buildings for future generations and often requires changing their function and performance parameters. This is made possible through the application of new technologies dedicated to minimally invasive structural reinforcement, particularly of walls and masonry, as in the case of the Brutt Saver technology [3-5].

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Historic building structures are not only valuable elements of cultural heritage but also a challenge for engineers and conservators [4, 6]. Old and often centuries-old walls, exposed over decades to the effects of time, weather conditions, loads, and changes in the ground, frequently require specialized repair and strengthening interventions. Literature also highlights the important role of masonry repairs and reinforcements in the context of threats to cultural heritage resulting from natural disasters, material degradation, or armed conflicts [7-11].

Traditional renovation methods often prove insufficient or too invasive, especially in the case of buildings with high historical value [12]. In response to these challenges, the Brutt Saver technology was developed—an innovative system created by the German company Brutt Technologies, enabling effective and minimally invasive stabilization and repair of brick, stone, and mixed masonry walls [3]. This article discusses the principles of this technology and its application in the conservation and strengthening of historic building structures. The effectiveness of this solution and the design requirements for masonry wall structures are demonstrated using the example of a historic front building at the now-defunct "URSUS" Mechanical Plant in Warsaw, Poland.

Brutt Saver Technology

Brutt Saver technology was developed by Brutt Technologies. It is a structural reinforcement and protection system that can be applied both to damaged structures made of brick, concrete, stone, or wood and to newly designed buildings as an additional reinforcement element. The system has found widespread use in strengthening masonry in historic and heritage buildings. It is based on the use of steel rods embedded in special thixotropic mortars—Saver Powder, which are produced as ready-to-use, two-component, polymer-modified cementitious mixes. Once mixed, they form a plastic compound ready for use, which does not run off vertical surfaces and adheres well to the substrate, providing both a filler and an optimal base for rods and anchors.

Depending on the type of structure being repaired, the mortars offer varying levels of strength and resistance to external factors. They are non-shrinking, elastic, fast-setting, and characterized by excellent adhesion to different materials.

The system is specifically designed for crack repair, masonry consolidation, and the reinforcement of vaults, arches, walls, and ceilings. It is widely used across Europe, including in Poland. The implementation method provides a minimally invasive solution for stabilizing buildings without extensive demolition or reconstruction. It is compatible with traditional building materials and can be used in damp and geotechnically challenging conditions. At its core, the Brutt Saver system involves installing specialized reinforcing elements, such as rods, ties, and anchors, into existing masonry structures. The system components are made from high-quality austenitic stainless steel AISI 304 or 316, known for their exceptional tensile strength and corrosion resistance. The manufacturing process hardens the ribs of the helical rods while keeping the core relatively soft, enhancing their bonding properties and structural performance.

The reinforcing elements—helical rods—are produced in diameters of 3, 4.5, 6, 8, and 10mm, and in lengths ranging from 5cm to 10m. They can be joined, bent, and bundled together. Their production complies with the standard EN ISO 9002:1994 (TÜV – Rheinland Europa Kft. Certificate No. 75 100 8417).

Reinforcement and Repair of a Historic Building – Case Study

Subject and Scope of the Study

The subject of this study was the building designated as "D" in the now-defunct "URSUS" Mechanical Plant in Warsaw, Poland. It was formerly known as Front Building No. 10, which originally served administrative functions. The renovated structure is located on cadastral plot No. 92/2, district 2-09-05 Ursus–Warsaw, and was entered into the Register of Historic

Monuments in Poland on October 3, 2019, under registration number 587/2019. It is located at 12 Dyrekcyjna Street in Warsaw, as shown in figure 1.

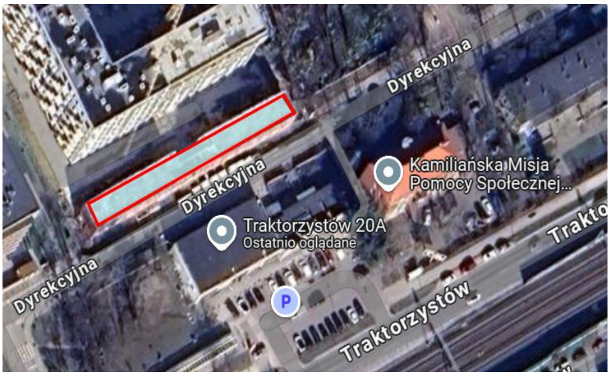


Fig. 1. Location of Building "D" in the now-defunct "URSUS" Mechanical Plant—Warsaw (Google Maps)

The scope of the work carried out included only the repair and reinforcement of the masonry (load-bearing walls) of the building using a technology based on reinforcing the existing cracked masonry with specialized helical stainless-steel profiles manufactured by Brutt Saver (CPSI) – the technical name used by Brutt Technologies. The study did not cover other works included in the main project, such as the filling and injection of cracks, which were part of the broader conservation program conducted for this building.

