SIGDERS Data Raise Questions About Edge Zones

By Philip D. Dregger, FRCI, RRC, PE

Meeting in Ottawa, Ontario, on September 21 and 22, 2011, A. “Bas” Baskaran and his National Research Council of Canada (NRCC) colleagues gave the Special Interest Group for Dynamic Evaluation of Roofing Systems (SIGDERS) consortium a detailed report about the recently completed Phase V SIGDERS research activities. He facilitated discussions outlining new goals and objectives for Phase VI of the research.

SIGDERS, established in 1994, represents a joint undertaking among the Canadian government and several North American roofing industry groups interested in dynamic evaluation of roofing systems. RCI has been a member of SIGDERS since 1997.

Over the last several years, SIGDERS has collected a range of data from three fully instrumented sites about how wind forces are transferred to mechanically attached single-ply membranes by real winds (i.e., as compared to winds generated in a wind tunnel). Detailed analysis of these data has confirmed many long-standing assumptions but has brought others into question.

For example, the data indicate that tensile loads transferred to fasteners securing roof membranes are well below levels predicted by ASCE 7 and conventional “tributary-area” type analysis. More recently, the data suggest that the distribution of maximum peak suction pressures near roof edges and corners may vary from those previously assumed.

ROOF EDGE ZONES MAY BE LARGER THAN EXPECTED

The long-held design assumption is that maximum wind-induced suction pressures on low-sloped roofs vary among field, edge, and corner zones by some set of ascending ratios (e.g., 1.0, 1.8, and 2.8, respectively). The dimensions of the corner and edge zones are currently established by comparing ratios of mean building height and least-horizontal roof dimension.

As indicated in *Figure 1*, data collected at the Rialto, CA, site during repeated strong Santa Ana wind events (>50-mph gusts), however, indicate a roughly uniform distribution of maximum uplift pressures in field, edge, and corner zones of the roof. The pressure taps positioned in “field” zones, but not too far from edge zones, indicated pressures in the same general range as those positioned within corner and edge zones. And the magnitude of the pressure in the “field” zone was much closer to that predicted using ASCE 7 for corner zones than for field zones. Santa Ana winds at the Rialto site approach the roof edge basically straight-on (i.e., perpendicular to the roof edge).

Among other things, these preliminary results, if confirmed, could mean that roof “edge” zones for some types of buildings and wind directions are considerably larger than currently believed.

After much discussion and troubleshooting of the field data, SIGDERS voted to expand the field monitoring task to a location somewhere in the southeastern U.S. in hopes of gathering data during a hurricane-speed wind event and verifying if similar high-magnitude suction pressure occurrences in the field zone are observed again.

These data are currently being reviewed as part of the ongoing SIGDERS research work. Upon approval, they will be presented to the RCI, Inc. members in March 2012 during RCI’s annual convention in Dallas.

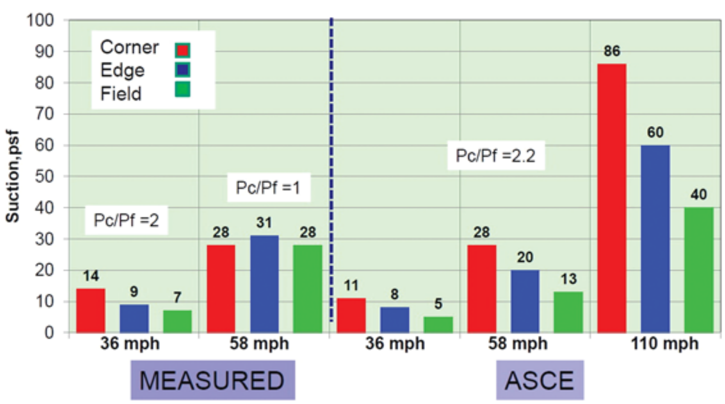

Figure 1 – Data collected at the Rialto, CA, site during repeated strong Santa Ana wind events (>50-mph gusts) indicate a roughly uniform distribution of maximum uplift pressures in field, edge, and corner zones of the roof. (Courtesy, NRCC.)

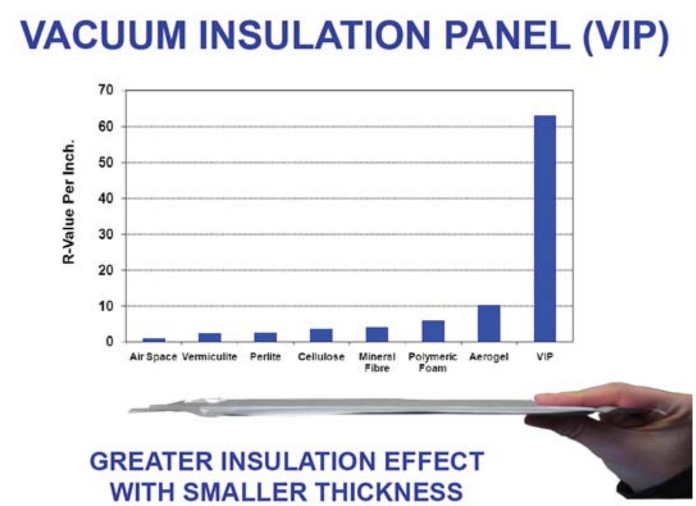

Figure 2 – SIGDERS wishes to research possible ways to practically incorporate very high-efficiency vacuum insulation panels into commercially viable roof systems. (Courtesy, NRCC.)

