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Forschung, Entwicklung,
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Zulassung neuer Baustoffe,
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„Transparent enclosures“ Conceptual development of a housing system using transparent membranes and a controlled ventilation to optimize the wintry housing for the exposed cultural assents during the winter period

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1 Abstract

A research team of the Fraunhofer Institute for Building Physics IBP and the Technical University of Munich (TUM) is developing a transparent enclosure system for cultural assets with a physically optimized interior climate. The functional principle is based on controlled ventilation and profitable use of solar radiation.

2 Winter protection today

Every autumn, thousands of stone sculptures or fountains are hidden under mostly wooden shelters to protect them against the winter. Therefore, a variety of artistically valuable objects are invisible for almost half of the year.

3 Trend toward visibility

In recent years, increasingly transparent enclosures were ordered for objects in highly frequented places, e.g. for the “Marienbrunnen” in Altötting or the “Schönen Brunnen” in Schwabach. Such decisions in favor of urbanistic quality are of course welcome but they throw up two problems:
First, the costs for the use of steel-glass constructions and the logistical effort are high.
Secondly, transparent enclosures are seen critically among experts since the sunlight causes a "greenhouse effect" with high fluctuations in temperature and humidity.
Can transparent shelters be designed in a way to ensure the same of even higher protective effect compared to conventional systems?

4 The research project

Starting from this question, a research team of the Fraunhofer Institute for Building Physics IBP and the professorship for design and building envelope of the Technical University of Munich (TUM) started to develop an enclosure system using transparent membranes. Criteria like easy assembly, transport and storage as well as low cost, sufficient durability and a favorable indoor climate had to be respected. The developed concept was tested during the winter period 2015/2016.

5 The new approach: Dehumidify instead of insulation

Long-term studies on the durability of building materials at the Fraunhofer IBP have led to the conclusion that moisture is involved in the damage of natural or synthetic stones in most cases. An enclosure should therefore reduce water intake, in the form of precipitation or condensation. An enclosure should therefore reduce water inflitration in terms of precipitation or condensation.

On the basis of these findings the researchers choose the approach to reduce material moisture of the protected object rather than to create a more constant internal temperature.

The considerations:

1. Frost-thaw changes can no longer cause damage because there is no longer sufficient liquid water in the stone pores
2. Thermo-hygric softening processes are weakened
3. Lower air and material humiditiy lead to reduced organism growths

In this case, the transparency does not only offer visibility of the cultural asset but the sunlight is also used to dry the monuments. In the case of solar radiation, moisture is to be removed by air exchange during climatically unfavorable phases to avoid infiltration of moisture by back-condensation. Thus, controlled ventilation is a key factor. In this way, year-round visibility and conservative interests are combined in one concept.

6 Measurement campaign and ventilation concepts

The ventilation concept aims to dehumidify the cultural assets as quickly and gently as possible after the beginning of the enclosure period in the late autumn. In the case of solar radiation, the air heats up within the enclosure and thus offers the possibility of absorbing more moisture. A controlled exchange of the air is necessary to ensure the transport of moisture out of the protective cover.

7 Results

The measurement campaign shows that the new building physics approach for transparent enclosures achieves good results in the area of drying stones, frost-thaw changes and especially in the undershooting the dew point temperature. Thus, transparent enclosures with controlled ventilation are an interesting alternative compared to currently used opaque enclosure systems, particularly with regard to year-round visibility with a simultaneous weather protection of the objects.