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Improved wind and ice load approaches for steel facade elements AiF No.: 20572N

Summary of the research project AiF No.: 20572N

In the research project 20572 N / 1 „Improved wind and ice load approaches for steel facade elements“ extensive investigations regarding the effects of wind and ice on facade elements were carried out.

The objective was to expand the existing regulations of the standard for facade elements with regard to types and construction methods that had not yet been taken into account. This included the load-bearing effect of particularly large facade elements (e.g. large industrial halls with sandwich element facades) as well as facades with air flow (e.g. fabric, perforated sheets, expanded metal, etc.).

For the load-bearing capacity of large facade elements, full-scale tests were carried out to analyze the load transfer effects. Influence matrices were determined, and in further calculation steps, these were convolved with measured load time series that were obtained in the wind tunnel. As a result, time series of the relevant impact effects could be determined, which were evaluated using extreme value statistics and compared with the normative calculation approaches. The comparison of the two approaches shows that the existing calculation methods reliably cover the effects due to wind, and no reductions can be recommended for the total load effect. However, the investigations showed that a positive influence can be taken into account for the verification of the fastener by recording the correlation effects over the area size and that the use of the coefficient cpe,10 safely cover the real impacts. This results in an effective load reduction compared to current practice, which affects both the design of the fastener and the element weakening due to the number of fasteners used (perforation).

Permeable facades used for architectural or functional reasons are currently not sufficiently covered by the design specifications of the wind load standard. As part of literature research, existing studies and recommendations from the specialist literature were initially compiled. In addition, extensive investigations were carried out on the various permeable facades (wire mesh, perforated sheets, expanded metal, lasercut sheets) and compared with the existing approaches. As a result, test-based recommendations could be formulated that facilitate the future planning of permeable facades. Specifically, the dependencies bet-

Editor: German Committee for Steel Construction DASt e.V. | Managing Director: Gregor Machura
Sohnstraße 65, D-40237 Düsseldorf | Tel. (0211) 54012-094 or (0211) 54012-080
For further inquiries, please contact: forschungsmanagement@dast.deutscherstahlbau.de

ween the flow-through area and the aerodynamic resistance (pressure loss) were determined and a transfer to the relevant force coefficients was carried out. The results can be used directly for application in static calculations.

Since the effective load impact depends not only on the aerodynamic properties of the permeable facades themselves but also on the type and location of their installation on the structure, this building context was also examined in more detail. Both single-shell and double-shell facades are used. The installation position on the building structure also has an influence on the load condition – in the case of a double-shell design, the distance to the closed interior facade also has an influence. In the context of wind tunnel tests, these influencing parameters were investigated in a targeted manner and processed using a context-related load reduction parameter.

In winter, under certain weather conditions, icing can form, which, in the case of permeable facades, leads not only to an increase in load due to the ice build-up but also to a change in the aerodynamic load situation. In addition to the change in the aerodynamic cross-section, the correlation between wind speed and climatic conditions for icing is also of interest. In climate statistical studies, a reduction factor was determined that takes into account the reduced characteristic wind speed in weather situations that are likely to cause ice formation. This therefore represents a practical way to evaluate the corresponding load combination of wind and ice loads.

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