

Solutions for the Rehabilitation of Historical Building Facades with Local Materials

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Abstract

The present research aims to identify the possibilities of rehabilitation of building facades in the centre of Chisinau, through the use of high-performance materials, use of high-performance technologies in execution, reduction of facade renovation costs, etc. In the process of organising the rehabilitation works of historical buildings of architectural value, we are dealing with the following: the value of the rehabilitation works of a historical building is very high, the duration of the rehabilitation is important, the attitude of the society is insufficient, the lack of strategies for the rehabilitation of buildings at the municipality level. In order to achieve this objective, we propose to research the following tasks: definition of the concept of rehabilitation of buildings in the Historic Centre of Chisinau; legislative, normative assurance of rehabilitation of historical heritage in the Republic of Moldova; analysis of the situation in Chisinau on the example of historical buildings with limestone finishes and examination by non-destructive methods of facades; solutions for rehabilitation of facades of historical buildings by comparing two types of technologies. In conclusion, emphasis will be placed on the choice of the most efficient method in terms of material, technology and cost.

Keywords

Nondestructive Examination, Cladding, Façade Rehabilitation, Historic Buildings, Limestone, Rehabilitation Solutions, Cracks, Testing

1. Introduction

As a result of the disappearance of the Soviet Union, the Republic of Moldova inherited a rich cultural heritage with a special architecture. A large part of the buildings in the Historic Centre of Chisinau was built in the 18th-20th centuries,

which is currently a challenge in terms of maintenance of this heritage of buildings that are in a process of continuous ageing and deterioration [1].

In about 30 years, there will be a serious problem of rehabilitation of buildings built before 1990, in terms of load-bearing capacity, strength, stability, operational safety, thermal comfort, preservation of architectural appearance and satisfaction of user requirements.

Most of the buildings in the central area of the capital of Moldova are made of limestone or brick blocks, without a reinforced concrete structure. The varied architecture is predominantly made of limestone decorative elements, and the facades of many old buildings are covered with limestone plywood [2].

Limestone is a local soft stone material used as a building material. It is mainly used on the territory of Moldova for masonry, “cotilet”. The limestone rocks that serve as raw material for cotilet were formed from sedimentary deposits in the Middle Sarmatic period, it is an ecological material with high longevity. The wide use of this material in the construction of buildings has given a special colour to the cities of Moldova. Cotilet has been obtained since the 15th century in the stone quarry near the small town of Cricova, not far from Chisinau [3].

Rehabilitation of historic buildings can be: architectural, aesthetic and functional. Architectural and aesthetic rehabilitation focuses on restoring the image of architectural features by preserving authenticity based on existing pictures. The resolution of functional problems of old buildings reflects on the qualities of the envelope and roof and aesthetic rehabilitation on the qualities of the exterior decorative elements and authentic colours that ensure the individuality of historic buildings. Preserving and enhancing functional performance also refers to the rehabilitation of installations or their replacement.

The theme of rehabilitation of historic buildings in Chisinau, Republic of Moldova has not been widely addressed before. Most historic buildings are left unattended and their restoration is left to the owners.

In Moldova, historical buildings of architectural value are protected by Law No 1530 “Regarding the Protection of Monuments”. The Republic of Moldova is in the process of implementing the Eurocodes following Government Decision No. 933 of 12.11.2014 “on the harmonization of national technical regulations and standards in the field of construction with European legislation and standards”. The legal framework for the implementation and adoption of the Eurocodes is provided by Law No 112 of 02.07.2014 “on the ratification of the Association Agreement between the Republic of Moldova, of the one part, and the European Union and the European Atomic Energy Community and their Member States, of the other part”. To achieve the objectives, CP A.01.02/L:2014 “Application and use of Eurocodes” was developed and applied in practice.

The topic of rehabilitation of historic stone/limestone buildings was approached in 2016 by Sala E, Zanotti C, Passoni C and *et al.* with the topic *Light-weight natural lime composites for rehabilitation of Historical Heritage* [4], where they developed several natural lime composite materials for compatible rehabilitation of historic heritage. Also in 2016, Emara A and Korany M per-

formed a case study on heritage houses in Germany, where they determined the deterioration factors affecting heritage houses in the Farasan Islands [5].

In 2020, Ismaeel W and Ali A approached the topic *Assessment of eco-rehabilitation plans: a case study “Richordi Berchet” palace*, where they focused on two different methods of assessing the condition of historic buildings, namely “Leadership in Energy and Environmental Design” (LEED) and “Life Cycle Assessment” (LCA) [6].

