TESTING APPLICATION STANDARD (TAS) 117(A)-95

TEST PROCEDURE FOR WITHDRAWAL RESISTANCE TESTING OF MECHANICAL FASTENERS USED IN ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 This protocol covers determination of the withdrawal resistance performance of fasteners used for the mechanical attachment of anchor sheets, insulation panels, base sheets and single ply membranes when installed in various substrates and exposed to axial symmetric loading.

1.2 The test procedures outlined herein utilize both static and pulsating loads. In the case of asymmetrical loading, the test results shall be evaluated separately.

1.3 All testing and calculations shall be conducted by an approved testing agency and all test reports, including calculations, shall be signed by a Registered Design Professional per F.S., Section 471 or 481.

2. Referenced Documents:

2.1 *The Florida Building Code, Building*.

2.2 *ASTM Standards*

D 1079 Standard Definitions and Terms Relating to Roofing, Waterproofing and Bituminous Materials

E 380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.3 *Norwegian Building Research Institute* Roofing Systems With Mechanical Attachments

3. Terminology & Units:

3.1 Definitions—For definitions of terms in this protocol, refer to Chapter 2 and Section 1513 of the *Florida Building Code, Building* and ASTM D 1079. Definitions from the *Florida Building Code, Building* shall take precedence.

3.1.1 The withdrawal resistance value under static load shall be defined as the mean load capacity obtained during testing under static load.

3.1.2 The withdrawal resistance value under pulsating load shall be defined as the mean capacity obtained, or the mean capacity when permanent deformation greater than 0.25 inch (6.3 mm).

3.2 Units—For conversion of U.S. customary units to SI units, refer to ASTM E 380.

4. Significance and Use:

4.1 The test procedure provides a means of determining of the withdrawal resistance performance of fasteners used for the mechanical attachment of anchor sheets, insulation panels, base sheets and single ply membranes when installed in various substrates and exposed to axial symmetric loading. The test procedure is acceptable for all types of fasteners used for the mechanical attachment of roof coverings, such as self-threading screws, various types of expansion anchors, wood deck fasteners, nails, etc. The substrate material may be steel, concrete, gypsum, cementitious wood fiber, lightweight concrete, wood, or composite deck systems.

5. Sampling:

5.1 Samples shall be tested as delivered and shall be provided directly from the fastener manufacturer. Unless otherwise specified, 14 samples shall be tested for each type of load (i.e., 14 for static load and 14 for pulsating load).

6. Test Method:

6.1 General:

6.1.1 The withdrawal resistance value under static load is determined through uniformly increased load

applied to the fastener. For structural concrete, this uniform load increase is based on vertical deflection rate of $^1/_2$ inch (12 mm) per minute. For all other deck types, this uniform load increase is based on vertical deflection rate of 2 inches (50 mm) per minute.

6.1.2 The withdrawal resistance value under pulsating load is determined through incrementally increased pulsating load applied to the fastener.

6.2 Apparatus:

6.2.1 A tensile loading device which can be operated with both static and pulsating tensile forces.

6.2.2 A load cell to measure the applied load.

6.2.3 A deflection or deformation gauge.

6.2.4 A holding device.

6.2.5 A load transfer device for applying load to the fastener. The top disc shall bear on a steel plate having a $^7/_{16}$ inch (11 mm) slot and a 1.2 inch (30 mm) diameter hole.

6.3 Preparation of test samples:

6.3.1 The fasteners shall not be prepared in any way; however, fasteners shall be installed in compliance with the fastener manufacturer's published installation instructions using the installation tool recommended by the fastener manufacturer for deck type being tested. If the tested fastener is designed for use as an insulation fastener, the fastener shall be installed through insulation.

6.3.2 Substrate–metal decks:

- The fastener samples shall be installed into the top flange of the metal profile, not in the flute. Fastener samples shall be installed as close to the center of the top flange as possible.
- Fasteners shall be tested on the day of installation.
- A minimum of 14 samples shall be tested for each type of load (i.e., 14 for static load and 14 for (pulsating load).

6.3.3 Substrate—structural concrete decks:

- Unless otherwise specified, structural concrete test samples shall be 12 inch by 12 inch square by 3 inch thick (300 mm by 300 mm by 76 mm) slabs having a compressive strength of 3,000 psi.
- Concrete test samples shall have cured for a minimum of 28 days prior to fastener installation. Fasteners shall be tested on the day of installation. Not more than 3 fastener samples shall be installed per concrete slab.
- The predrilled hole for each fastener sample shall be at not less than $^1/_2$ inch (12 mm) deeper than the required attachment depth for the fastener sample to allow for concrete powder fill in the predrilled holes. It is acceptable for the predrilled hole to penetrate the concrete substrate sample.
- A minimum of 14 samples shall be tested for each type of load (i.e., 14 for static load and 14 for pulsating load).

6.3.4 Substrate–gypsum decks:

- Gypsum test samples shall be 6 inch diameter by 3 inch deep (150 mm diameter by 76 mm deep) poured gypsum cylinders or 6 inch by 6 inch square by 3 inch deep poured gypsum blocks.
- Gypsum test samples shall have cured for a minimum of 28 days prior to fastener installation and fasteners shall

be tested on the day of installation. Not more than 1 fastener sample shall be installed per gypsum cylinder.

- A minimum of 14 samples shall be tested for each type of load (i.e., 14 for static load and 14 for pulsating load).

