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DIVISION OF ENGINEERING SERVICES
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METHOD OF TEST FOR CREEP PERFORMANCE OF CONCRETE ANCHORAGE SYSTEMS

A. SCOPE

This method describes the test procedure to be used for determining the creep performance of resin capsule anchors and mechanical expansion anchors.

B. REFERENCES

Caltrans Standard Specifications - Section 75, "Miscellaneous Metal"
Caltrans Standard Specifications - Section 90, "Concrete"

C. APPARATUS

1. A testing apparatus equivalent to that shown in Figure 1 shall be designed so that the anchorage system is loaded through a base plate beneath the nut on the threaded shaft of the protruding stud. The clear distance between the supports of the testing apparatus in contact with the concrete test slab and the protruding stud shall be 3-1/2 times the embedment depth for depths less than or equal to 6.5 inches, and 2 times the embedment depth for depths greater than 6.5 inches. The load collar with base plate attached and arms on which indicators are mounted shall be designed and built sufficiently rigid to minimize elastic deflections.

2. A pin or swivel connector near the base of the pull bar linkage shall be required to eliminate the transfer of bending moments to the anchorage system.

3. A load cell or load monitoring device is required to measure the external tensile force applied to the pull bar of the testing apparatus. This device shall be accurate to within ± 1% of the actual applied load.

4. Two dial indicators, linear variable differential transformers (LVDTs), or other suitable displacement gages per testing apparatus, shall measure the linear displacement to within 0.001 inch.

5. Thermocouples shall be provided and installed (embedded) that accurately measure the temperature of the concrete test slabs.

6. A large heat chamber shall be capable of maintaining the required testing temperature of concrete creep specimens to within ± 4°F of the specified value.

7. A suitable torque wrench is required.

8. A hammer and setting tool shall be utilized to install the mechanical expansion anchors, if required.

D. DESCRIPTION OF TERMS

Creep - all movement associated with the installed concrete anchorage system that occurs while loading and during the sustained loading periods, including short-term slip and creep. Elastic deformations are considered small and are also included in overall creep measurements.

Mean Creep Value - total movement of the anchorage device calculated by subtracting the initial mean indicator value from the mean indicator value at the end of the creep test.

E. PREPARATION OF TEST SPECIMENS

1. Concrete Test Slab

   a. Fabricate an unreinforced concrete test slab having sufficient size to provide adequate edge distance and spacing between anchors, as described in Section E-2a, and to accommodate anchorage systems being tested. Minimum slab depth shall be the minimum required hole depth plus 4-hole diameters. See Section E-2b(3).

   b. Thermocouples shall be embedded at a depth of 1⁄2 the actual embedment depth of the rebar or threaded rod from the surface of the concrete into which the anchors are to be installed. The thermocouples must be either cast in place or installed into maximum 0.5 inch diameter holes drilled into cured concrete, with the holes sealed in a manner so as to ensure that temperature readings reflect the concrete temperature.

   c. Concrete used for the test slab shall contain a minimum of 505 lbs/cu. yd. of cementitious material and shall conform to the requirements in Section 90 of the Caltrans Standard Specifications. The aggregate used for the test slab shall be considered non-innocuous. The aggregate shall be rounded, crushed gravel, or crushed rock and conform to the 1-inch maximum combined aggregate grading. Admixtures shall not be used. Concrete shall be cured by either the water method or the curing compound method. At the beginning of each sustained direct tension test, the concrete shall have an age of not less than 21 days and the associated compressive strength shall not be greater than 4750 psi. Anchorage systems to be used in early age or lightweight concrete, or concrete having compressive strength requiring special ingredients shall be evaluated using concrete having a similar composition.

2. Installation of Anchorage Systems

   a. Locate the hole positions on the concrete test slab so as to provide a minimum edge distance of 6 hole diameters and a minimum spacing between holes (center to center) of 12 hole diameters.

b. Drill holes to conform to the following requirements:

(1) Use the appropriate type of drilling apparatus and size of drill sites for preparing holes, as recommended by the anchor manufacturer or by Caltrans specifications. Dimensions of carbide tips of drill bits shall conform to ANSI Specification B212.15.

(2) Drill holes so that their axes are normal to the plane of the concrete surface.

(3) The required hole depth shall be as follows:

(a) for mechanical expansion anchors that are:

1. internally threaded shell drop-in type anchors, the required hole depth is 0.5 inch plus the anchor body length.

2. integral stud-type anchors, the required hole depth is the minimum depth recommended by the manufacturer.

