STRUCTURAL INTERVENTIONS FOR THE REVITALIZATION OF A WATER MILL

Roberta Răduca, *„Babeș-Bolyai" University of Cluj-Napoca, ROMÂNIA*
Zeno-Iosif Praisach, *„Babeș-Bolyai" University of Cluj-Napoca, ROMÂNIA*
Mihaela Molnar*, *„Babeș-Bolyai" University of Cluj-Napoca, ROMÂNIA*
Eugen Răduca, *„Babeș-Bolyai" University of Cluj-Napoca, ROMÂNIA*

ABSTRACT: This paper presents a case study on the Riesz Mill in Valeapai, Caraș-Severin, Banat Region, focusing on the structural rehabilitation strategies that ensure both the preservation of its architectural and historical integrity, but also its reintegration into the rural economy through tourism and sustainable development. Structural engineering solutions are proposed for its rehabilitation, focusing on reversible and compatible interventions on stone, brick, and timber elements. The approach integrates traditional materials with modern reinforcement techniques to ensure both structural stability and authenticity. The restoration aims to preserve the original mechanical equipment and architectural identity while adapting the ensemble for public use through tourism and education. By combining engineering innovation with heritage conservation, this paper illustrates how sustainable structural interventions can stimulate rural development and revitalize local communities.

KEY WORDS: Rural Heritage, Water Mill Restoration, Structural Engineering, Rural Tourism, Sustainable Development

1. INTRODUCTION

The water mills in the region of Banat had a major impact thourgh the history, because they were important economical polls, but also social polls in the rural communities.
The evolution of technology marks the gradually disappearing of mills.
During the Feudal Period, thousands of mills operated, yet by the 1960s, only about 500 were recorded. [1] Due to technological progress, mills have become an endangered typology of rural industrial architecture.
Today, the preservation and rehabilitation of rural technical heritage represents not only a cultural necessity, but also an opportunity for sustainable regional development. The reactivation of historical mills, such as the Riesz Mill in Valeapai, can serve as a catalyst for rural tourism, local entrepreneurship, and education.

2. HISTORICAL AND TECHNICAL BACKGROUND

The site is located in the village of Valeapai, part of the Ramna commune in Caraș-Severin County, within the Banat region. The settlement lies between the Oravița–Reșița area and the border with the Lugoj region. Historically, the village has belonged alternately to both administrative territories. [2]
The establishment of the Austro-Hungarian Empire resulted in the spread of noble families across Banat. The manors functioned as administrative centers of noble estates, while the mills served as their economic engines and social cores.
During the Austro-Hungarian Empire, the Atanasievici brothers built the Manor in 1840 and the Mill in 1864. The First World War marked the sale of the noble estate, acquired by the Riesz family. The Agrarian Reform of 1921 initiated the estate's division, while the Soviet period led to its complete dismantling. After the 1989 Revolution, the buildings were abandoned. [3]
The project site is located on the northeastern edge of the village, surrounded by agricultural lands. The northern boundary is defined by the Pogăniș River, and access is provided by an unpaved communal road. The site contains three main buildings: the Riesz Mill, the Miller's House, and the ruins of the Barn.

The Mill has undergone several modernization phases. Initially built in 1864 as a traditional vertical-wheel mill, it burned down in 1905 and was reconstructed in 1906, equipped with a turbine. In 1929, an additional annex was added. [4] The technical equipment is partially intact but shows traces of vandalism.
Within the ensemble, the mill stands as the dominant volume of the composition, while the miller's House is in a semi-ruined state and the barn has collapsed entirely.

