

Takeaways From ASTM's Symposium on Roofing Research and Standards Development

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On December 6, 2015, ASTM Technical Committee D08 on Roofing and Waterproofing hosted the eighth symposium in the series, “Roofing Research and Standards Development.” I was honored to have cochaired the symposium with Dr. Sudhakar Molleti of the National Research Council of Canada. By all accounts from the many gratifying comments that the attendees relayed after the symposium ended, it was an exciting and stimulating success.

Ten papers were presented during the course of the day, although 11 were included in the symposium proceedings. The proceedings are compiled in ASTM Selected Technical Papers (STP) 1590 (2015) and are available for a nominal fee from the ASTM bookstore (http://www.astm.org/DIGITAL_LIBRARY/STP/SOURCE_PAGES/STP1590.htm).

I would like to provide a flavor of the papers and their practical significance. In this regard, I call your attention to the following two papers:

- “Developing a Test Method for a Very Severe Hail Rating for Low-Slope Roofing Assemblies,” coauthored by Daniel A. Boardman and Daniel E. Brown of FM Approvals, Norwood, MA.
- “Understanding the Puncture Resistance of Thermoplastic Polyolefin

Membranes,” coauthored by Sarang Bhawalkar, Tammy Yang, and Thomas J. Taylor of GAF, Parsippany, NJ.

While having diverse titles, both papers dealt with the impact performance of low-sloped roof membrane assemblies. The respective coauthors independently developed the papers for reasons specific to their organizations’ needs without each other’s knowledge. After their back-to-back presentations, the audience quickly grasped that some conclusions of each paper were complementary to those of the other paper. I believe it worthwhile to pass on, in summary form, a few of their details and conclusions. Readers with an interest in the full details are referred to the papers themselves.

VERY SEVERE HAIL RATING

The motivating force for the Boardman and Brown paper is that insurance industry losses due to hail have been increasing. Additionally, a region of the United States comprising Oklahoma, Kansas, and several northern counties of Texas has been identified as a very severe hail region. A rating system for classifying low-sloped assemblies intended for use in that region is not available, but is needed.

ANSI/FM 4473, *Impact Resistance Testing of Rigid Roofing Materials by Impacting With Freezer Ice Balls*, is available

for steep-slope roofing and includes a maximum Class 4 rating requiring test specimens to withstand 2-in. ice sphere impacts with a kinetic energy of 23.8 to 26.1 ft-lbf. Because the ANSI/FM 4473 test does not apply to low-sloped assemblies, the testing described in the paper was conducted to investigate the applicability of the method to low-sloped systems. The testing also provided opportunity to study the use of freezer ice balls for impacting the low-sloped roofing materials considered to be less rigid than those for steep roofing assemblies.

A total of 34 membrane test specimens were prepared. The specimen membrane covers included EPDM, PVC, TPO, SBS-modified bitumen, APP-modified bitumen, and built-up roofing products from a number of manufacturers and with varying thicknesses. FM Approvals had previously classified these products for severe hail. Two impacts were performed at each location. The acceptance criteria were pass/fail with a specimen failing when a tear or crack through the membrane cover was observed.

The test results showed that 18 of the 34 test specimens (i.e., 53%) experienced tears and cracks in the membrane covers. Because these covers had previously passed a severe hail test, these results indicated that the testing described in the study was differentiating and more severe than that used for the severe test classification. The authors concluded that the test shows

promise as the basis for a severe hail test.

Specific findings in the testing included:

- Failure was not apparent on some specimens until after the second impact.
- More failures occurred with lower density iso board substrates than with gypsum board substrates.
- More failures occurred with thin membrane covers than with thick covers.
- In some cases, damage occurred to the membrane substrate when no damage to the membrane cover was observed. This raised concerns that hail in practice could unknowingly compromise the uplift resistance of an in-place assembly.
- Two thirds of all failures in the testing occurred due to impacts at fastener/metal plate locations.

Although not specifically addressed in the paper, this latter finding raises questions regarding whether it is prudent to use mechanically fastened assemblies with the plates and fastener heads directly below the membrane in areas that may experience severe hail.

TPO PUNCTURE RESISTANCE

Bhawalkar, Yang, and Taylor initially describe that puncture or impact resistance for single-ply membranes is currently ill-defined. As a consequence, they undertook the study to investigate various modes of TPO membrane puncture using test specimens with varying membrane thicknesses, substrates, and attachment methods.

Three types of test methods were included. One method used a low-speed puncture

(<20 in./min.) akin to stepping on a sharp object setting on the membrane. Another method used a high-speed puncture (>20 in./min.) similar to dropping a tool or piece of equipment. The third method was hail testing based on the ANSI/FM 4473 test using 2-in. ice spheres with a kinetic energy of 23.8 to 26.1 ft·lbf. (Note that this testing was comparable to that done by Boardman and Brown.)

The membrane samples included 60-mil sheets representing products from four major TPO manufacturers, as well as 45-mil and 80-mil sheets from one of those four manufacturers. In addition, fleece-backed sheets of different thicknesses and varying fleece weights from a single manufacturer were included.

Significant conclusions given by Bhawalkar, Yang, and Taylor included:

- For both the low-speed and high-speed puncture tests, the membrane specimens from the four manufacturers performed comparably.
- Puncture resistance is a function of thickness and reinforcement. Regardless of puncture speed, thicker membranes had increased resistance. Likewise, fleece backing provided improved resistance. Cover boards always improved performance, with the improvement dependent of the type of impact and cover board.
- In many hail tests, there was unobserved damage to the membrane substrate even though there was no visible damage to the membrane. The data obtained allowed the authors to make specific recommendations for preferable substrates to

be used under TPO membranes in severe hail regions.

- In the hail testing, all TPO membranes tested in the field of the specimen passed as long as there was not an insulation fastener under the point of impact. Similarly, all lap seams tested passed, provided there was not a fastener under the point of impact. In contrast, all TPO specimens, regardless of the membrane thickness, failed when impacted above a metal fastener.

Based on this latter finding, the authors remarked, "This result clearly suggests TPO installations in high-hail areas should consider fully adhered methods of attachment for both the membrane and the top layer of insulation or cover board." Note how remarkably similar this finding is to that made independently by Boardman and Brown, although they did not provide as specific a recommendation on using fully adhered assemblies as Bhawalkar, Yang, and Taylor did.

In summary, these two papers have an abundance of information regarding hail and puncture resistance of low-slope roofing membrane products. Building envelope consultants practicing in severe hail regions should familiarize themselves with the data and recommendations in the papers. An important takeaway: Serious consideration should be given to the types of membrane assemblies installed in severe hail areas to minimize the risk of hail failure. In the extreme, this includes avoidance of mechanically attached systems with fasteners and plates placed directly under the membrane cover.

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