

Performance of Hurricane Shutters Under Impact by Roof Tiles

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Project motivation: An experimental investigation evaluated the performance of shutter systems designed to protect windows from windborne debris during hurricanes. Damage to windows is a common failure during hurricanes, and can lead to significant additional damage due to rain water ingress and increased wind loading on the roof and walls. The Florida Building Code addresses this issue by requiring the use of window protection (e.g. metal shutters) for residences close to the coast (Windborne Debris Region). Hurricane Charley (2004) produced evidence that the use of window protection is an effective mitigation, reducing the probability of window damage by at least a factor of 2.5 relative to unprotected windows. However, some code approved opening protection systems failed due to impact from roofing tiles, a commonly used roof cover in many hurricane prone regions. Window protection products must undergo impact tests using a nine pound 2x4 piece of lumber, to evaluate their ability to deflect windborne debris without breaking the glass being protected. This study replaces the 2x4 piece of lumber with a roof tile, to document the vulnerability of window protection systems to damage from a common debris type.

Project scope and results: Post-hurricane damage studies indicate that roof tiles are a primary source of windborne debris in residential areas with predominantly tile roof cover. Florida Building Code approved steel and aluminum storm panel shutters of various thicknesses 180 were impacted with a nine pound roof tile, and 60 were impacted with a nine pound 2x4 lumber, both at the code required speed of 35 mph. Deflections were recorded to determine the potential damage to glass behind the shutter. The results indicate that there is a significant difference in the deflection of the tested panels when impacted by roof tiles and 2x4 lumber of identical weight, speed and impact location. The implication is that the deflection of the metal panel window protection system is sensitive to debris type. In most tests, the deflection imparted by a tile impact exceeded the specified setback from the glass, as determined by 2x4 lumber tests. Although the tested products did conform to the requirements for product certification; current product testing using a 2x4 lumber does not provide a performance evaluation that is conservative with regard, to the protection of windows from tile debris commonly observed in post hurricane damage studies.

Summary Outcome: The tested window protection products are likely to allow glass breakage if impacted by roof tiles propelled by hurricane winds. This is by no means a rejection of the value of using window protection, which is vitally important to mitigate a very common cause of residential damage. Rather, the study presents evidence that questions the efficacy of applying the current debris impact test standard, to evaluate shutter systems intended for use in neighborhoods where tile roof cover is dominant.

The complete study has been documented in the following peer reviewed journal publication:

Fernandez, G., Masters, F., Gurley, K. "Performance of Hurricane Shutters Under Impact by Roof Tiles," *Engineering Structures*, 32(10): 3384-3393, 2010.