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A White Paper: Impact Testing of Impact-Resistant Shingles

An increasing number of asphalt roof shingles are being touted for their hail impact-resistance. Hail resistant shingles are desired because the process of removing and replacing a roof is costly and disruptive. Furthermore, many property insurance carriers offer significant discounts on insurance premiums when impact-resistant shingles are installed. Haag Research & Testing Co. (HRT) performed a study on impact-resistant asphalt roof shingles to evaluate their performance.

The study involved testing five different impact-resistant shingles with two different impact testing protocols. One of these protocols (UL 2218) subjects roofing products to steel balls dropped from specified heights, developing kinetic energies that are comparable to free-fall energies of hailstones measuring 1-1/4, 1-1/2, 1-3/4, and 2 inches in diameter. Products that pass the test are given impact ratings of Class 1, 2, 3, or 4, respectively. The other protocol (ANSI/FM 4473) subjects roofing products to propelled ice balls measuring 1-1/4, 1-1/2, 1-3/4, and 2 inches in diameter, at specified kinetic energies that comport to energies of free-falling hailstones of these sizes. Products that pass ANSI/FM 4473 are also given Class 1, 2, 3, or 4 ratings.

The impact testing standards specify certain impact locations and the number of impacts. Specified locations are to include edges, corners, unsupported areas, overlaps, and joints. Two coincident impacts are to be made at each location, requiring the second impact to strike within 1/2 inch of the first impact. The purpose of impact testing edges, corners, unsupported areas, overlaps, and

joints is because these areas are particularly vulnerable to impact damage. The coincident impact is to determine if the first impact weakened the product such that a second impact at that location might cause damage. Both procedures specify visual examination of the tested products to determine if the products passed or failed to pass the tests. The UL 2218 protocol also requires 5X magnification during visual examination.

In addition to following the hail impact testing protocols during this study, HRT utilized hot solvent desaturation procedures to extract the reinforcements from the shingles by dissolving the asphalt or modified asphalt bitumen from the shingles. This allowed the shingle reinforcements to be examined for fractures or strains caused by the impacts without hand manipulation which can initiate damage.

All of the shingles selected for testing by HRT had UL 2218 class ratings, including four Class 4 and one Class 3 rating. None of the shingles had ANSI/FM 4473 class ratings. The flexible nature of asphalt shingles tends to make them more resistant to steel ball drop testing than ice ball impact testing and it could be this reason asphalt shingle manufacturers tend to favor UL 2218 over ANSI/FM 4473. All of the tested shingles were new, and specimens were from four different manufacturers. One of the shingles had modified asphalt, three of the shingles were laminated (architectural) varieties, two were thick high-profile designs, and four had additional reinforcement backing on the bottom of shingle exposures. This selection provided a relatively wide range of shingle designs and a covered a variety of shingle manufacturers.

The pass/fail criteria in the UL 2218 and ANSI/FM 4473 test procedures involve only visual inspection after testing. UL 2218 calls for bending flexible materials over a four-inch-diameter mandrel to aid the visual examination for fractures; however, bending the tested shingles over a mandrel would damage the shingles due to their design, invalidating the tests. Two of the Class 4 rated shingles tested in this study passed the UL 2218 Class 4 test and the other three shingles (including the Class 3 rated shingle) failed to pass a Class 1 test. One of the Class 4 shingles passed Class 3 ANSI/FM 4473, and the other four shingles failed to achieve Class 1 ratings. Both shingle designs that passed UL 2218 Class 4 and the shingle that passed ANSI/FM 4473 Class 3, had additional reinforcement backing. These pass/fail determinations were made only using visual examination procedures described in the test standards. Upon extracting the reinforcements utilizing solvent desaturation, HRT discovered fractures in the shingle reinforcements of all shingles at Class 1 and higher for both steel ball and ice ball tests. Consequently, both testing protocols failed to accurately ascertain the performance of the shingles.

The reinforcement backing on some shingles obscured the fractures from view, giving false indications the shingles had survived the impact testing unscathed. Both test procedures fall short of determining the impact resistance of asphalt shingles (and other bituminous roofing products) because the reinforcements (structural element of the shingle) are not examined for impact-caused fractures or strains.

Although the absence of reinforcement examination through the desaturation process resulted in some shingles passing Class 3 or Class 4 criteria, most of the shingles failed to achieve even a

Class 1 rating from either test even before desaturation. Given the consistent nature of gravity, the consistent properties of steel balls, and the specific testing requirements prescribed by the standards, there should be minimal differences in test results (if any) between accredited testing laboratories if the procedures in the standards are strictly followed. HRT is an accredited testing laboratory by the International Accreditation Service (IAS) and is accredited to perform both UL 2218 and ANSI/FM 4473 tests, as well as desaturation testing.

Desaturation of bituminous roofing products is a well-established procedure for laboratory examination of reinforcements following impact testing procedures. ASTM D3746, *Standard Test Method for Impact Resistance of Bituminous Roofing Systems,* is a long-standing test procedure for determining the impact resistance of asphalt built-up roofing (ABUR). This standard calls for extraction of reinforcements via the use of a suitable solvent. HRT performs desaturation analysis during forensic examinations of roofing involved in insurance claims and legal disputes and has done so for decades. In order to improve the validity of current hail impact testing standards, HRT recommends modifying the UL 2218 and ANSI/FM 4473 testing protocols by adding examination of reinforcements by utilization of solvent extraction to the pass/fail criteria for determining the impact resistance of bituminous roofing products. Implementation of solvent extraction in these test procedures would increase the confidence of consumers, insurers, insurance regulators, and roofing contractors, that the stated performance of these roofing products is accurate. Further, this could encourage roofing manufacturers to improve the impact resistance of their products to meet the more stringent criteria in these tests.

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