Demonstrating Product Compliance with Tornado and Hurricane Requirements

It can be challenging to keep pace with the changing building code requirements for product approval. Tornado performance requirements can now be added to the list of optional performance requirements for building products. This informational bulletin seeks to clarify the requirements for demonstrating product compliance with various tornado and hurricane requirements.

General Requirements
The minimum performance requirements for demonstrating tornado and hurricane resistance are addressed by FEMA 361 and ICC 500. For tornadoes, one specimen of each product is tested for the wind speeds as shown in Table 1 and for impact resistance. For hurricanes, one specimen of each product is tested for the wind speeds as shown in Table 1, for impact resistance, and for pressure cycles after impact resistance testing as further described herein. By contrast, Miami-Dade County and ASTM E 1886 / E 1996 require that three identical specimens of each product be tested for hurricane-resistance requirements.

Tornado and hurricane resistance requirements are similar, but they differ in a few areas:

1. Different 2x4 missile specifications (see Table 2)
2. Different missile impact speeds (see Table 2)
3. Only hurricane-resistance requires pressure cycling after impact resistance

Where FEMA 361 and ICC 500 requirements diverge, the most stringent requirement governs.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Minimum Design Wind Speed (mph)</th>
<th>Maximum Design Wind Speed (mph)</th>
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</thead>
<tbody>
<tr>
<td>Tornado</td>
<td>130</td>
<td>250</td>
</tr>
<tr>
<td>Hurricane</td>
<td>160</td>
<td>225 (Southern-most tip of Florida)</td>
</tr>
<tr>
<td></td>
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<td>255 (Guam)</td>
</tr>
</tbody>
</table>
**Wind Speed**

- **Tornado Wind Speeds Map (from FEMA 361)**
- **Hurricane Wind Speeds Map (from FEMA 361)**

**Pressure Testing**
Positive and negative static pressure-testing of the fenestration product is conducted per ASTM E 330 at 1.2 x Design Pressure (DP). Doors are tested only in the weaker direction (i.e. away from the door stops). The DP varies depending on the area of the country in which the product is intended for use and installation (refer to FEMA wind speeds maps herein).

For hurricane-resistance requirements, if a door without glazing is static pressure-tested to 1.5 x DP, it is exempt from pressure cycling tests after impact resistance.

**Impact Resistance**
The fenestration product is impacted two times in the glazing infill with a 2x4 meeting the specifications as shown in Table 2. For tornadoes, the 2x4 travels at a velocity specific to the design wind speed level up to the maximum wind speed shown in Table 2. For hurricanes, the 2x4 travels at a velocity of 1/2 of the design wind speed up to the maximum wind speed listed in Table 2. Doors are also impacted on the glazing (if applicable) as well as on the door panel at a hinge, at the lock handle, at the upper latch point (shoot bolt), and at the midspan of the astragal (if a double door) and/or the midspan of the mullion, if applicable. A product must meet the following criteria after impact testing:

1. There can be no perforation of the interior surface of the tested component.
2. Dislodgement and/or disengagement of the specimen or fasteners shall be demonstrated harmless by failing to perforate a #70 kraft paper witness screen located 5" from the interior surface of the specimen.
3. There can be no spalling (fragment) that perforates a #70 kraft paper witness screen located 5" from the interior surface of the specimen.
4. Permanent deformation to the interior of the specimen must be less than 3".

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**Table 2**

<table>
<thead>
<tr>
<th></th>
<th>2x4 Specifications</th>
<th>Missle Impact Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tornado</td>
<td>15 lb / 13' 6&quot; long</td>
<td>100</td>
</tr>
<tr>
<td>Hurricane</td>
<td>9 lb / 8' 0&quot; long</td>
<td>128</td>
</tr>
</tbody>
</table>

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**Notes:**
1. Values are nominal three second gust wind speeds in miles per hour at 33 ft above ground for Exposure Category C.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Multiply miles per hour by 0.447 to obtain meters per second.
Pressure Cycling (for hurricanes only)

After impact resistance testing, the fenestration product is subject to pressure cycling per ASTM E 1886 to meet hurricane-resistance requirements. As stated above, doors without glazing that are static pressure-tested to 1.5 x DP are exempt from pressure cycling tests after impact resistance. A product is considered to have passed if it meets these requirements: no deglazing that would allow air to infiltrate the fenestration product (ASTM E 1996); no cracks larger than 5” x 1/16” (ASTM E 1996); and doors remain shut and latched (FEMA 361).

Conclusions

Methods for demonstrating a product’s tornado-resistance are similar to methods for demonstrating a product’s hurricane-resistance. These methods can be combined into a single test plan, as long as the test plan is designed to account for the differences in requirements upfront. Miami-Dade County and ASTM E 1886 / E 1996 requirements can be combined into the same test plan as well, bearing in mind that three samples must be tested.

References

ASCE 7-05, “Minimum Design Loads for Buildings and Other Structures”


ASTM E 1886-05, “Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials”


Testing Application Standard (TAS) 201, 202, and 203 (for Miami-Dade County)

About Architectural Testing

Architectural Testing is the one-stop solution for your tornado and hurricane resistance testing. Their experienced staff is committed to assisting you through all of the requirements, including calculations, testing, and reporting. At your request, the test report may be reviewed and sealed by a Professional Engineer. To meet your needs, Architectural Testing currently has a staff of Professional Engineers licensed in 17 different states: CA, DE, FL, IN, MA, MD, MI, MN, NC, NY, OH, PA, SC, TX, VA, WA, and WI.

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