



CEL CONSULTING, INC

Product Evaluations - Metallurgy
Structural Investigations - Forensics

L.H. DOTTIE CONCRETE ROD HANGERS

TESTING PROGRAM ACCORDING TO:

ASTM E488:

Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

Performed for

L.H. Dottie Company
Commerce, California

By: CEL Consulting



Lee Mattis, P.E.

December 11, 2015 **Revised March 9, 2016**

Report Number 15C299

CEL Project No. 53004C

CEL Consulting is an independent consulting engineering firm and laboratory with expertise in the testing and evaluation of construction materials. CEL has no affiliation with L.H. Dottie or any other construction products manufacturer or distributor.

This is a complete report of a testing program conducted by CEL at laboratory facilities in Oakland, California. It must be reproduced in its entirety when submitted to any approval agency. It shall not be reproduced except in its entirety without prior written approval by CEL. Results of laboratory testing are not necessarily indicative of performance to be expected in actual installations. Without direct involvement in the design and installation of actual applications, no warranties or guarantees of performance of the product can be provided. The user of this document expressly disclaims and indemnifies CEL from any liability arising out of the use or misuse of these test results.

TABLE OF CONTENTS

1.	Introduction.....	1
2.	Scope of Testing.....	1
3.	Test Specimens.....	1
	3.1 Concrete Rod Hanger Description	
	3.2 Threaded Rod Inserts	
4.	Facilities and Test Equipment.....	2
	4.1 General	
	4.2 Tension Testing	
	4.3 Shear Testing	
5.	Test Members.....	3
	5.1 Description	
	5.2 Component Materials	
	5.3 Strength Determination	
6.	Test Procedures.....	3
	6.1 Anchor Installation	
	6.2 Anchor Testing	
7.	Test Results.....	4
8.	Use of Results.....	6
9.	Conclusion.....	6
10.	References.....	6

Appendices 1 through 4

1. INTRODUCTION

The purpose of this testing program is provide tension and shear test results in normal weight concrete for the L.H. Dottie Concrete Rod Hangers.

2. SCOPE OF TESTING

Tests were conducted according to ASTM E488-96. The program consisted of static tension and shear tests at one embedment in 2000 and 4000 psi concrete strengths. All tests were conducted with distance to the test supports of 2 times embedment per E488 Table 2 and with sufficient distance to test member edges to preclude any influence on the results. The test numbers, sizes and test quantities are provided in Table 1.

Table 1

Test Type & Concrete Strength	Threaded Rod Diameter, in & Test Quantities		
	1/4	3/8	1/2
Tension – 2000 psi	5	5	5
Tension – 4000 psi	5	5	5
Shear – 2000 psi	5	5	5
Shear – 4000 psi	5	5	5

3. TEST SPECIMENS

3.1 Concrete Rod Hanger Description: L.H. Dottie Concrete Rod Hangers are self-tapping screw-type anchors designed to be installed in holes predrilled using normal size ANSI carbide bits. The embedded ends are hardened with configuration suitable for cutting threads in a predrilled concrete hole. The exposed ends have a hex head configuration and are threaded to accept threaded rods or fasteners. They are typically used for suspending various mechanical and electrical equipment from the underside of elevated concrete slabs using threaded rods or threaded fasteners.

Selected dimensions of rod hangers that were tested were measured and compared to the product dimension drawings provided by the supplier. Three specimens of each were measured and results averaged. The product drawings and results of the dimensional measurements are provided in Appendix 1. Dimensions measured were in compliance with the product dimension drawings

Mechanical and chemical tests were performed on the different rod hangers to verify these properties. The requirements were found on product inspection sheets provided by the supplier and were not listed on the dimension drawings provided. The raw material was

determined to be AISI 10B21 steel. The hardness requirements were core hardness 450 HV (Vickers Pyramid Number) maximum and surface hardness 680-750 HV. Hardness was found to be in substantial compliance with these values. Case thickness was not determined. The results of these tests are provided in Appendix 1.

3.2 Threaded Rod Inserts: All-thread rods meeting ASTM A193 B7 requirements were installed in the threaded body of the concrete rod hangers to apply the test loads. High strength steel was used to apply the maximum test load to the rod hangers.

4. FACILITIES AND TEST EQUIPMENT

4.1 General: All testing was performed at the CEL anchor testing laboratory in Oakland, California. Test equipment was adequate to impose anticipated ultimate loads and complied with Section 5 of ASTM E488. A hollow-core hydraulic cylinder, controlled by an electric pump with metering valve, was used to apply load to the hangers by linkages of threaded rods and steel fixtures. Loads were measured using an electronic load cell mounted under the hydraulic cylinder and a PC-based data acquisition system.