Historical Context

The buildings and remnants of the former "URSUS" Mechanical Plant have been entered into the register of historic monuments. They have survived in various states of preservation, yet they still represent significant artistic, historical, and scientific value for the Ursus district in Warsaw. The oldest preserved structures reflect the industrial architectural style of the interwar period. On November 26, 2019, the Mazovian Provincial Conservator of Monuments issued conservation guidelines regarding the redevelopment of the front of the workshop hall (Building No. 10) of the former "URSUS" Mechanical Plant for commercial and service purposes. These guidelines pertain to, among other things, securing and stabilizing the historic fabric, halting degradation processes, and documenting the undertaken measures. The restored building holds substantial historical value and is the oldest structure of the industrial complex outside the original factory premises of the former "URSUS" Mechanical Plant.

Research Methodology and Installation Scheme of Saver Profiles

The front building of the mechanical workshop hall of the former "Ursus" Mechanical Plant in Warsaw is an example of post-industrial architecture, with masonry walls constructed from brick.

A field survey methodology and structural assessment of the cracked walls were applied, which allowed for the diagnosis of the building's technical condition and the development of appropriate solutions based on the Brutt Saver method. The adopted approach within the decision-making and implementation process for the renovation of this historic structure enabled its adaptation to a new functional program.

In accordance with the repair and reinforcement design for the walls, the locations for groove milling and drilling holes for the ends of the Saver profiles were determined. The grooves, with dimensions in line with the execution scheme (Fig. 2), were milled using a groove cutter. Example layouts of the reinforcements used (masonry stitching) are shown in Figures 3 and 4. These depict sections of the execution scheme marked in Figure 2 as "A" – Figure 3 and "B" – Figure 4. The symbols used in the drawings are listed in Table 1.

Fig. 2. View of the wall masonry of the implementation scheme.
Fragment "A" is shown in figure 3 and fragment "B" in figure 4

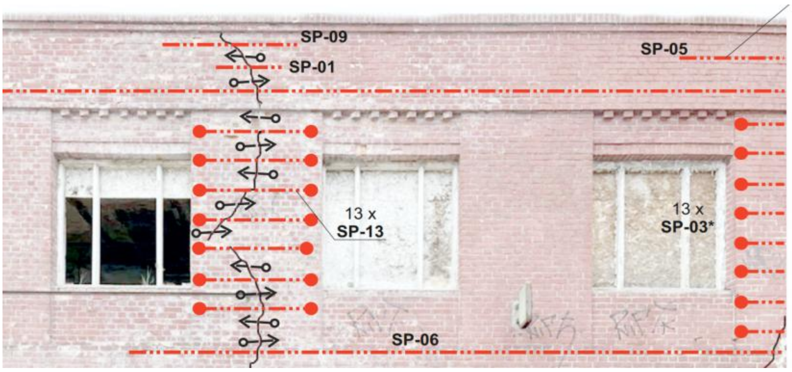


Fig. 3. Fragment "A" of the executive diagram from figure 2

Fig. 4. Fragment "B" of the executive diagram from figure 2

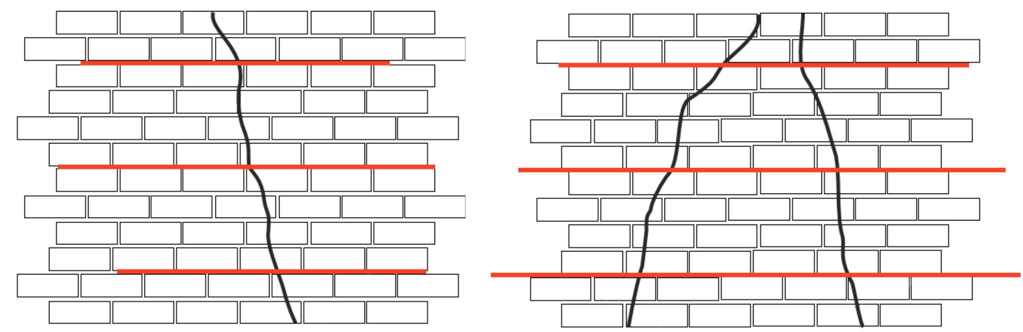
Table 1. Legend of designations for the execution diagram (Figs. 3 and 4)