3. REVITALIZATION STRATEGY

The intervention strategy, at a macro scale, proposes a regional touristic circuit designed to connect a series of noble estates, focusing on manors and mills as complementary elements within the same historical domain. At a mezzo scale, within the village of Valeapai, a local touristic route is proposed, marked by the existing vegetation in front of the houses, aiming to connect the remaining components of the former noble estate.
The proposal focuses on reactivating the ensemble by transforming it into a multifunctional space dedicated to an association activities. The project relies on the involvement of the local community and on transmitting cultural heritage through the development of rural tourism. Since the required functions could not be entirely integrated into the existing ensemble, the construction of a new volume was proposed. [5]
The restoration charters, international examples, and case studies emphasize the importance of conserving the technical equipment and the mill itself. [6] Contemporary interventions should be clearly marked, yet remain neutral in terms of colors and materials.
The Riesz Mill and its technical equipment embody a concept of preserving the memory of the place, while the Miller's House and the Barn are approached as semi-ruin and ruin interventions. The concept of the new volume seeks integration within the context and relationship with the surrounding landscape and topography. [5]

4. STRUCTURAL ANALYSIS AND REHABILITATION SOLUTIONS

4.1 STRUCTURAL SYSTEM OVERVIEW

Although it remains the best-preserved structure on the site, the Riesz Mill shows visible deterioration. Major damages include vertical and horizontal structural cracks, partial roof collapse, and extensive moisture infiltration leading to mold growth throughout the building.
The mill's primary load-bearing walls are built of solid brick masonry, while the annex additionally integrates structural steel elements, fabricated from repurposed railway rails. The ground slab and intermediate floor decks are composed of timber planks supported on wooden beams, whereas the floor slabs of the annexes and basement are constructed from reinforced concrete. The roof structure is a timber truss system. (Fig. 1)

Fig. 1 – Structural system

The interaction between these materials creates specific vulnerabilities: differential settlements, humidity-related degradation, and loss of rigidity at timber–masonry joints.

4.2 STRUCTURAL MODEL

The masonry walls of the mill exhibit cracks and moisture infiltration, which may compromise their structural integrity. To address these issues, interventions such as the injection of compatible lime-based mortar to fill the cracks, as well as the installation of discreet steel ties to enhance tensile resistance, are recommended.

For a preliminary evaluation, the vertical load-bearing capacity of the masonry walls is calculated using:

$\sigma_d = N_d / A$ [7]

where:
σ_d = design compressive stress [N/mm²]
N_d = design load (dead + live loads) [N]
A = wall cross-section area [mm²]

The compressive strength of historical fired brick masonry with lime mortar is typically:

$f_k = 1.0–2.0$ N/mm²

and the design strength:

$f_d = f_k / \gamma_m$

with $\gamma_m = 2.0$
and $f_d \approx 0.5–1.0$ N/mm²

The northern section of the building is the most severely affected, where the intrusion of invasive vegetation has led to partial collapse of the masonry walls. (Fig. 2)

Fig. 2 – Collapsed zone

Reconstruction of this area should be carried out using traditional building techniques, carefully replicating historical materials and workmanship, while simultaneously ensuring that the rebuilt structure meets current structural performance requirements based on engineering calculations.
Interventions must respect the historical material compatibility and avoid rigid modern mortars that could damage the masonry.

4.3 TIMBER BEAM VERIFICATION

The existing timber beams were evaluated using the simplified bending formula:

$\sigma_b = M / W$ [8]

where:

σ_b = bending stress [N/mm²]

$M = (q \cdot l^2) / 8$ = maximum bending moment for a simply supported beam under uniform load [N·mm]

$W = (b \cdot h^2) / 6$ = section modulus [mm³]

At the ground floor and basement levels, the structural system comprises transverse timber beams measuring 120×120 mm and longitudinal beams of 240×200 mm. On the upper floor, the transverse beams are 210×180 mm, while the longitudinal beams remain 240×200 mm. (Fig. 3)
The span at this level is greater than at the lower floors, which results in increased bending moments and higher structural demands on the upper beams. For a proper assessment, the bending stress of the upper floor beams should be evaluated using the standard formula.
If the calculated bending stress approaches or exceeds the allowable stress for the timber species, reinforcement measures such as steel plates or additional support must be considered to ensure structural safety and durability.