4.2 Tension Testing: A hydraulic cylinder and electronic load cell with the ball and socket fixture in between were mounted on a steel load bridge assembly positioned over the anchor. Reaction loads were not imposed on the surface of the concrete within a distance of two times embedment from the anchor axis as required. A round coupler was installed on the projecting A193 B7 threaded rod insert installed in the concrete rod hanger body. A high strength threaded pulling rod was inserted through the hydraulic cylinder and load cell and threaded into the round coupler. A heavy nut and plate washer above the hydraulic cylinder were used to transfer load to the pulling rod. Anchor movement relative to the surface of the concrete test member during loading was measured using the LVDT positioned over the projecting end of a 1:1 displacement balance. The other end of the displacement balance rested on the flanged surface of the coupler.

4.2 Shear Testing: Loading plates with hardened inserts of the same thickness as the threaded insert rod were used to apply the test loads. Anchors were installed into the sides of test members with the loading plate placed over the threaded insert rod and connected to the hydraulic cylinder and load bridge assembly in a similar configuration as the tension tests. The LVDT was positioned to measure displacement of the test anchor relative to the concrete surface in the direction of the applied load.

The load and displacement measuring devices were calibrated within one year in accordance with CEL procedures using standards traceable to NIST.

Photographs of the test setups and typical failure modes are provided in Appendix 4.

5. TEST MEMBERS

5.1 Description: Concrete test members of normal weight concrete were prepared in accordance with the requirements of E488 Section 6.4. No steel reinforcing was installed in any of the test members. Test members varied in size from 48" by 48" by 12" thick to 72" by 72" by 19" thick. Concrete placement, sampling and preparation of compression test specimens were performed by CEL personnel for all test members.

5.2 Component Materials: Concrete was supplied by Cemex from their plant in Oakland, CA. Information about the concrete aggregates is located in Appendix 3 along with the concrete mix designs.

5.3 Strength Determination: Compression test specimens were tested in general conformance with ASTM C39 at Consolidated Engineering Laboratories Concrete Laboratory. All test specimens were field-cured in the immediate vicinity of the test members under similar environmental conditions until just prior to testing.

Test member strength was determined in accordance with typical procedures using strength-age relationships developed based on compression tests done at specified intervals. The Excel logarithmic trendline function was used for this purpose, and the strength-age graphs with the trendline formulas are provided in Appendix 3 along with the supporting compression test data sheets. Test member strengths, calculated using the trendline formulas, are provided on the anchor test data forms (ATDFs).

6. TEST PROCEDURES

6.1 Anchor Installation: The holes were drilled a rotary hammer drill in the percussion mode. The brand, model number, size and type of rotary hammer drill was representative of the types typically used in field installations. Carbide tipped drill bits meeting the requirements of ANSI B212.15 were used. The holes were drilled perpendicular to the surface of the test slabs within a 6 degree tolerance, verified by visual observation, in a manner representative of actual field installations. Hole depth was approximately 1/4" deeper than the required embedment, measured from the concrete surface to the tip of the embedded end, and drilling debris removed by blowing out the holes with compressed air. The hangers were driven into the hole with a drill motor using the hex socket provided by L.H. Dottie. Some of the tools disengaged from the hanger hex head before reaching full embedment. They were installed to full embedment by hand using a socket wrench.

6.2 Anchor Testing: The loading system and LVDT were assembled and positioned as described in Section 4. An initial load of approximately 5% of the expected ultimate capacity of the anchor was applied to the test anchor according to Section 8.5 of E488. The continuous load application method described in Section 8.6.1 of E488 was used. The required loading rate of 25% to 100% of the expected ultimate capacity of the anchor system per minute was

achieved by controlling the hydraulic flow from the pump with an adjustable valve. Load application was continued until failure of the anchor. Test information was documented in an Excel data spreadsheet file consisting of an anchor test data form template for each test series. Descriptive information was recorded manually on the anchor test data form, and test data was imported from the data acquisition system to the computer file after each test. Load versus displacement graphs were plotted automatically from the test data in the same computer file. The ATDFs with corresponding graphs are located in Appendix 2. They are organized by test type, concrete strength and hanger size.

7. TEST RESULTS

Summarized results for each product are provided in Tables 2 through 5. Refer to CEL Anchor Testing Code System on Page 7 for translation of the CEL "Test Series Number" found on the anchor test data forms and graphs.