	single Saver profile Ø8 or 7TC in milledslots - joint width approx. 12-16mm, depth (without plaster thickness) min. 3.5cm
	two Saver profiles Ø8 or 7TC in milledslots - joint width approx. 12-16mm, depth (without plaster thickness) min. 4.5cm
	anchors Saver Ø 10 installed in holes Ø 16-18 filled with Saver Powder S mortar
	marking of Saver Profile ends mounted in holes according to auxiliary diagram
	ends of Saver profiles 10-15cm long, bent at a right angle and anchored in holes Ø 14-16 filled with Saver Powder mortar

Recommendations for the installation of Saver profiles for the investment

In the scope of the applied technology for carrying out the work, detailed guidelines for their execution were developed, illustrated in the form of reinforcement diagrams for the wall structure. Below is the selection of minimum lengths for the Saver profiles depending on the structure of the wall cracks, as shown in figure 5.

a) b)



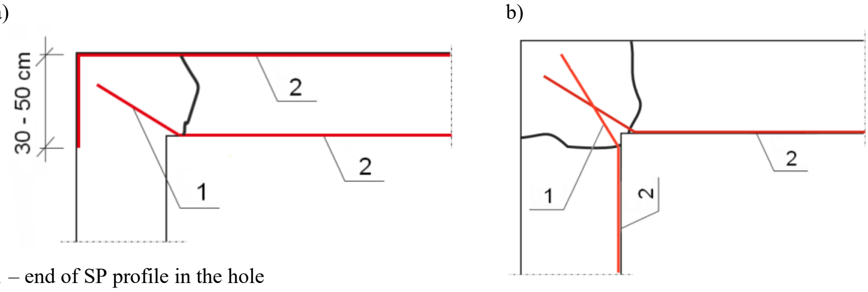
a) min. 50cm to the left and right of the crack, make the profiles different in length on each level, but not shorter than 1 meter

b) min. 50cm to the left and right of the extreme cracks, make the profiles of different lengths on individual levels, but not shorter than the distance between the extreme cracks + 1 meter

Fig. 5. Selection of the minimum lengths of Saver profiles depending on the crack structure of the wall: a) single crack, b) double crack

Figure 6 shows the diagrams of wall corner reinforcement with Saver profiles, including double-sided reinforcement of the wall and its internal reinforcements.

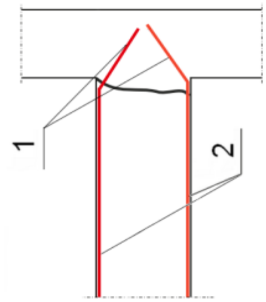
a) b)



1 – end of SP profile in the hole
2 – SP profile

Fig. 6. Reinforcement scheme of the wall corner with Saver profiles: a) double-sided reinforcement; b) internal reinforcements

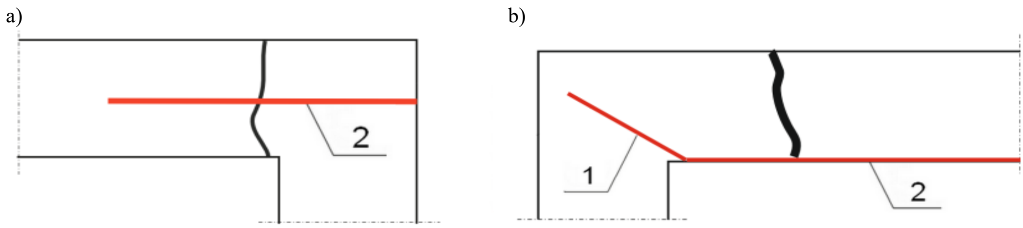
Partition walls reinforced with Saver profiles according to figure 7. This achieved greater stabilization of the partition wall.



1 – end of SP profile in the hole
2 – SP profile

Fig. 7. Scheme of reinforcement and stabilization of the partition wall with Saver profiles

Supporting diagrams, including implementation recommendations and installation of anchors and Saver profiles, are shown in figure 8.