Fig. 3. – Timber structure

4.4 LATERAL STABILITY AND SEISMIC CONSIDERATIONS

The main vulnerability lies in the lack of horizontal diaphragms. To increase global stiffness timber floors will be strengthened with diagonal steel straps, improving the in-plane shear resistance.

The equivalent shear stiffness K is improved according to:

$K_{new} = K_0 (1 + \eta)$ [9]

where:

η=0.4–0.6 for diagonal bracing

The horizontal stiffness can increase by 40 – 60%, significantly reducing wall displacement during wind or seismic actions.

4.5 FOUNDATION STABILIZATION

The ultimate bearing capacity of the soil is estimated by the Terzaghi formula for shallow foundations:

$q_{ult} = cN_c + qN_q + 0.5\gamma BN_\gamma$ [10]

The foundation soil must be stable, and a detailed geotechnical investigation by a qualified specialist is required. Given that water previously flowed through this area, the site is susceptible to uneven settlements or potential landslides. Furthermore, the location is prone to flooding every few years, which may affect the long-term stability of the foundations and should be carefully considered in the structural design and conservation strategy.

Table 1 – Structural reinforcement summary

Structural element	Issue	Intervention	Engineering model
Masonry walls	Cracks, moisture	Mortar injection, steel ties	Tensile reinforcement
Timber floors	Weakness	Steel plate reinforcement	Composite action
Roof truss	Partial collapse	Timber replacement	Traditional joints
Foundation	Infiltration	Drainage system	Soil stabilization

5. CONCLUSIONS

The rehabilitation of the Riesz Mill demonstrates that heritage conservation can be supported by rigorous structural analysis and engineering tools. Applying Eurocode-based verifications ensures the safety of historical materials while maintaining authenticity.

The integration of engineering innovation into rural heritage protects the built fabric and fosters sustainable rural development through tourism and education.

The author's personal contribution is reflected in the integrated approach to the rehabilitation of the Riesz Mill ensemble, combining heritage preservation principles with structural engineering analysis. The conceptual framework, spatial reactivation strategy, and adaptive reuse proposal were developed based on original architectural research and on-site documentation carried out by the author. The correlation between architectural design intentions — such as the reinterpretation of the mill as a multifunctional cultural and educational space — and the structural consolidation solutions demonstrates a personal interdisciplinary methodology.

REFERENCES

[1] D. Țeicu, Moara de Apă din Banat, Muzeul Banatului Montan, Reșița & Complexul Muzeal Arad, Arad, 2012, pp. 372-384

[2] T. O. Gheorghiu, Locuirea Tradițională Rurală din Zona Banat-Crișana [Elemente de Istorie și Monografie; Protecție și Integritate], DTP Express, Pg. 17-18

[3] A. Kremm, Valeapai – 420 de ani: pagini monografice, consemnări, rememorări: o istorie subiectivă, Cosmopolitan-Art, Timișoara, 2017, 978-606-988-008-1

[4] R. Trifan, Morile Banatului – Patrimoniul mulinologic al județelor Timiș și Caraș Severin, Asociația ACASĂ ÎN BANAT, 2023, 978-973-0 38941-8

[5] B. Gîrbovan and R. Răduca, "Valorificarea patrimoniului rural din Valeapai cu accent pe Conacul Atanasievici și Moara Riesz", Faculty of Architecture and Urbanism, Politehnica University of Timisoara, Romania, 2025 – including the written and drawing parts

[6] Industrial Heritage Re-tooled, The TICCIH Guide to Industrial Heritage Conservation, James Douet, 2012

[7] EN 1996-1-1:2005, Eurocode 6 – Design of masonry structures
[8] EN 1995-1-1:2004, Eurocode 5 – Design of timber structures
[9] CEN/TS 1992-4, Eurocode 8 – Design of structures for earthquake resistance
[10] K. Terzaghi, Theoretical Soil Mechanics, 1943

*Corresponding author