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Abstract

This paper investigates the application of structural glass in restoration and conservation practices in order to highlight and safeguard our built heritage. Cast glass masonry is introduced in order to consolidate a half-ruined historic tower in Greece, by replacing the original parts of the façade that are missing. Dry connections between the elements contribute to a completely reversible system that complies with the conservation guidelines suggested by the Venice Charter, while the interlocking nature of the glass units ensures the overall stability and the desired structural consolidation of the monument.

Keywords: restoration; structural glass; cast glass; dry connection; interlocking geometry; reversibility.

1 Introduction

Contemporary conservation philosophy, based on the principles and recommendations of Venice Charter (1964), suggests that every intervention should be minimum and distinguishable in order to reveal its time and avoid falsified interpretation of the original structures [1]. Current restoration treatments with traditional materials bear the risk of conjecture between original and new elements, while the ambition to enhance the structural integrity of historic structures, often results in visually invasive and irreversible solutions that can impair the authentic image of the monuments. As restoration practices have evolved through time, always imbued with the spirit of the era, there is a question that still remains unanswered: How can one intervene in another's work, maintaining its significance and authenticity? [2]

In this context, glass could be the answer to the on-going materialization debate between restoring and preserving; a promising solution able to consolidate the historic buildings and, at the same time, reveal their stratification. Transparency enables the simultaneous perception of both the original and ruinous state of the monument, giving a material and immaterial appearance that relates the structure to both the past and the present setting.

2 The case study

The case study of a historic tower, located in Greece, is explored in order to investigate the potential of glass as restorative material. A glass masonry articulated by cast glass units is proposed for the restoration of the half-collapsed southeast façade in respect of the existing construction technique and aesthetics of the original limestone

masonry. Glass is used to connect the freestanding walls and reinforce the building against earthquakes; at the same time it protects the historic materials by sealing the lower part, which is closer to the sea and more susceptible to weathering.

Figure 1. Illustration of the cast glass masonry

2.1 Dry connections

In order to ensure a reversible design, which could be easily removed in case of future alterations, the glass masonry introduces dry connections between the cast glass units. The brittle nature of glass does not allow for a direct contact of glass components, as abrupt failure may occur due to minor flaws in the surface of glass. For this reason, a transparent plastic interlayer is used instead of adhesive or mechanical connections, maximizing transparency and allowing for disassembly. The purpose of such intermediate layer is to carry the deviations in thickness and flatness of the units, while transferring the compressive and shear forces in a homogeneous and uniform way.

The overall stability of the glass structure is achieved through the interlocking geometry of the glass units, as a physical constraint against movement. A special interlocking cast glass unit is developed in order to meet these criteria, based on the locking principle of the LEGO® bricks.

The connection between historic and new materials is designed as the weakest link; a warning mechanism in case of overloading. Rubbery interlayer is used in-between the existing and the glass masonry establishing a flexible connection that allows for small deformations due to the thermal expansion of the materials. Embedded mechanical connections are also used as point anchors to the monument in order to stabilize the new glass structure, while being minimally intrusive for the aesthetics and integrity of the historic materials.

2.2 Prototype & Testing

A prototype in scale 1:2 has been fabricated and tested, under the supervision of *Glass & Transparency research Group* at *TU Delft*, in order to give an insight on how this interlocking dry connection works. A small set-up of five glass blocks tested in shear has shown that the LEGO®-inspired glass masonry performs well against lateral out-of-plane loads, such as the wind, reaching the ultimate failure load of 17.3 kN.

3 Conclusions

Glass could reinstate the image of our monuments through distinct, yet discreet restoration treatments. It has the unique ability to provide the image of the original form, by exposing the traces of time and ageing, while introducing a distinct line between the old and the new. In an age of scientific advancements and innovations in multiple disciplines, restoration and conservation practices are highly regarded as a matter of cultural and national identity. The use of glass in compatible and elegant restoration scenarios could prove a considerable design tool not only for the preservation of our heritage but also as direct demonstration and reflection of the technological spirit of our era.

4 References

[1] International charter for the conservation and restoration of monuments and Sites; Venice: 1964. Available from https://www.icomos.org

[2] Stanley-Price, N. The Reconstruction of Ruins: Principles and Practice. In Richmond A, Bracker A, editors. Conservation: Principles, Dilemmas and Uncomfortable Truths. Elsevier, 2009.