FLORIDA DEPARTMENT OF TRANSPORTATION
State Materials Office
5007 NE 39th Avenue
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Florida Method of Test
for
ANCHOR SYSTEM TESTS FOR ADHESIVE-BONDED ANCHORS AND DOWELS

Designation: FM 5-568

1. SCOPE

This document describes the test methods for determining the bond strength and performance characteristics of adhesive-bonded anchors and dowels in structural applications of connections to uncracked concrete. This method is applicable to products specified under FDOT Standard Specifications Section 937 and installed under Section 416.

2. OUTLINE OF METHOD

2.1 Proposed adhesive products are used to bond threaded steel anchor rods to concrete test members under various installation conditions. Cured specimens are then tested for response to various loading and exposure conditions.

2.2 Referenced Documents

2.2.1 American Society of Testing and Materials, Philadelphia

ASTM E 488 “Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.”

ASTM E 1512 “Standard Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors.”

2.2.2 Standard Specifications for Road and Bridge Construction, Florida Department of Transportation.

Section 416 “Installing Adhesive-Bonded Anchors and Dowels.”
Section 937 “Adhesive-Bonded Anchors and Dowels”

3. TERMINOLOGY

3.1 Terms used in this document shall have the following meanings:

Confined Test Specimen - a bonded anchor in which the reaction force from

a static tension load is sufficiently close to the anchor to preclude concrete failure, but allow bond failure.

Effective Embedment Depth - the depth through which the anchor transfers force to the surrounding concrete by an adhesive bond.

Encapsulated System - an adhesive anchor system in which pre-proportioned components are packaged in a capsule. Mixing is accomplished inside the drilled hole as the capsule and its contents are crushed by the anchor rod, which is driven by a rotating drill.

Injection System - an adhesive anchor system in which pre-proportioned components are contained in separate cartridges. Mixing is automatically accomplished within the cartridge head or by static vanes inside a dispensing nozzle.

Unconfined Test Specimen - a bonded anchor in which the reaction force from a static tension load is a sufficient distance from the anchor to allow concrete failure and/or bond failure.

3.2 Symbols used in this document shall have the following meanings:

d	Nominal diameter of a bonded anchor rod, mm.
h_{ef}	Effective embedment depth, mm.
N_0	Tension failure load for a Confined Tension test, kN.
N_d	Tension failure load for a Damp-Hole Installation test, kN.
N_h	Tension failure load for a Horizontal Installation test, kN.
N_s	Tension failure load for a Short-Term Cure test, kN.
N_t	Tension failure load for a Elevated Temperature test, kN.
N_u	Tension failure load for a Unconfined Tension test, kN.
$\hat{o}_o$	Uniform bond stress for a Confined Tension series, MPA
$\hat{o}'$	Uniform bond strength for an adhesive product, MPa.
$\hat{o}_d$	Uniform bond stress for a Damp-Hole Installation series, Mpa.
$\hat{o}_h$	Uniform bond stress for Horizontal Installation series, Mpa.
$\hat{o}_s$	Uniform bond stress for Short-Term Cure series, MPa.
$\hat{o}_t$	Uniform bond stress for Elevated Temperature series, Mpa.
$\hat{o}_u$	Uniform bond stress for an Unconfined Tension series, MPA.
v_u	Coefficient of variation for an Unconfined Tension series.

4. CALCULATED VALUES

4.1 Except as otherwise stated herein, the strength performance of test specimens shall be based on the applied tension load at failure. Failure shall

be defined in accordance with ASTM E 488.

4.2 An average tension failure load for each test series shall be calculated and reported as the arithmetic mean of the individual failure loads for all specimens in that series.

4.3 Coefficients of variation for each applicable test series shall be calculated and reported as the sample standard deviation divided by the mean.

4.4 An average uniform bond stress shall be calculated for each test series as:

$$\hat{o}_x = \frac{(N_x)_{avg}}{\pi \times d \times h_{ef}} \quad \text{where: } x = o,d,h,s,t, \text{ or } u$$

4.5 A specified bond strength for the adhesive product shall be calculated as:

$$\hat{o}' = \hat{o}_u[1\text{-}2.0\ v_u]$$

5. APPARATUS

5.1 The test apparatus shall be as required by the applicable sections of the referenced documents and described herein.

5.2 Structural test members shall be constructed using FDOT Class II concrete with limestone aggregate to the minimum dimensions required by ASTM E 488. Members shall be uncracked and unreinforced within the potential failure region of the test specimen. Reinforcement shall only be used to accommodate handling.

