Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 132 (2017) 387–392

Energy Procedia

www.elsevier.com/locate/procedia

11th Nordic Symposium on Building Physics, NSB2017, 11-14 June 2017, Trondheim, Norway

Rain intrusion rates at façade details – a summary of results from four laboratory studies

Lars Olsson[a,b,*]

[a]*RISE Research Institutes of Sweden, Section Building Physics and Indoor Environment, Box 857, SE-501 15 Borås, Sweden*
[b]*Chalmers University of Technology, Department of Civil and Environmental Engineering, SE-412 96 Gothenburg, Sweden*

Abstract

More knowledge and realistic data on inward leakage is needed not only to better understand and confirm rain resistance of different facades, but also to carry out reliable theoretical moisture risk assessments of façade details in external walls. This article is an attempt to highlight amounts of expected leakage based on four laboratory studies. The results show that under heavy driving rain conditions, there may be continuous point leakage of significant volumes of water (0,01-0,05 l/min) in small invisible deficiencies, and corresponds to up to 2% of the applied water load. The leakage rate also depends, more or less, on the size, position and geometry of the deficiency, cumulative runoff rates, size of projecting details and surface properties.

Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics.

Keywords: Driving rain; water lekage, rain intrusion, wall, window, building envelope, risk assessment, EN 12865

1. Introduction

One of the intended functions of the exterior walls is to separate and protect the indoor from the outdoor climate to provide an energy efficient building with good indoor environment (thermal comfort, shading from sun and rain etc.).

* Corresponding author. Tel.: +46-10-5165023.
E-mail address: lars.olsson@ri.se

1876-6102
Peer-review under responsibility of the organizing committee of the 11th Nordic Symposium on Building Physics
10.1016/j.egypro.2017.09.639

However, water can leak into outer walls and façades (1-3) to a greater or lesser degree, even in pressure-equalized façades (3, 4).

Further, the risk of rain intrusion is greater in the presence of façade details than in an unimpaired wall, since inward leakage often occurs in correspondence to the joints around façade details. Joints around window-wall interfaces are one of the most common façade details, and windows often make up a relatively large proportion of the façade area. For this reason, although the façade material itself is impervious to rain, the wall itself may still be damaged due to leaks around façade details (5). Research in this area has been performed in order to quantify and understand the amount of leakage but more research is needed (6, 7) and to design and assess new and existing solutions, in a reliable manner (8).

The purpose of this summary is to give a picture of expected rain intrusion rate at façade details during driving rain conditions.

2. Four laboratory studies

Laboratory measurements allow us to study how façades behave in response to specific different loads, to reproduce trials, assure resistance to driving rain and quantify leakage in a controlled manner. These types of studies are not easy to perform in the field, as it is highly time-consuming and requires a lot of resources. Given the need for more knowledge of façade rain resistance and inward leakage rates, brief results from 4 studies are summarized here. The first three studies are fully or partly published before, the last one is not: Hundreds of commercial tests performed on commission from customers (9); 29 window-wall interfaces and comparison between well and not well designed/performed joints around windows (10); different façade details with small visible and invisible deficiencies (11); slits with different geometry and size.

2.1. Test procedures

The experiment was carried out partly using the standardised test method of EN 12865 “Determination of the resistance of external wall systems to driving rain under pulsating air pressure”, but was extended to include additional load combinations and repetitions (12). Simulation of driving rain was obtained by using specified water spray nozzles (1.5 l/min-m^2 and run-off of 1.2 l/min-m) and dynamic pressure loading with compressed air at successive pressure steps, such as 0 Pa, 0–75 Pa, 0–150 Pa, 0–300 Pa, 0–450 Pa and 0–600 Pa. In some of these experiments, the rain load was also reduced to represent lower driving rain intensity.

Under each façade detail, collection funnels were fitted against the rear of the façade. Each funnel emptied into a glass bowl or plastic container to collect the water and weigh it. However, the actual leakage rate was not measured in the study of hundred commercial tests. Instead the leakage rate was estimated and classified to a five-point scale.

2.2. Tested walls

Various types of commercial façade systems and weather barrier systems (hundred commercial tests) were tested in full-scale wall (3 x 3 m) with a set of predesigned common façade details (9). The tested systems were for example: ventilated façades with façade layer of render on fiber cement board, fiber cement board, composite board and wood panel. Furthermore, sandwich element of metal sheets or concrete with cellular plastic insulation and ETICS (External Thermal Insulation Composite Systems) as well as ETICS with a drainage possibility on the outside between the second line of defense and substrate were tested. The test walls were mainly mounted by the façade supplier themselves.

In the study of 29 window-wall interfaces, windows were mounted in four test walls (3 x 3 m) with three different façades or wall constructions, such as: one with ventilated composite board as façade, one with concrete façade of sandwich element of concrete with cellular plastic within and two with ETICS with a drainage possibility on the outside between the second line of defense and substrate (10). Actually, some of the window-wall interfaces had intentionally not well performed joints for the reason to compare it with well performed joints (by façade supplier).