ARCHITECTURAL MEMBRANES FOR FUNCTIONAL BUILDING'S REFURBISHMENT

EVALUATION OF ITS POTENTIALITIES AS EFFICIENT ALTERNATIVE TO COMMON REFURBISHMENT SOLUTIONS

Ph.D. student: Mónica Macieira

Supervisors: Paulo Mendonça1, João Miranda Guedes2

1 LaDiPT, School of Architecture, University of Minho;
2 CONSTRUCT, Faculty of Engineering, University of Porto

Abstract: The building’s rehabilitation has been assuming an increasing importance due to the current environmental concerns. The technological innovations transform permanently the construction market, opening horizons for new applications, including architectural membranes (facades and foil polymer materials). Used primarily in outdoor roofs and shading structures, architectural membranes are aimed to be involved in other applications as well. It is found that there are architectural membranes’ solutions with the potential for buildings functional rehabilitation. Membrane materials have some intrinsic benefits for buildings rehabilitation as: lightness, translucency, water tightness, flexibility, easy (de)construction, incorporation of technological upgrades by f functionalization, among others. The current PhD study in development focuses on the architectural membrane applications in building rehabilitation, covering spatial, functional (structural) building physics) and economic aspects. There are few studies on the membrane materials applications for buildings rehabilitation. The present study aims to overcome this gap, focusing on the assessment of the effectiveness of architectural membrane solutions, through the selection of some case studies, comparing them, as alternatives, to current ones.

Keywords: rehabilitation, membranes materials, functional performance evaluation.

Introduction

Architectural membranes (composite textiles and foil ‘skins’) are used for space definition, covering and waterproofing, and they can be used for covering rehabilitative specific solutions in buildings refurbishment context, when the needs of lightweight, energy saving, high transparency increasing, unobtrusion and flexibility could be obtained. These are mainly a business as well as special requirements. A few millimetres membrane can be a self-supporting material (integrating structural or constructive purposes) and a selective sunlight filter capable of absorbing or reflecting ultraviolet or infrared light whenever needed, they can also be used in conjunction with and in artificial isolation materials.

There are some direct advantages in using membrane solutions. It can be summarized as follows: (a) embodied energy reduction – taking advantage of the reduced mechanical, transport, and labor inputs, (b) reduced membrane’s embodied energy, (c) efficiency in the recycling of materials, (d) productivity increase - facilitate the yard’s management in tight and complex spaces. Costs are also a critical issue in the construction industry, simplifying the process and avoiding scaffolding formwork, and also reducing construction waste.

However, despite these benefits, many building practitioners are unfamiliar with the behaviour and the characteristics of membranes. The lack of information about their use and properties, by the design and construction community, limits their possibility of selecting the highest possible solutions in quality assurance and control of construction projects.

By adopting building with lightweight solutions can beproblems from the comfort point of view due to too much reduced, insufficient thermal inertia and sound insulation. If a building is rehabilitated, they can also be interesting solutions from the sustainability point of view. A mixed weight strategy – combining heavyweight with lightweight solutions - can solve this problem. The contribution of this strategy will be evaluated for rehabilitation scenarios of existing building.

Aims and research objectives

The main objective of the study of building technologies, with membrane materials suitable, for building rehabilitation and to compare them with “conventional” solutions (brick or concrete). The objective is to these new membrane solutions can be an efficient alternative to “conventional” solutions for functional rehabilitation of buildings, regarding also economic and environmental aspects.

The purpose is to establish an approach and oriented comparative analysis to demonstrate the potential of rehabilitation’s interventions making use of membrane materials as an efficient eco-solution. Nowadays, membranes material can meet the durability, mechanical strength requirements, lighting properties and other aspects that could be explored in rehabilitation interventions from which architects and engineers can be gain an interest in membrane solutions.

Research will be conducted over the themes: construction economy, functional performance and environmental impact of building rehabilitation with membrane materials.

Figure 1: Countries where case studies are located.

Figure 2: Distribution of the case studies by their durability and intervention building element.

Table 1

<table>
<thead>
<tr>
<th>Type of intervention</th>
<th>Number of case studies</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Facade refurbishment</td>
<td>20</td>
<td>≥ 10 years</td>
</tr>
<tr>
<td>Roof replacement</td>
<td>15</td>
<td>≥ 10 years</td>
</tr>
<tr>
<td>Roofing over atrium</td>
<td>12</td>
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Figure 3: Distribution of the case studies by their durability and intervention building element.

About 60 analysed projects of building refurbishment with membrane technologies

From the sample analysis were also identified five basic design options: (1) building inside a building: a membrane structure spans the entire building; (2) integration of an intervention of a roof; (3) envelope refinishing as a second skin; (4) suspended ceilings and partitioned niches.

Identified principles on functional refurbishment projects with membrane solutions are as follows:

(1) Replacement
(2) Integration
(3) Justuxtaposition

Examples of some analysed project: case studies.

- (a) Školní kostel - Lyceum church, Canada - interior views, before and after intervention to reconfigure the effects of asbestos.
- (b) Building inside a building approach - conversion of an warehouse into an arts and crafts exhibition office, Germany.
- (c) Recomposition of vaulted ceiling to achieve higher acoustic performance, with microperforated membrane based product in ITALIA, Choc-Republic.
- (d) Wall replacement with membrane of fibreglass textile coated with ETFE - Dreessen's train station, Germany (before and after).
- (e) Panoramic extension with membrane extension of EPP - church of Eibar, church, France.
- (f) Roof replacement with ETFE membrane to promote the reuse of a ruin: Carpenter's Inn, church, Canada.
- (g) Roof replacement with porcelain based PVDF - EDF headquarters, Lyon, France (before and during refurbishment work).
- (h) Facade replacement with membrane of fibreglass textile coated with double pneumatic ETFE membrane and facade - Fine Art Centre, France.

Ongoing tasks

- Evaluation of hygiene of membrane surfaces applied in old buildings - constructive detailing and prototyping construction and on-site hygienometric measurements.
- Development of a constructive membrane solution as alternative to "lath" solutions.

Realised outputs


Targeted research stakeholders/beneficiaries

For the industry, the knowledge of potentials under study and access to the results of functional and economic assessment of these solutions, can encourage the production of materials and components of these solutions in the national market, reducing the need of imports. Also professionals related with construction/building sector can benefit positively from this research.

Acknowledgments

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