Keeping Open Spaces Dry Through Thoughtful Design

Wind Driven Rain Impacts
The desire for naturally ventilated public spaces has driven architectural design to be increasingly open to the local environment, particularly in East Asia, the Caribbean and other warm regions. In addition, many sporting venues and amphitheaters are also designed to be semi-exposed due to design choices or to meet international sporting regulations. Natural light, fresh air and a general increase in satisfaction with a space are all common benefits. However, as a space becomes more open, it becomes important to be able to predict and mitigate the impact of undesirable weather events on critical areas.

Experience has shown that rain will be carried by winds into any exposed areas and can negatively effect both safety (by making floors slick and exposing electrical systems to water) as well as occupant comfort. Overall usability of the space will then be compromised.

There is no universal criterion of how much wind driven rain is “too much” for a given space. That value depends on mainly on the intended use of the space, the architecture and cultural norms. Acceptability criteria are usually developed on a project-by-project basis.

It is also important to ensure that any mitigation measures taken do not create further problems in a different location. A holistic approach is required and simulating the effects of mitigation on both the rain infiltration as well as local air flows is necessary taking into account the frequency and severity of rain occurrences.

Process
- **Climate Analysis:** RWDI first looks at the meteorological record of the site to determine prevailing wind directions and speeds during rain events as well as the overall frequency and severity of the rain events. At this stage an estimate of rain infiltration risk can be developed based on the results of the climate analysis, the building massing, and droplet trajectory physics.

- **Air Flow Modeling:** If there appears to be sufficient risk for rain penetration, a computational fluid dynamics (CFD) model of the site and surrounding environment will be generated, and simulations conducted, for the wind direction(s) and speed(s) of interest. These simulations will account for the effects that the local built and natural environments will have on airflows, this also accounts for the effects of any proposed mitigation measures. RWDI can also leverage existing CFD models of the site from previous studies if available.

- **Rain Modeling:** RWDI simulates rain by inserting a cloud of spherical particles which are sized to average rain drop diameters. The position of each particle is then tracked as it moves through the site under the influence of gravity, drag and the airflows simulated previously. The distribution of particles on surfaces of interest is used to determine the relative “wetness” of those surfaces. Multiple droplet diameters can be tested to represent different rain events and a wetness ratio developed.
## Sample Project Listing

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Wadala Towers Development</td>
<td>Assessed rain infiltration potential through open “sky gardens” and façade openings into the core spaces of this 13 tower development.</td>
</tr>
<tr>
<td>Amphithéâtre de Trois-Rivières</td>
<td>Assessed potential rain penetration into audience and equipment areas, and provided guidance on positioning and size of protective rain-screens.</td>
</tr>
<tr>
<td>One George Street</td>
<td>Tested several strategies to mitigate wind driven rain infiltration into a partially exposed grade level area as well as the building lobby.</td>
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<tr>
<td>CenturyLink Field</td>
<td>Investigated rain infiltration potential into spectator areas beneath roof canopies.</td>
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<tr>
<td>Arthur Ashe Stadium</td>
<td>Designed and tested using CFD a screen to protect spectators from rain penetration under canopy.</td>
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## Amphithéâtre de Trois-Rivières

Trois Rivières, Quebec

RWDI investigated the potential for wind driven rain to reach the audience seating and equipment areas. Several potential rain-screen configurations were simulated and their ability to prevent rain from reaching the audience area was compared. Also, the effect of the rain screens on local wind flows was assessed to ensure that the mitigation measures did not drive rain into other potentially sensitive areas.

A frequency analysis based on historical weather data was conducted early to estimate likelihoods of rain events with winds strong enough to cause significant wetting of the critical areas within the amphitheatre.

Architectural rendering of Amphithéâtre de Trois-Rivières (top – courtesy of Architect: Paul Laurendeau & François Beauchesne in joint venture) and the CFD model used for the rain infiltration study (above). Initial rain screen positions are outlined in red.

Rain infiltration contours for various rain-screen configurations. Darker blue indicates increased potential for wetting. (Left)