The research consists in the expertise of a historical building in the center of Chisinau, based on the data obtained from the analysis, the most efficient method of rehabilitation of the building will be determined by comparing two methods, while preserving the architectural appearance.

The aim of the research is to demonstrate the appearance of the facade of a historical building and the possible rehabilitation of the facade in compliance with technical standards and legal aspects.

2. Methodology

Most of the historical buildings in Chisinau are in a deplorable state. While some buildings are maintained in a satisfactory condition inside, the facades of these buildings are in an unsatisfactory condition [7].

In order to demonstrate the level of deterioration of the historical facades [8] in the centre of Chisinau, a study was carried out on the building of the former community of medical sisters “Red Cross from Harbovat Monastery”.

The building of the former community of medical sisters “Red Cross of Harbovat Monastery”, an architectural monument of national significance, which was built in 1905-1910, made of limestone with the architecture of the building made in modern style, with details specific to the eclectic style.

In 1940 it was owned by the Ministry of Health and Welfare (Figure 1).

Specific elements of the modern style facade are the striations on the surface of the columns, the combination of building materials of different colours and compositions, burnt brick and limestone, the latter being used as an anchor on the brick background.

At present, the building’s functionality is ensured by hosting the IMSP State Polyclinic, the headquarters of the National Health Insurance Company and the



Present



Passed

Figure 1. broadcasting co-ordinator council building.

Audio-visual Council of the Republic of Moldova. In 2008, the building located at 46 Vlaicu Parcalab Street; Chisinau was renovated inside and the facade was cleaned by sandblasting.

In 2022, the research team carried out a visual survey of the facade of the building at 46 Vlaicu Parcalab Street, using non-destructive methods to determine the condition of the facade's plywood, which is made of limestone [7].

Equipment such as a professional camera, a laser ruler for accurate size determination and an ultrasonic tester was used for the non-destructive visual inspection [9] [10] [11] [12].

Using the ultrasonic device shown in **Figure 2**, façade degradations were determined by a visualization of the received ultrasonic waves, which has an oscilloscope mode to visualize and analyse the A signals. This apparatus allowed the determination of gaps, cracks and other internal defects that occurred during operation.

The data obtained from the on-site inspection allowed us to determine possible solutions for the rehabilitation of the façade [13] [14].

3. Results and Solutions

Each historical building with architectural value requires a separate study on the rehabilitation of building elements, mainly for facades, enclosures and roofs, which ensure the aesthetic appearance of the buildings in the Historic Centre of Chisinau.

The rehabilitation of historic buildings requires the organisation of the following basic activities: technical expertise; finalisation of the rehabilitation materials; design of the intervention works; preparation of the specifications; preparation of the cost estimate; determination of the sources of financing; execution of the rehabilitation works; monitoring of the execution of the works; periodic acceptance on completion of the works; final acceptance at the end of the period of qualitative execution of the works.

Following the expertise of the facade of the building at 46 Vlaicu Pârcălab Street, cracks, deposits of biological microorganisms, degradation of the limestone plywood and other degradation of architectural elements were determined and are presented in **Figure 3**.



Figure 2. Ultrasonic pulse velocity tester.

One method of dealing with the damage that has occurred is to restore the entire façade by removing the existing limestone slabs and replacing them with new ones, but taking into account the architectural appearance that cannot be altered.

Figure 4 shows models of limestone slabs that can be used to rehabilitate the facades of historic buildings. The thickness of the plywood varies from 1 cm to



Figure 3. Results of the visual inspection of the building façade.



Figure 4. Limestone cladding for facade rehabilitation.

1.5 cm, also the limestone plywood is processed and has low water absorption.

Figure 5 shows limestone plywood patterns that have been handcrafted by carvers to arrive at that identical architectural element for the rehabilitation of the façade of the historic building.

To ensure the quality of the rehabilitation of limestone facades, we recommend the following sequence of works:

- 1) Removal of the old layer by cleaning (washing with water jet, high pressure), degreasing and sanding of the masonry from cut limestone blocks;
- 2) Filling joints with mortar, identical to that used for masonry, decorative element or cladding;
- 3) Replacing damaged or crushed limestone blocks by cutting them on-site, following their dimensions and configuration, preventively reinforcing and reinforcing (*if necessary*) the contact surface;
- 4) Restoration or replacement of the decorative limestone element, preventively strengthening and reinforcing (*if necessary*) the contact surface;
- 5) Final cleaning of masonry, cladding and decorative limestone elements by sanding;
- 6) Vacuuming limestone dust from the façade surface [15].

