CEL CONSULTING, INC
Product Evaluations - Metallurgy
Structural Investigations - Forensics

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Subject: Report of Steel Rod Hanger Testing in Various Steel Thicknesses

As requested tests were performed on the subject rod hangers. ICC-ES AC118, Section 4.3, Connection Tests was used as a guideline for the testing. Only average ultimate loads were to be determined and reported. Determination of allowable loads is not included in the scope of work.

Scope

The following table provides the scope of the testing.

Steel Base Material Thickness	Mount Type, Shank Diameter, in, & Test Quantities			
	Vertical Mount		Side Mount	
	1/4-20	12-20	1/4-20	12-20
20 ga. (use for 18 ga.)	5	-	5	-
16 ga. (use for 14 ga.)	5	-	5	-
14 ga.	-	-		-
12 ga.	5	5	5	-
3/16"	5	5	5	-
1/4"	5	5	5	-

Test Specimens

Steel Rod Hangers were submitted to our laboratory for the testing.

Selected dimensions of rod hangers that were tested were measured and compared to the product dimension drawings provided by the supplier. Two or 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 C1022 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.

Steel Base Material

Steel base material for the testing was obtained from commercial sources. The specification was ASTM A653, Grade 33 for sheet metal material and ASTM A36 for 3/16" and 1/4" material. Actual ultimate tensile strengths (UTS) were detrermined by testing machined coupons in accordance with ASTM A370 for the gage thicknesses. Certified mill test reports (CMTR) were available for the 3/16" and 1/4" thicknesses. Test results and the CMTRs are provided in Appendix 3.

The actual UTS were used to normalize the test results to the minimum UTS for the ASTM specifications. Actual thicknesses for gage materail were used to normalize the test results to the minimum specified steel thicknesses. Straight line reductions were performed using the ratios of the minimum to actual values.

Testing Procedures

The Steel Rod Hangers have self-drilling points and do not require a pilot hole for installation.

Testing was performed on a 20 Kip capacity Instron universal testing machine with elongation measured internally (calibration traceable to N.I.S.T.). The samples were tested utilizing fixtures that conform to requirements of AISI Cold-Formed Steel Design Manual, S905 with modifications as described herein.

For vertical mount tests the hanger was installed into the steel base material with the mating nut installed on the back side except for the 12-20 which was tested without a nut. The steel base material with installed hanger was placed inside a steel test fixture with a 2” diameter opening so that the fixture restrained the steel base material during load application. The fixture was secured to the Instron base. A high strength threaded pull rod was installed in the hanger and attached to the Instron. Load was applied at a rate of 0.100 in/min until failure.

For determination of side mount shear strength, the fasteners were installed in accordance with AISI S905 Section 4.2 Figure 2 with the exception that load was applied to only one hanger using a special fixture. The hanger was installed into the base material as described above. The hanger head was placed in a hole in an offset steel fixture that was slighty larger than the hanger head and secured to the fixture with a high strength threaded rod installed through a tapped hole in the fixture bottom and threaded into the tapped hole in the hanger side mount. Load is transferred by the fixture to the high strength threaded rod and to the hanger head which is also attached to the threaded rod. The offset steel fixture was needed to account for the eccentricity of the single hanger connection. The steel fixture was secured to the Instron head and the base material was gripped in jaws attached to the Instron bed. Load was applied at a rate of 0.100 in/min until failure.

Photographs of test set-ups and typical failure modes are shown in Appendix 4.

Results

The following tables provide summarized results. Load versus displacement graphs are provided in Appendix 3.

1/4" Screw Shank Vertical Mount with Nut

Rod Diameter, inches	Screw Shank Thread Size Inches	Steel Thickness	Average Ultimate Load, lbs. [1]	COV, %	Failure Mode
1/4	1/4-20	20 ga.	1,275	5.6	Sheet metal deflection and hanger pullout
		16 ga.	3,296	15.1	Sheet metal deflection and hanger pullout
		12 ga.	4,035	11.6	Sheet metal deflection and hanger pullout
		3/16"	4,223	7.7	Tensile in threads
		1/4"	4,085	14.9	Tensile in threads

[1] Results normalized to minimum specified steel strength & minimum sheet metal gage or steel thickness

1/4" Screw Shank Side Mount with Nut

Rod Diameter, inches	Screw Shank Thread Size Inches	Steel Thickness	Average Ultimate Load, lbs. [1]	COV, %	Failure Mode
1/4	1/4-20	20 ga.	1,453	7.8	Shear in sheet metal
		16 ga.	2,827	2.2	Shear in sheet metal
		12 ga.	2,656	0.5	Shear in anchor threads
		3/16"	2,536	2.0	Shear in anchor threads
		1/4"	2,679	2.6	Shear in anchor threads

[1] Results normalized to minimum specified steel strength & minimum sheet metal gage or steel thickness

12-20 Screw Shank Vertical Mount without Nut

Rod Diameter, inches	Screw Shank Thread Size	Steel Thickness	Average Ultimate Load, lbs. [1]	COV, %	Failure Mode
1/2	12-20	12 ga.	1,030	6.5	Pullout from sheet
		3/16"	3,178	9.7	Plate bent & screw pull through
		1/4"	3,804	2.7	Screw tensile

[1] Results normalized to minimum specified steel strength & minimum sheet metal gage or steel thickness

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.

Conclusion

The testing program was conducted in substantial conformance with the requirements of AC118, Section 4.3, and referenced documents.

References

1. ICC Evaluation Service, LLC, Brea, CA: AC118, *Acceptance Criteria for Tapping Screw Fasteners, June 2012*
2. American Iron and Steel Institute, Washington D.C.: *Cold-Formed Steel Design Manual 2008 Edition, S905, Test Methods for Mechanically Fastened Cold-Formed Steel Connections*
3. American Society for Testing and Materials, West Conshohocken, Pennsylvania: ASTM A36-14, *Standard Specification for Carbon Structural Steel*; ASTM A653-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

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Appendix 1 – Test Specimens
Appendix 2 – Load-Displacement Graphs
Appendix 3 - Steel Base Materials
Appendix 4 – Photographs