6.3.5 Substrate—cementitious wood fiber decks:

- Cementitious wood fiber test samples shall be 6 inch by 6 inch (150 mm by 150 mm) samples having a thickness of 2 inches, 2 $^1/_4$ inches, 2$^1/_2$ inches or 3 inches (50 mm, 57 mm, 63 mm or 76 mm).
- Cementitious wood fiber test samples require no curing time prior to fastener installation. Fasteners shall be tested on the day of installation. Not more than 1 fastener sample shall be installed per cementitious wood fiber sample.
- A minimum of 14 samples shall be tested for each type of load (i.e., 14 for static load and 14 for pulsating load).
- Results from fastener testing in thinner substrate samples may be utilized as a design value for applications over a thicker substrate (i.e., results from fastener testing in 2 inch substrate samples may be utilized as design values in 3 inch cementitious wood fiber). However, results from testing in thicker substrate samples may not be utilized as a design value for applications over thinner substrates.

6.3.4 Substrate–Lightweight concrete decks (aggregate, cellular or hybrid):

- Lightweight concrete test samples shall be 6 inch by 6 inch by 3 inch deep (150 mm by 150 mm by 76 mm deep) poured lightweight concrete samples.
- Two sets of 14 lightweight concrete test samples shall be tested for withdrawal resistance under static load. The first set of 14 samples shall have cured 3 days prior to fastener installation. The second set of 14 samples shall have cured 28 days prior to fastener installation. Fasteners in both sets of 14 lightweight concrete samples shall be tested on the 28th day of curing. Not more than 1 fastener sample shall be installed per lightweight concrete sample.
- The withdrawal resistance value under static load shall be the greater of the two mean values determined in compliance with Sections 6.4.1 and 6.5, herein.
- A minimum of 14 samples shall be tested for withdrawal resistance under pulsating load using the withdrawal resistance value under static load, noted above, to determine the pulsating load interval noted in Section 6.4.2. Test samples for withdrawal resistance under pulsating load shall be constructed in the same manner as those which yielded the withdrawal resistance value under static load.

6.4 Procedure:

6.4.1 Withdrawal resistance under static loading:

- The withdrawal resistance under static load shall be tested first.
- The test specimen, consisting of the installed fastener and substrate samples, shall be secured in the tensile loading device in such a manner that any bending or shear loads are avoided.
- The tensile loading device shall be operated at a vertical deflection rate of $^1/_2$ inch (12

mm) per minute for testing in structural concrete and a vertical deflection rate of 2 inches (50 mm) per minute for testing in all other substrates.

- The withdrawal resistance value under static load shall be the mean of 12 test results after eliminating the "high" value and the "low" values, providing the statistical analysis criteria, noted in Section 6.5, are met.
- The withdrawal resistance value under static load shall be calculated and documented prior to testing for withdrawal resistance under pulsating load.

6.4.2 Withdrawal resistance under pulsating loading:

- The withdrawal resistance under pulsating load shall be tested using the documented withdrawal resistance value under static load, determined above.
- The initial pulsating load interval shall be $^1/_5$ of the withdrawal resistance value under static load after this value is rounded to the next whole 10 lbf (45 N).
- Pulsating load interval increments shall be $^1/_5$ of the withdrawal resistance value under static load after this value is rounded to the next whole 10 lbf (45 N). The minimum load increment shall be 10 lbf (45 N).
- Each pulsating load interval shall consist of 200 load cycles (i.e., loading and unloading). Subsequent to each pulsating load interval, the tensile loading device shall be set to the next pulsating load interval, increasing the previous load interval by the predetermined load interval increment, until failure occurs.
- For tests which exhibit elastic deformation, the load cycle speed is increased at pulsating load interval #3 and in all subsequent intervals. The intent is to maintain the same total testing time as in pulsating load interval #2. Deformations at each load interval shall be recorded.

6.5 Statistical analysis of results:

6.5.1 Eliminate the "high" and "low" values recorded during withdrawal resistance testing under static load and calculate a mean and a standard deviation from the remaining 12 recorded values using the following equations.

$$F = \frac{1}{12}\sum_{i=1}^{12} F_i \qquad \text{and,}$$

$$S_F = \sqrt{\frac{1}{11}\sum_{i=1}^{12}\left(F_i - \overline{\mathrm{F}}\right)^2} \qquad \text{where,}$$

$\overline{F}$ = mean load;

S_F = standard deviation;

F = record load; and,

i = test number

6.5.2 Determine the percent deviation from the mean (S'_F) using the following equation.

$$S'_F = \left(\frac{S_F}{F}\right)\times 100$$

If the percent deviation from the mean (S'_F) is greater than 20 percent, then the test results shall be considered null and void and the withdrawal resistance performance under static load shall be retested.

6.5.3 Eliminate the "high" and "low" values recorded during withdrawal resistance testing under pulsating load and calculate a mean and a standard deviation from the remaining 12 recorded values using the equations noted in Section 6.5.1.

7. Report:

7.1 The final test report shall include the following relevant information:

7.1.1 Name and address of the testing laboratory.

7.1.2 Identification number of the test report.

7.1.3 Name and address of the organization or the person who ordered the test.

7.1.4 Purpose of the test.

7.1.5 Method of sampling and other circumstances (date and person responsible for the sampling).

7.1.6 Name and address of manufacturer or supplier of the tested object.

7.1.7 Name or other identification marks of the tested object.

7.1.8 Description of the tested object.

7.1.9 Date of supply of the tested object.

7.1.10 Date of the test.

7.1.11 Test method.

7.1.12 Conditioning of the test specimens, environmental data during the test (temperature, pressure, RH, etc.).

7.1.13 Identification of the test equipment and instruments used.

7.1.14 Any deviations from the test method.

7.1.15 Test results and statistical analysis computations.

7.1.16 Date and signature.