1 – end of SP profile in the hole; 2 – SP profile

Fig. 8. Auxiliary diagrams for the installation of anchors and Saver profiles:
a) anchor installation; b) recommendation to bend the ends of the Saver profiles at an angle of 30 to 40 degrees

In the case of a wall with a thickness of approximately 30cm, Saver anchors with a length ranging from 50 to 60cm were used. The drilling angle "a" and the distance of the drilling point from the crack were calculated so that the length of the anchor on both sides of the crack was the same and equal to L/2 (Fig. 9a). The above assumptions also applied to cross-mounted anchors (Fig. 9b).

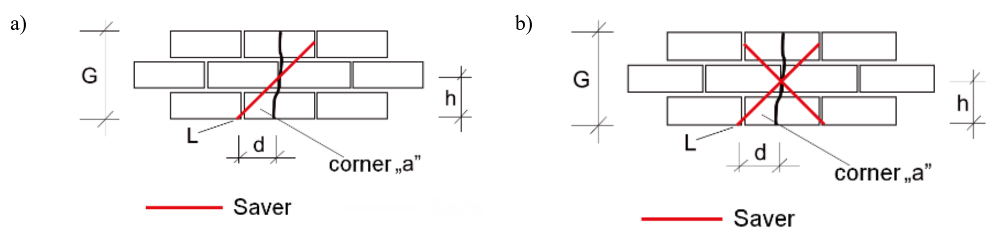


Fig. 9. Installation diagram of anchors and cross anchors in a wall of thickness G

The required values were calculated from formulas (1) and (2):

$$h = \sqrt{0,25L^2 - d^2} \tag{1}$$

$$sina = h/d \tag{2}$$

Results and discussion

Finding a new commercial function for derelict post-industrial buildings is one way to save them and leave them for future generations. In this way, not only is the architectural structure of the building preserved, but also the history of the place with which it is associated. In assessing the aspect of the compatibility of the Brutt Saver technology with the conservation requirements, it is worth emphasizing that the renovation and reconstruction works carried out saved the present building from demolition and, moreover, preserved the basic structure of the building while meeting the current performance requirements.

The article highlights that the use of Brutt Saver technology enables wall strengthening works to be carried out without the need to demolish existing masonry or make visible changes to the building structure. This approach is in line with conservation principles, which dictate the preservation of the authenticity of the materials and architectural form of the building. The durability of the Brutt Saver technology is based on the use of high-quality materials resistant to corrosion and aging, which translates into the long-term effectiveness of the repairs carried out. The system makes it possible to effectively stabilize cracks, reinforce masonry joints, and restore the load-bearing capacity of walls without aggravating existing damage. In addition, the improved safety of the building results from the ability to precisely adapt the technology to the specific structural destruction, reducing the risk of further degradation of the building.

For the renovated front building of the mechanical workshop hall of the former "Ursus" Mechanical Plant in Warsaw, the technology has been selected to meet not only the technical requirements but also the conservation recommendations specified for this type of monument, making it a solution that is both effective and fully respectful of the cultural heritage important for the preservation of the post-industrial heritage of the Ursus-Warsaw area.

The renovation and reconstruction work will save the building in question from demolition, and the new use to which the building will be put after renovation will make it possible to gradually recoup the costs incurred and to cover the ongoing expenses of operating the building.

Conclusions

The methodologies used in the decision-making and implementation process for the restoration of historic structures allow the structure to be rationally adapted to current operational requirements while preserving its original historic character as much as possible. The article is devoted to modern methods of conservation and strengthening of historic structures, with particular emphasis on Brutt Saver technology. Using the example of a renovated building located on plot of land no. 92/2 within 2-09-05 Ursus in Warsaw, the authors present the practical application of this innovative technology. The Brutt Saver system uses specialized fasteners to reinforce walls and structural elements in a minimally invasive manner, thus preserving the historic building fabric.

The article also discusses the technical aspects of the system used, its compliance with conservation requirements, and its advantages, such as durability, effectiveness in stabilizing damaged sections, and improving the safety of the building. The implementation example presented demonstrates the need for an individual approach to each case of renovation of a historic building and the important role of cooperation between designers, contractors, and conservation services. The Brutt Saver technology was presented as a valuable tool in the long-term protection and revitalization of the architectural heritage of historic buildings.

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