5.3 Anchor rods with continuous threads shall be fabricated from high-strength steel sufficient to fail the adhesive bond without fracture of the concrete (e.g. ASTM A 193 Grade B7).

5.4 An environmental chamber shall be capable of maintaining concrete test members, anchor specimens, and related test apparatus at not less than 43°C for a continuous period of not less than 42 days.

6. SAMPLING

6.1 Adhesive products shall be randomly selected by the testing agency from commercial distribution sources.

7. PROCEDURE

7.1 Handling, preparation, installation, and curing of proposed adhesive products shall be in accordance with the manufacturer's published instructions. Only tools and dispensing equipment recommended by the manufacturer shall be used. Specimens shall be prepared such that they are representative of field installations of commercially available products.

8. REQUIRED TESTS

8.1 Perform each of the following test series in accordance with the applicable sections of ASTM E 488 and ASTM E 1512 except as otherwise stated.

8.1.1 Confined Tension - Perform static tension tests on single anchors except:

a. Anchor diameter shall be 16 mm and embedment shall be 102 mm.

b. Test loads shall be applied to confined test specimens.

8.1.2 Damp-Hole Installation - Perform static tension tests on single anchors except:

a. Anchor diameter shall be 16 mm and embedment shall be 102 mm.

8.1.3 Elevated Temperature - Perform static tension tests on single anchors except:

a. Anchor diameter shall be 16 mm and embedment shall be 102 mm.

b. Minimum temperature during testing shall be 42°C.

c. Test loads shall be applied to confined test specimens.

8.1.4 Horizontal Orientation - Perform static tension tests on single anchors except:

a. Anchor diameter shall be 16 mm and embedment shall be 102 mm.

b. The longitudinal axis of the anchor shall be horizontal during installation and curing.

c. Test loads shall be applied to confined test specimens.

8.1.5 Short-Term Cure - Perform static tension tests on single anchors except:

a. Anchor diameter shall be 16 mm and embedment shall be 102 mm.

b. The longitudinal axis of the anchor shall be horizontal during installation and curing.

c. Test loads shall be applied no later than 24 hours after installation.

8.1.6 Long-Term Load (Creep) - Perform static tension tests on single anchors except:

a. The distance between the reaction force and anchor location of the testing assembly shall be in accordance with the requirements of Table 2 of ASTM E 488.

b. The minimum long-term test load shall be 40 percent of the average tension failure load established by an Unconfined Tension test series using the same anchor diameter and embedment depth.

c. The minimum temperature of the concrete test members and anchor specimens during application of the long-term test load shall be 43°C.

d. The duration of applied load shall be a minimum of 42 days.

e. After the 42 day loading period, the temperature of the concrete members and anchor specimens shall be permitted to cool to 21°C± 3°C after which an Unconfined Tension test shall be performed on all anchor specimens.

8.1.7 Unconfined Tension - Perform static tension tests on single anchors except:

a. A separate test series shall be performed for each of three aspect ratios of h_{ef} and d as follows:

1. An anchor diameter of 16 mm and embedment of 102 mm, and

2. An anchor diameter of 16 mm and embedment of 152 mm, and

3. An anchor diameter of 19 mm and embedment of 152 mm.

9. REPORT

9.1 All installed anchor specimens shall be reported. Any deviations from the requirements of this document shall be identified and described. Any installed specimens not tested shall also be reported with a description of

why testing was not performed. A complete and separate report shall be prepared for each proposed adhesive product, and shall include, as a minimum:

9.1.1 All applicable information required in Section 13 of ASTM E 488, Section 8 of ASTM 1512, and this document.

9.1.2 Manufacturer's published product information including, as a minimum:

a. Complete and detailed instructions for proper installation and curing.

b. Complete and detailed descriptions of any related accessories permitted or required for field installation including mixing nozzles and installation tools.

9.1.3 A statement certifying that all tests were performed in accordance with the requirements of this document with any deviations or untested specimens described within, and are accurately represented by the report result. This statement shall bear the seal of a professional engineer licensed to practice in the State of Florida who is independent of the manufacturer.