

Consultant's Corner

Wind Tunnel Studies To Test or Not to Test?

by Mark Baker

The subject of wind tunnel testing may bring up a variety of questions for the glazing industry. For example, when does wind tunnel testing for cladding systems (to determine design wind pressures) make sense, and is it always permitted in lieu of calculations?

The document ASCE 7-98 “Minimum Design Loads for Buildings and Other Structures” provides three methods for calculating cladding design wind pressures:

- Method 1—Simplified procedure (for buildings less than 30-feet high);
- Method 2—Analytical procedure (per formula $p=q(GC_p)-q_i(G_{cpi})$);
- Method 3—Wind tunnel procedure.

Section 6.6.1 of the standard states, “Wind tunnel testing shall be permitted in lieu of methods one and two for any building or structure.”

Wind tunnel testing is considered more accurate than analytical calculation of cladding wind loads because it takes into account unusual building shapes, site location, immediate building surroundings and building surface characteristics. Analytical methods tend to be conservative as a result of simplification. For many regular-shaped low- or mid-rise buildings located in non-coastal areas, the analytical methods are perfectly adequate.

Recommended Testing Situations

However, for tall, non-rectangular buildings with unusual shapes located in extreme wind zones, wind tunnel testing is recommended. For instance, curved walls, set-backs and balconies have been shown to break up airflow, resulting in reduced design wind loads. Wind tunnel testing does not always reduce highest design loads, however, they do identify areas of the façade where the extreme loads occur.

Table 1 (see page 25) presents a comparison of cladding wind loads for a 400-foot building located in Dade County, Fla. determined using the analytical method (per ASCE 7-88) versus wind loads determined using the wind tunnel method.

Although the typical cladding loads did not change much, the magnitude of the peak negative pressures decreased dramatically. In addition, the peak loads occurred in very localized areas. It is not commonly known that wind tunnel studies to determine design loads for components and cladding systems are independent of tests to determine loads on the structure. Therefore, components and cladding tests can be commissioned alone, and at significantly less expense and time than a full-blown structural and cladding load test. Preliminary results for components and cladding wind load testing, including model construction, testing and analysis of data are typically available in six to eight weeks.

Learn from Others Mistakes

On a recent project, a developer retained our company early in the construction phase of the project to review the progress of the cladding package for a high-rise, oceanfront condominium. Our initial review revealed that the glazing contractor had designed and tested the windows and sliding glass doors at design loads significantly less than the design loads required for the project that had been calculated analytically. The subcontractor indicated that the products intended for the project would not meet the higher loads.

Based upon the building size (height), shape (non-rectangular), oceanfront location (exposure category D) and extensive balconies, we suggested that the developer authorize a wind tunnel study to determine cladding wind loads. Doing so reduced the design wind loads for most of the project to below the levels the glazing contractor had designed. Peak design loads identified during testing were addressed by the subcontractor with supplemental anchoring and reinforcement.

Our experience in South Florida is that the reduced cladding loads resulting in lower system costs often cover the cost of wind tunnel testing. Therefore, for glazing subcontractors involved in a major project, it is often in their best interest to suggest that the developer/architect/structural engineer consider conducting wind tunnel studies. The earlier in the process that the decision is made the better.

Not only is it important to identify projects that would benefit from wind tunnel studies, but the data must be reviewed properly with the design team, analyzed and decisions made based upon the results for the full benefit of the testing to be realized.

For example, on an extremely tall tower that was tested very early in the design phase of the project, design modifications were incorporated based upon preliminary wind tunnel studies that resulted in a reduction of the area and magnitude of the peak design wind pressures for the project.

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