Following the proposed technology, a cost study has been carried out which shows that for 1 m² of facade renovation with limestone plywood, the average price will be between 30 - 35 euros. The cost includes the price of material, transport and labour.

Another method of facade rehabilitation may be to replace limestone plywood with modern materials at the expense of the authenticity of the materials from which the decorative elements are made. Decorative elements are made of polystyrene, which is a high-pressure resistant, non-water-absorbing, easy to process and easy to use material that is easily bonded to any type of surface, are presented in **Figure 6**.



Figure 5. Limestone decoration elements for facade rehabilitation.

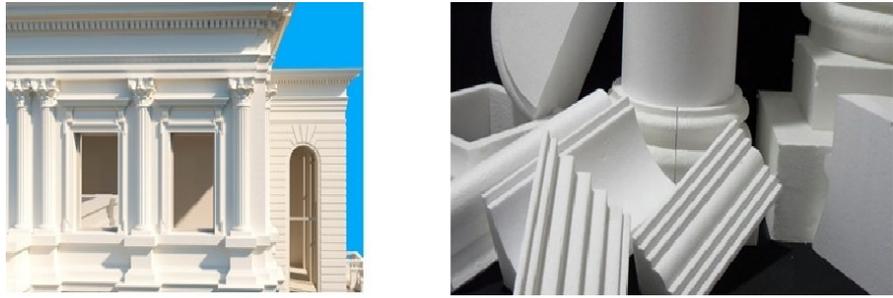


Figure 6. Polystyrene decoration elements for facades.

Three-dimensional cutting of polystyrene elements of any complexity, this is an important reason for its widespread use in restoring the image of historic buildings. Practical and economical materials are preferred for carrying out decoration-finishing works, this can be designed and carried out based on photographs of architectural elements of historical buildings.

The technology of decorative polystyrene cladding is as follows:

- 1) Removal of all existing plywood;
- 2) Wall cleaning and wall rehabilitation if necessary;
- 3) The decorative polystyrene elements are mounted on the existing wall using a reinforcement mesh and the adhesive chosen according to the type of material used in the masonry;
- 4) To protect the decorative elements, apply primer to reinforce the polystyrene and acrylic or silicone decorative plaster.

Cladding with decorative polystyrene elements is easy to make, it is also more economical in terms of costs which average 15 - 20 euros per 1 m², but the life-span of these types of facades is shorter [16] than when using stone or limestone plywood.

4. Conclusions

Monuments are objects or groups of objects of historical, artistic or scientific value, which are testimonies of the evolution of civilizations, as well as of spiritual, political, economic and social development, and which are registered in the Register of Monuments of the Republic of Moldova protected by the State.

Research has led to the following conclusions:

- 1) The conservation and rehabilitation of historical buildings in Chisinau are not only of scientific interest, but also of aesthetic, technical and economic interest, which should contribute to the creation of the value of the cultural-architectural heritage, and the issue of addressing this aspect should be a priority of national interest.
- 2) Technical expertise of the load-bearing structure of historic buildings is mandatory to carry out its rehabilitation, including the façade.
- 3) Most of the laws are taken from the USSR or European legislation in this field, whether they refer to thermal rehabilitation, energy performance, energy use or rehabilitation of historic buildings, etc., but they need to be updated with

the situation in Moldova.

4) The reconstruction and rehabilitation of the “Building of the former community of the Red Cross medical sisters of the Harbovat monastery” on 46 Vlaicu Parcalab Street is a necessity, which was identified after the on-site inspection and the researchers recommend starting the renovation as soon as possible.

5) Comparing these two methods proposed by the research team, it is possible to emphasize the efficiency of limestone plywood which has a longer life than decorative polystyrene elements. The technology of limestone cladding is much more innovative compared to polystyrene cladding. As far as costs are concerned, it can be mentioned that the price is lower for cladding with polystyrene decorative elements, but taking into account the lifetime of these elements, it follows that cladding with limestone elements is much more efficient.

6) The renovation of the facade of the historic building in question should be carried out with limestone plywood in order to preserve its authenticity, this material is also local and does not involve additional transport costs, is environmentally friendly and sustainable.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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