NEWBuildS

Technical Note 14

February, 2014

EFFECTS OF OVERHANGS ON WIND-DRIVEN RAIN WETTING OF FACADES

KEYWORDS: Wind-driven rain, Roof overhangs, Building Envelope, CFD modeling

OVERVIEW OF PROJECT

Rain penetration has led to extensive building envelope failures in Canada, particularly the Lower Mainland of British Columbia and some areas on the east coast. The reduction of wind-driven rain load on building façade should be the first step to ensure durable wood construction. Roof overhangs are traditionally used and have been shown to be effective in reducing the exposure of buildings to WDR in certain climates. However, their effects on WDR wetting of façades are not fully understood nor quantified. This research project aims to i) develop and validate a CFD model to predict wind-driven rain loads on buildings; and ii) quantify the effectiveness of overhangs through CFD modeling with an ultimate goal to provide recommendations on effective overhang design for different Canadian geographic locations. A CFD model adopting the established approach was developed and validated by comparing literature data reported in wind-tunnel testing of wind-flow field and catch ratio[1] contour on a similar cubic building.

The CFD model was used to evaluate the influence of overhang width, wind speed, wind direction and rainfall intensity on the WDR wetting of facades for a cubic low-rise building (10m x 10m x 10m) and a rectangular mid-rise building (40m x 15m x 20m). A global overhang effectiveness index, defined as the percentage change between the area-weighted averages of the local catch ratio values without and with the overhang, was introduced and used to quantify the effect of overhang for the entire façade (A100) and three partial areas A45, A30 and A15, covering the upper 45%, 30% and 15% of the façade, respectively.

KEY RESULTS

The main findings include:

- The introduction of the overhang changes both the magnitude and the pattern of the WDR deposition on the façade. This change, which varies locally, is attributed to its direct shielding effect and the disturbance it introduces to the wind flow upstream of the building, i.e. its indirect effects.
- The protection provided by the overhang increases as the overhang width increases; and the upper portion of the facade, which receives a larger amount of WDR, is better protected by overhangs (Fig. 1). The effectiveness of the overhang decreases when moving from the upper edge of the facade towards the ground. Overhangs help protect the upper half of the façade (up to 80%) from wind-driven rain under the examined wind and rain conditions, while the lower half remains almost not affected at all by the overhang.
- The effectiveness of overhang varies with different wind and rain conditions. Typically the protection of overhang reduces when wind speed increases (Fig. 2); overhangs better protect the

[1] Catch ratio is defined as the ratio of the wind-driven rain deposited on a vertical façade to the rainfall through the horizontal surface.

Researchers: Hua Ge[1]; Seyed Sepehr Mohaddes Foroushani[1], David Naylor[2]
Affiliation: [1]Concordia University, [2]Ryerson University
Contact email address: hua.ge@concordia.ca; seyedsepehr.mohaddes@ryerson.ca

facades under oblique winds (Fig. 3); and the performance of overhang is almost independent of the rainfall intensity (Fig. 4).

- Under certain wind and rain conditions, the overhang leads to a local increase in the catch ratio, which is an indication of the potential adverse effects that overhangs might have.
- When compared to the rain drop distribution and catch ratio contours on façades, the global effectiveness index appears consistent and provides a meaningful measure of the effects of the overhang.

To provide recommendations and design guidelines for effective overhang design, further development and validation of the CFD model is required:

- A full-scale measurement of WDR on a six-story building with adjustable overhang will be carried out and measured data will be used to further validate the CFD model;
- The time-dependent aspect of wind and rain will be included in the CFD model
- A more realistic urban environment taking into account the influence of surroundings will need to be included in the CFD model
- Once the CFD model is fully validated, a series of overhang configurations for a number of typical building geometries ranging from low-rise, medium-height to high-rise buildings will be investigated. A wind-driven rain database will be generated for different wind and rain conditions. The effectiveness of overhang for different climatic regions will be evaluated based on the statistical analysis of the wind and rain data of these regions.

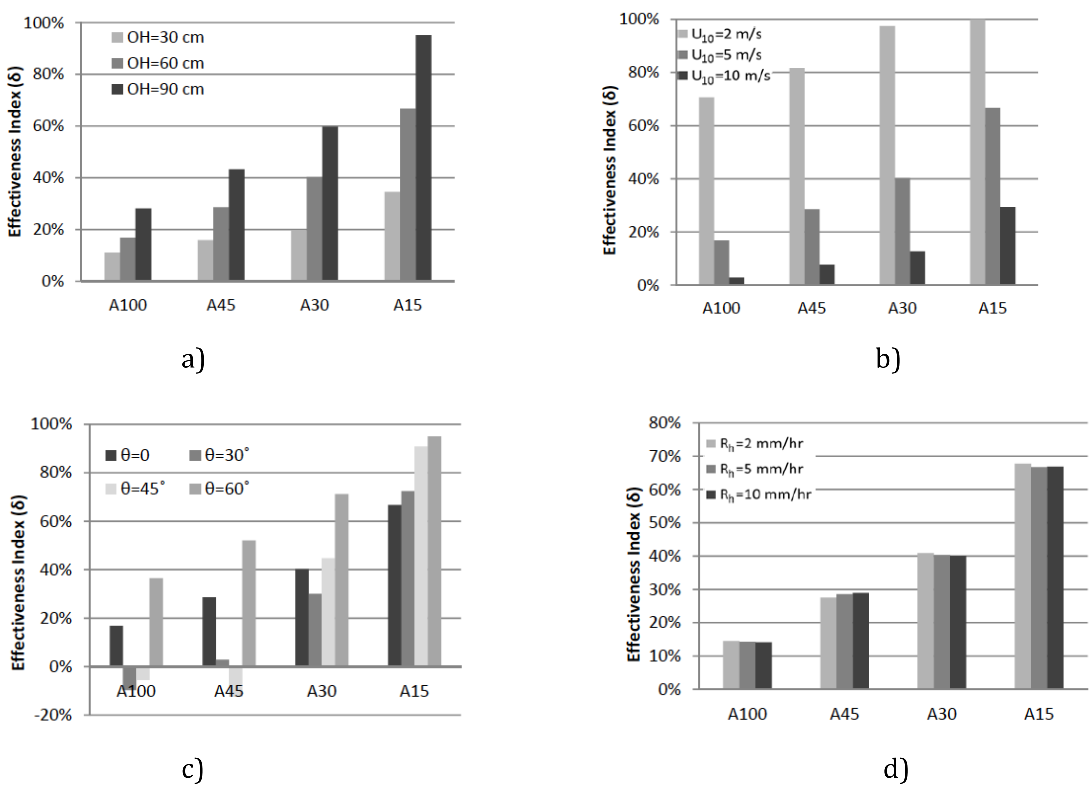

Figure 1. Effectiveness index of overhangs over different portions of the windward façade: a) different overhang sizes (θ=0o, U10=5 m/s, Rh=5mm/hr); b) 60cm overhang under different wind speeds (θ=60o, Rh=5mm/hr); c) 60cm overhang under different wind angles (U10=5 m/s, Rh=5mm/hr) and d) 60cm overhang under different rainfall intensities (θ=0o, U10=5m/s).