(b) for threaded rods or rebar bonded with resin capsule anchors, the minimum hole depth shall conform to recommendations by the manufacturer.

c. After drilling the hole, remove dust and residue in the hole by blowing out with oil-free compressed air, using an OSHA-approved nozzle. Use of a brush or other instrument to loosen dust particles or water to wash out residual dust in hole, unless specifically required by the manufacturer, is not permitted.

d. Install the anchorage system using directions provided by the Engineer or the manufacturer's recommended instructions. For shell drop-in type mechanical expansion anchors, the top of the anchor body shall be installed 0.5 inch below the concrete surface. For resin capsule anchors, curing time shall not exceed 8 hours or the minimum curing time as required by the Engineer. No artificial curing conditions (i.e., high heat) shall be permitted.

e. Bond two small flat metal bearing plates to the surface of the concrete at an appropriate distance from the anchorage device so as to provide smooth surfaces for the contacts of the dial indicators or LVDTs.

f. Position the load collar with displacement indicators over the protruding stud. Install a washer and nut onto the stud and apply an appropriate installation torque to the nut using a calibrated torque wrench. If the manufacturer of the anchor device or the Engineer has not specified an installation torque value, the torque values shown in Section 75 of Caltrans Standard Specifications will be used.

F. PROCEDURE

1. Install two displacement indicators (LVDTs or dial indicators), one on each end of a rigid arm securely fastened to the load collar of the testing apparatus. Position the indicators so as to measure displacements normal to the concrete surface. The tips of the indicators shall rest on bearing plates previously bonded to the concrete surface. Mount these indicators so that their shafts are equidistant from the concrete anchorage device and are not less than 12 hole diameters apart from each other.

2. Immediately after the required installation torque has been applied to set/preload the anchorage system being tested and indicators have been properly oriented, apply a 100 lb-force external tensile load to seat components of the testing apparatus. Record each indicator reading and average the two readings to obtain the initial mean indicator value.

3. Adjust the ambient temperature of the concrete test slab so that the test temperature is reached within 24 hours. It must be at least 70°F for testing mechanical expansion anchors and 112 ± 2°F for testing of resin capsule anchors. Read and record the load and displacement.

4. For mechanical expansion anchors, apply the appropriate full sustained tension test load, shown in Section 75 of Caltrans Standard Specifications, at a uniform rate not to exceed 1000 lb/min, within 48 hours of installation of the anchorage system. For resin capsule anchors, after curing the bonding material as specified by the manufacturer, apply the appropriate tension test load shown in Section 75 of Caltrans Standard Specifications. This test load shall be applied to the base plate of the test fixture so as to indirectly load the stud of the anchorage system.

5. Read and record each indicator again immediately after the specified sustained tension test load has been applied and average the values.

6. Maintain the sustained tension test load to within ± 5% of the required value for the duration of the creep test.

7. Monitor the displacement and sustained load for at least 48 hours for mechanical expansion anchors and 42 days for resin capsule anchors, after applying the full test load.

a. For mechanical expansion anchors, read and record a minimum of 5 additional sets of displacement values at 2-hour intervals during the last 10 hours of testing. One of the required readings shall be made at 48 hours with the specified sustained tension test load applied.

b. For resin capsule anchors, measure creep movements at least hourly for the first six hours, and daily for the duration of the tests. Ample displacement readings shall be taken so that a smooth continuous load-displacement curve can be plotted. One of the required readings shall be made at 48 hours with the specified sustained tension test load applied. The final reading shall be at 42 days at the elevated temperature, and with the load applied.

8. Determine and report a mean creep value at 48 hours for each test performed by subtracting the mean indicator value of the fully loaded creep specimen at 48 hours from the initial mean indicator. See Sections F-2 and F-7.

G. SAMPLING AND TESTING

In order to qualify a particular brand and diameter of anchorage device, a minimum of three replicate tests per diameter must be performed. A satisfactory performance for a given diameter is obtained when all qualification tests performed on a particular anchorage device pass. A satisfactory performance for an anchorage device of a given diameter, design and particular embedment depth tested will constitute acceptance of additional anchor lengths having greater embedment depth.

Duplicate samples are required (a total of 6 replicate samples per diameter) to allow for any potential retesting.

H. RETESTING

1. When a system fails to pass initial qualification testing, only one retest shall be allowed. If any failure occurs during retesting, the device is rejected and no further testing will be permitted, unless the manufacturer significantly alters the design of the anchorage device.

2. Any future changes in the anchor design or materials from what was originally tested will void approval. Retesting will then be required.