Table 2 – 2000 psi Tension

Hanger Size, inches	Hanger Embed, inches	Test Member ID	Concrete Strength, psi	Test Date(s)	CEL Test Series Number	Average Ultimate Load, lbs.	COV, %	Failure Mode
1/4	1 1/4	15924-3KN (B)	2127	10/27/15	15CCH104-2k	1053	8.6	Surface Cone
3/8	1 1/2	15924-3KN (B)	2140	10/28/15	15CCH106-2k	1615	9.1	Surface Cone
1/2	2 3/4	15924-3KN (B)	2140	10/28/15	15CCH108-2k	5271	7.8	Surface Cone

Table 3 – 4000 psi Tension

Hanger Size, Inches	Hanger Embed, inches	Test Member ID	Concrete Strength, psi	Test Date(s)	CEL Test Series Number	Average Ultimate Load, lbs.	COV, %	Failure Mode
1/4	1 1/4	14826-3KN	4095	11/2/15	15CCH104-4k	1798	6.3	Pullout
3/8	1 1/2	14826-3KN	4095	11/2/15	15CCH106-4k	2983	14.1	Cone
1/2	2 3/4	14826-3KN	4096	11/3/15	15CCH108-4k	6888	4.6	Cone

Table 4 – 2000 psi Shear

Hanger Size, inches	Hanger Embed, inches	Test Member ID	Concrete Strength, psi	Test Date(s)	CEL Test Series Number	Average Ultimate Load, lbs.	COV, %	Failure Mode
1/4	1 1/4	15924-3KN (B)	2127	10/27/15	15CCH1404-2k	1807	11.8	Shear in rod insert threads
3/8	1 3/4	15924-3KN (B)	2140	10/28/15	15CCH1406-2k	3156	14.7	Rod insert bending/ pullout
1/2	2 3/4	15924-3KN (B)	2140	10/28/15	15CCH1408-2k	6723	6.4	Shear in rod insert threads

Table 5 – 4000 psi Shear

Hanger Size, inches	Hanger Embed, inches	Test Member ID	Concrete Strength, psi	Test Date(s)	CEL Test Series Number	Average Ultimate Load, lbs.	COV, %	Failure Mode
1/4	1 1/4	14826-3KN	4095	11/2/15	15CCH1404-4k	1941	6.1	Shear in rod insert threads
3/8	1 1/2	14826-3KN	4095	11/2/15	15CCH1406-4k	2953	10.7	Shear in rod hanger threads
1/2	2 3/4	14826-3KN	4095	11/2/15	15CCH1408-4k	6624	8.8	Shear in rod insert threads

Notes (all tables):

1. Hanger size is the thread size of the rod hanger body.
2. Embedment is measured from the concrete surface to the tip of the embedded end.
3. COV is the statistical coefficient of variation of the five test replicates indicating the variation of individual test results.
4. The ultimate loads are based on failures of the concrete rod hangers due to use of high strength threaded rod inserts for testing. Use of lower strength threaded rod inserts will result in lower load levels and should be evaluated by the designer or user.

8. USE OF RESULTS

The data derived from these tests may be used for allowable stress design (ASD) provided an appropriate factor of safety is applied to the average ultimate loads. Rod hangers must be installed to their full embedment using procedures described in this report.

Since the concrete strengths were within 10% of the nominal concrete strengths of 2000 psi and 4000 psi, the results are applicable to these nominal concrete strengths and above.

9. CONCLUSION

The testing program was conducted in general conformance with applicable sections of ASTM E488 and typical practice for testing anchors in concrete.

10. REFERENCES

1. American Society for Testing and Materials, West Conshohocken, Pennsylvania: ASTM E488-96, *Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements*
2. American National Standards Institute, New York, New York, ANSI B212.15-1994, *Carbide-Tipped Masonry Drills and Blanks for Carbide-Tipped Masonry Drills*

ANCHOR TESTING CODE SYSTEM

CEL Consulting Standard One-Digit Numbering System

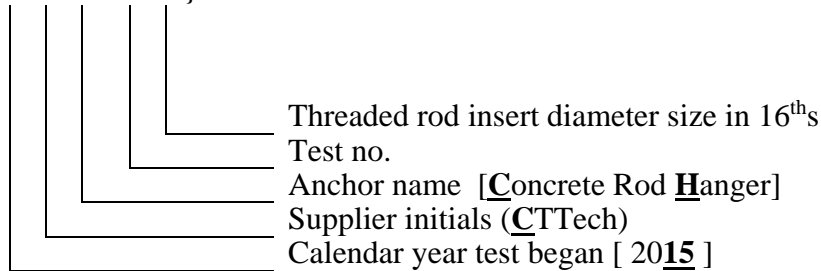
Applicable for the ICC test series and concrete test member coding.

1 through 9 = Use numbers as they are
10 and above:

A = 10	D = 13	G = 16	J = 19
B = 11	E = 14	H = 17	K = 20
C = 12	F = 15	I = 18	L = 21

Test Series Number Code:

Ex{15 C CH 1 04}



Test Member Code:

Ex. {15 9 24-3KN (B)} 9/24/15 pour date

Nominal concrete strength/CEL pour differentiation letter
Day
Month [Use above chart]
Calendar year (last digit)