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Technical Report

Safety analysis of large-area hall roofs in the event of unintentional loading due to heavy rainfall

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EXECUTIVE SUMMARY

There are approximately 500 construction disasters in Poland every year. According to the data of the Chief Inspector of Construction Supervision, the main causes of disasters in 2014-2021 were fortuitous events including: **strong winds, intense precipitation, fires.** In 2021, the building structures that suffered disasters by type were: 4.9% warehouse buildings, 1.5% industrial facilities.

The collapse of the roof of a hall in Szczecin on 18 August 2023 stirred public opinion and the media. The roof collapsed over part of the hall, which is over 10,000 square metres, and there were 144 people inside at the time. All were evacuated.

The information available in the media shows that a storm front passed over the city at that time. The probable direct causes of the disaster were heavy rainfall and strong wind, as well as obstruction of the drainage system, possibly due to various reasons, including poor servicing or inadequate cross-sectional design. The collapsing roof came to rest on warehouse racks, which helped avoid tragic consequences.
Assuming a completely clogged drainage system, after 15 minutes of heavy rain, 15.3 mm of water column will accumulate on one square metre of roof, which corresponds to a weight of 15.3 kg/m^2.

• The additional load bearing reserve for a steel roof designed in accordance with applicable standards is 3.7 kg/m^2. Heavy, 15-minute rain causes the additional load bearing reserve of the steel girder to be exceeded by more than four times.
• In the case of a reinforced concrete roof, this reserve is 24.3 kg/m^2. For a reinforced concrete girder, a similar heavy rain will result in only 60% of the reserve being used.

• Using the PANDa model (Polish Rain Intensity Atlas) to determine the duration of intense rainfall, the full load bearing reserve for a steel truss (3.7 kg/m^2) is exhausted in less than 5 minutes.
• Similarly, for a pre-stressed concrete girder, the full load bearing reserve (24.3 kg/m^2) is exhausted after more than 60 minutes.

Given the existing risks, the current design guidelines need to be reformulated for safety reasons.

The entire Technical Report is available at:
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