I. REPORTING OF RESULTS

Results of all creep tests shall be reported. The report of the creep tests shall include the following:

- Dates of testing and report preparation.
- A listing of the observers of the qualification tests with the signature and title of the person responsible for testing.
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- Identification of the anchorage system including the manufacturer, type and model number, the type of steel used in anchor parts, the thickness and type of corrosion protective coating, dimensions, and other pertinent information.
- The number of specimens tested.
- The concrete mix design, including the type of aggregates used in the concrete, and the date that the concrete was cast.
- The compressive strength of the concrete and age, in days, of the test slab and the date when creep tests were started.
- A physical description of the test slab including dimensions and method of curing used.
- Photographs of the test specimen.
- A drawing and photographs of the testing apparatus.
- A description of the procedure, installation tools, and materials used to install the anchorage system, including the installation torque.
- The diameter of the carbide tip on the drill bit used, to the nearest 0.001 inch.
- The depth of the drilled hole.
- The depth of embedment of the anchorage system.
- The length of time, in hours, from the installation of the anchorage system to the application of the sustained tension test load.
- A continuous record of the temperature of the concrete slab during the creep test.
- A description of the procedure used to apply and maintain the sustained tensile test load and actual rate of loading used.
- A plot of mean indicator displacement values and corresponding tension loads as required per Sections F-2, F-3, F-5 and F-7 with their respective elapsed test times.
- The mean creep values at 48 hours per Section F-8 for the anchorage system tested (one required for each test conducted).

J. SAFETY AND HEALTH

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing, or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

The Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 681 contains 8 pages)

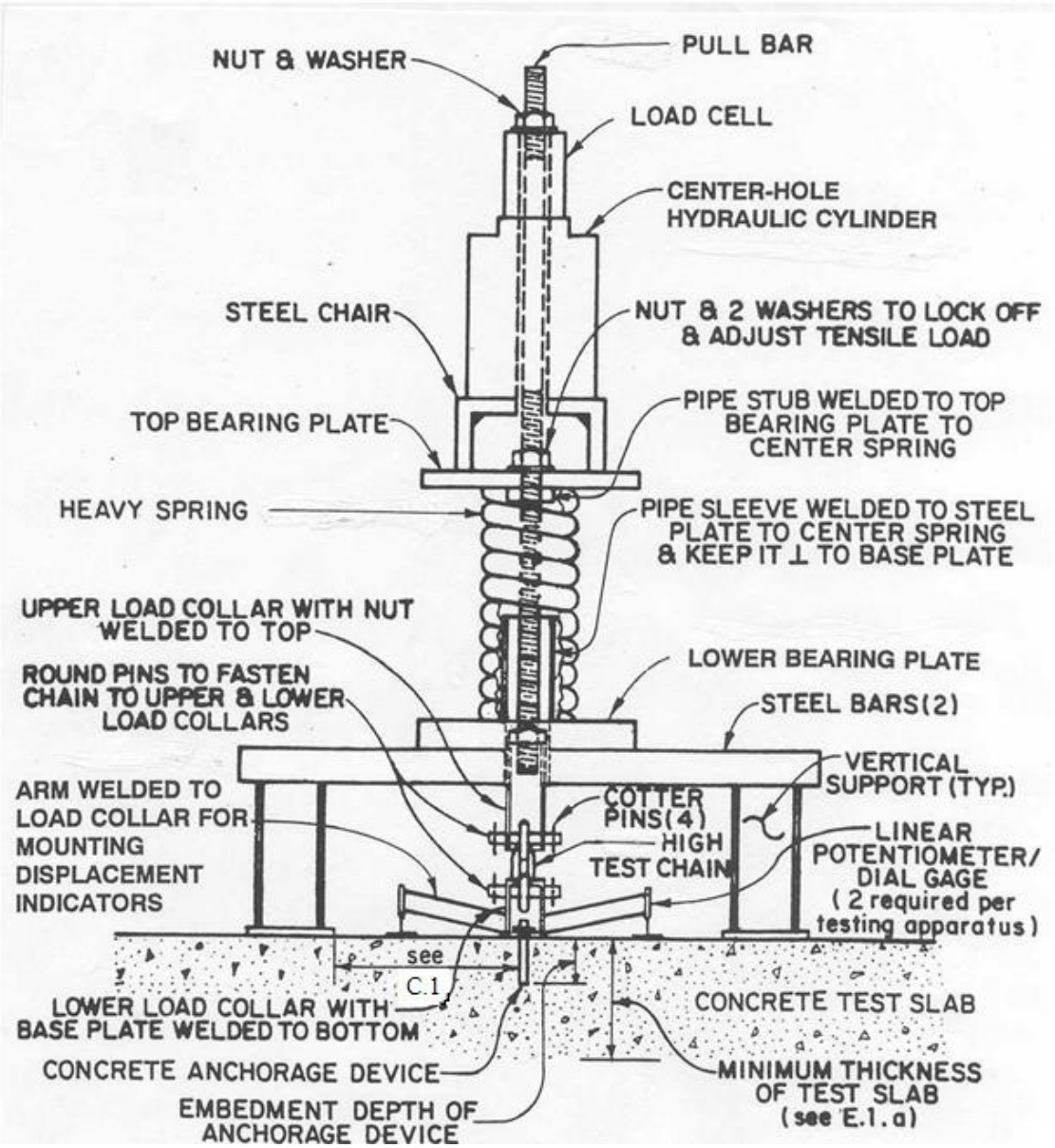

FIGURE 1. EXAMPLE OF THE CREEP TESTING APPARATUS