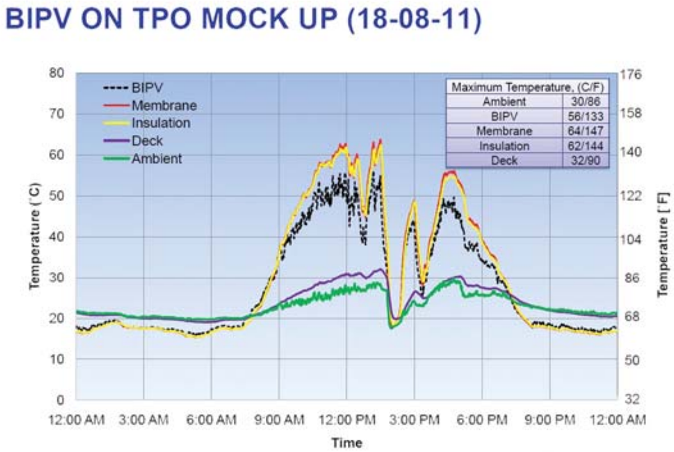

Figure 3 – Temperatures measured below a thin-film-type solar PV panel adhered to the surface of a TPO membrane. (Courtesy, NRCC.)

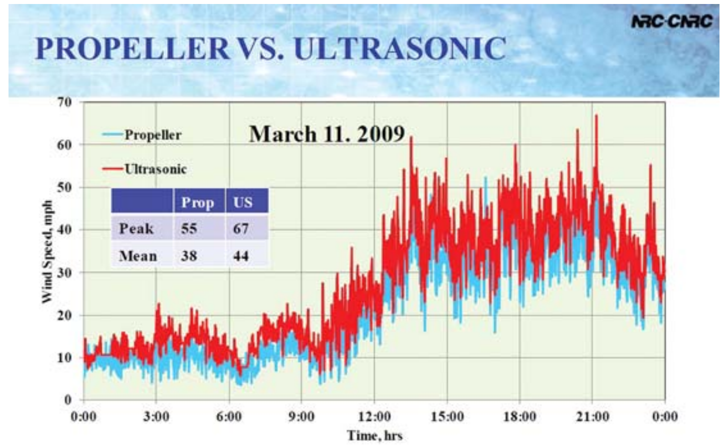

Figure 4 – "Peak" gust wind speeds recorded by ultrasonic (US) anemometers are consistently 10% to 20% higher than "peak" gust wind speeds recorded by propeller anemometers in side-by-side comparisons. (Courtesy, NRCC.)

PHASE VI OBJECTIVES

In addition to continuing field monitoring of roof system responses to high winds, Phase VI of the SIGDERS program will focus on some emerging technologies:

- **Viability of Vacuum Insulation Panels.** Research possible ways to practically incorporate very high-efficiency vacuum insulation panels (~R60/inch) into commercially viable roof systems through composite construction (see *Figure 2*).
- **Solar PV-Related Durability Considerations.** Conduct dynamic testing on assemblies consisting of roof coverings with offset-mounted solar PV panels above them. Record temperatures of roof system components (membrane, insulation, etc.) installed below and in direct contact with solar PV panels above. *Figure 3* indicates temperatures measured below a thin-film-type solar PV panel adhered to the surface of a TPO membrane.
- **Solar PV-Related Roof Wind Design.** Explore partnering with solar PV industry stakeholders to conduct full-scale wind tunnel tests and develop wind design guides focused on installation of solar PV arrays on low-sloped roofs.

SPECIAL INTEREST TO ROOF CONSULTANTS

Excerpts from the day and a half of technical presentations that were of particular interest to this reporter follow:

- "Peak" gust wind speeds recorded by ultrasonic (US) anemometers are consistently 10% to 20% higher than "peak" gust wind speeds recorded by propeller anemometers in side-by-side comparisons conducted at three different locations. *Figure 4* indicates data recorded one day at one side-by-side location. Roof professionals should keep this difference in mind when investigating roof wind damage and confirm if maximum gust wind speed information on which they rely was recorded by a US or propeller-type anemometer.
  Note: In this author's experience, wind speeds reported by weather stations at most major airports are now obtained by US anemometers, while wind speeds reported by most fully automated (and often remote) stations are obtained by propeller-type anemometers.
- When located on top of a roof, an anemometer needs to be positioned above the roof surface at least half the height of the building (>0.5 H) to safely avoid turbulence and accelerations caused by the wind stream being diverted up and over a building with a low-slope roof.
- Field monitoring of winds in the 55- to 60-mph range indicated that:
  — Although maximum wind "events" (time at or near maximum wind) may linger about 12 seconds, maximum tension stress "events" in the membrane (time at or near maximum stresses) lasted only about four seconds.
  — The maximum pressure between the mechanically attached membrane and the rigid board insulation (no vapor retarder) was only about 30% of the total pressure difference (i.e., the pressure difference between air inside and outside of the building just above the roof membrane).
  — Winds with gusts on the order of 20 mph were needed before the roof membrane would noticeably flutter upward, and winds with gusts on the order of 30 mph were needed before significant loads began to be transferred to the roof membrane fasteners.

For more information about SIGDERS, its formation, members, and publications, see www.sigders.ca.

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