Causes of failures and methods for repair of weather panels

Autor(en): **Block, Klaus**

Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

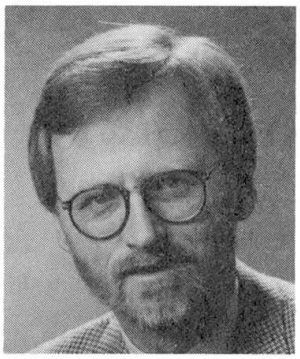
Band (Jahr): **77 (1998)**

PDF erstellt am: **24.06.2024**

Persistenter Link: https://doi.org/10.5169/seals-58195

Causes of Failures and Methods for Repair of Weather Panels

Klaus BLOCK
Civil Engineer
University of Dortmund
Dortmund, Germany



Klaus Block, born 1949, received his Civil Engineering degree from the University of Braunschweig, Germany in 1975, Ph.D. (Dr.-Ing.) in 1983, Head of Department of the Institute of Civil Engineering, University Dortmund

Summary
Based on investigations of his own the author concludes that many façades do no longer fulfill the requirements of stability. Before applying an External Thermal Insulating Composite System (ETICS) on Large Panel Structures it has to be checked if the external "weather panels" are stable and durable especially with regard to the additionally caused hygrothermal forces. Hints are given for detecting structural failures and their causes. For the rehabilitation and stabilization of curtain walls and weather panels a number of solutions in the form of bolt or corbel structures are available.

1 Structural Concept

Newly erected buildings appear in all their glory; unfortunately this cannot be preserved for long. Within a few years first signs of aging appear that are mainly caused by weather. The relevant actions were often unknown to the designer, or even inaccessible. Today details for the design of façades, e.g. the hygrothermal actions, are better known. The design, the manufacturing, and the construction of façades require special knowledge, especially regarding multi-layer sandwich panels.
The designer has to take into consideration that

- the thickness of the weather panel according to the design is often only 6 cm,
- the stresses from the dead weight of the structure are concentrated at only a few locations where they are transferred to the substructure.

Therefore it is clear that the required precision for the manufacturing is within a range of millimeters. Furthermore the transfer of the dead load causes deflection forces and tensile stresses in very thin members, which require special care when placing the required reinforcement.
Many façades do not fulfill the requirements of stability according to the present state of knowledge. Considering the difficult production of filigree concrete members lots of buildings call for immediate action. This paper compiles hints to help controllers detect potential defects. Principles and systems for the rehabilitation and stabilization of weather panels are described.

2 Causes of failure

Since the 1960s residential and public buildings in the former German Democratic Republic have been predominantly built as large panel structures. With the beginning of the 1970s the 'Wohnungsbauserie 70' (WBS 70) was standardized. The room-size units were manufactured by collective combines so that it could happen that precast members from different production plants were delivered to one construction site.
It is necessary to describe the production of a sandwich panel in order to explain actual dimensional deviations. The panel was produced in a horizontal position. The sandwich panel

was manufactured in three steps. As a rule the load carrying layer was poured first; after having applied the insulant the casting of the weather panel was done. If it was done the other way round, it could happen that through the weight of the load carrying panel the insulant was pressed into the weather panel, the concrete of which was not yet hardened. This led to significant thickness variations of the weather panel. Sometimes the fresh concrete passed through the joints of the insulant thus forming 'concrete bridges' between the weather panel and the load carrying wall.
Devices for the subsequent stabilization of weather panels require an official agrément. The applicants had to measure and evaluate the actual thickness in various buildings where the target thickness was 60 mm. The mean value of 57 mm was in the range of usual tolerances. The 5%-fraktile of this sample was 40 mm. An extreme value was 80 mm.
In the draft of a letter by the Ministry of Building and Construction of the GDR to the manager of the collective combines, dated January 1989 [1] it can be read that "... the investigation on the weak points of the weather panels revealed a poor and alarming quality performance of sandwich panels." This evaluation was based on a paper by K. Ritter [2] describing 27 typical mistakes.
Another deficiency was the use of steel without corrosion protection for the load carrying anchors. In sandwich panels anchors with a welded "normal steel - stainless steel" joint were found, e. g. as detailed in design documents by the collective combine of Rostock. There are no basic objections against this kind of connection if the welded parts and the structural steel are protected against corrosion. With regard to the dimensional it is difficult to verify an appropriate corrosion protection. A comprehensive inventory of the actual layer thickness can be obtained where new façade elements are mounted. In this case holes have to be drilled for fastening the new façade with anchor bolts. In Jena these measurements revealed weather panels with a thickness down to 25 mm. Partially the reinforcement of the weather panel was exposed and already corroded.
It can be stated that load carrying anchors made of stainless steel are a **necessary but not sufficient** requirement for durability. The actual thickness of the weather panel plays an important role as well. Panels that are partially too thin have to be secured additionally; where the thickness is insufficient it might be necessary to replace the panel. Panels whose thickness is less than 40 mm require subsequent stabilization. The required stability of such panels cannot be verified due to the lack of secondary reinforcement and the insufficient anchorage length of the load carrying anchor within the weather panel. Usually on these panels new lightweight units are applied. The additional load has to be transferred into the load carrying wall without impairing the overall stability. A spot check-like control of a few panels is not sufficient because the quality of precast units from different manufacturers may differ considerably. **A conclusion from 'n' to 'n+1' is not acceptable. A comprehensive securing appears to be more appropriate, both technically and economically, rather than an extensive building diagnosis.**

3 Symptoms for early damage detection

Easily noticeable corrosion damages indicate serious defects. Besides the characteristic color of rust concrete pieces spalled off due to corrosion pressure are also easily detectable. A settling of the weather panel due to lack of load carrying capacity produces compression and protrusion of the sealing compound or cracking of the upper edge sealant. The lateral joints show diagonal cracks. But also varying widths of the joints –unless they were caused during the erection process- horizontal or vertical recesses indicate flaws. In a particular case the weather panels had settled in such a way that the quarry stone cladding underneath became load carrying and sheared off.
It can be concluded that often the combination of several symptoms indicate a damage. The diagnosis should be established by experienced engineers.