MAFFEI
STRUCTURAL ENGINEERING

Technical Report

RP Watkins "Original Watkins Hanger"
Allowable downward loads from experimental testing

To: Michael Summers, RP Watkins

Prepared by: Karl Telleen and Joe Maffei, Maffei Structural Engineering

20 January 2017

Scope

This report provides allowable loads for vertical (downward) load bearing capacity of the Original Watkins Hanger in accordance with the experimental testing standard ASTM D7147-11 "Standard Specification for Testing and Establishing Allowable Loads for Joist Hangers," which is referenced by the 2015 International Building Code.

Maffei Structural Engineering provided recommendations for testing in a report dated 1 September 2016. RP Watkins fabricated test specimens. Applied Materials Engineering (AME) carried out testing as described in the testing report dated 13 January 2017 (attached herein as Appendix 1).

Description of the Original Watkins Hanger

The Original Watkins Hanger by RP Watkins, is a product for attaching a wooden joist, beam, or truss (referred to herein as the "supported member") to an Insulated Concrete Form (ICF) structural wall. The Original Watkins Hanger consists of a single piece of cold-formed galvanized steel. It comes in a range of widths to accommodate the width of the supported member. The supported member bears on the hanger's seat that protrudes from the ICF form. Before the wall concrete is placed, the vertical tabs of the hanger are inserted through cut slits in the ICF form such that they penetrate through the insulation and into the concrete. Two reinforcing bars are placed horizontally through the holes in the tabs, and one bar is placed vertically, between the hanger tabs. After the concrete wall is cast and cured, the supported member is installed, bearing on the hanger seat and fastened to the hanger using nails. For I-joists, wood blocking is provided on each side of the joist web at the hanger.

415-329-6100
maffei-structure.com
San Francisco :: Oakland

Summary of test results and allowable load

Table 1 summarizes key results from experimental testing and the resulting allowable load for design. This summary is based on the detailed test results shown in Appendix 1.

In accordance with ASTM D7147-11 Section 13, the allowable downward load is calculated as the lesser of:

(a) The lowest ultimate load per hanger divided by 3.

(b) The average, over each hanger in each specimen, load that produces a vertical deflection of 0.125 inches at the bottom of the hanger with respect to the wall.

The ultimate load measured in the test was limited by the strength of the wood joist.

Table 1 Summary of test results and allowable load

specimen	ultimate load per hanger (lbs)	load per hanger at 0.125" deflection (lbs)		allowable load per hanger (lbs)
		hanger 1	hanger 2	
1	6520	3307	3839	
2	6260	3716	3091	
3	6192	3723	2795	
	Minimum / 3 = 2064	Average = 3412		**Allowable = 2064**

Applicability of allowable load

Figure 1 and Figure 2 show the configuration and dimensions of the tested specimens. The allowable load specified above is applicable to hangers having the configuration shown in Figure 1. Project parameters are permitted to vary within the ranges stated in Table 2.

Adjustments to allowable load

For applications on projects where the project specified concrete strength ($f'_{c,\,specified}$) for the ICF wall is less than 91% of the tested concrete strength ($f'_{c,\,tested}$) stated in Table 2, the allowable load stated above shall be reduced in accordance with ASTM D7147-11 Section 13.5.9 by multiplying by:

$\sqrt{(f'_{c,\,specified}/\,f'_{c,\,tested})} \leq 1.0$

For applications on projects where the project specified thickness (t_{spec}) and/or tensile strength (F_{u_spec}) for the hanger sheet metal material is less than the tested hanger sheet metal thickness (t_{tested}) and/or tensile strength (F_{u_tested}) stated in Table 2, the allowable load stated above shall be reduced in accordance with ASTM D7147-11 Section 13.5.7 by multiplying by:

$(3.0/2.5)(F_{u\_spec}/F_{u\_tested})\ (t_{spec}/t_{tested}) \leq 1.0$

Table 2 Range of applicability for selected parameters (continues on next page)

Parameter	Test	Range of applicability on projects
Hanger seat depth (horizontal dimension)	3 inches	As tested
Hanger total vertical dimension	7 inches	As tested
Hanger vertical dimension of tabs	5.75 inches	As tested
Hanger hole pattern	See Figure 1.	As tested
Hanger seat width	3.5 inches	As tested or narrower
Hanger thickness	16 gauge galvanized (t_{tested} = 0.059 inches)	As tested or thicker. If thinner, allowable load shall be reduced in accordance with ASTM D7147-11 Section 13.5.7. See "Adjustments to allowable load."
Hanger material	Steel tensile strength F_{u_tested} = 55 ksi	As tested or greater. If less, allowable load shall be reduced in accordance with ASTM D7147-11 Section 13.5.7. See "Adjustments to allowable load."
Supported member type and dimensions	Wood I-joist 11.875" deep. Flange 3.5 inches wide, 1.375 inches deep.	Sawn lumber, glulam, structural composite lumber, wood I-joist, or wood open web joist. Flange thickness must be as tested or thicker. Width must be as tested or narrower. Hanger width must be sized to match supported member width. Blocking must be provided between hanger sides and joist web, where occurs.
Concrete strength	$f'_{c,\ tested}$ = 2470 psi	As tested or greater. If less, allowable load shall be reduced in accordance with ASTM D7147-11 Section 13.5.9. See "Adjustments to allowable load."
Thickness of concrete core of ICF wall	4 inches	As tested or thicker
Thickness of foam each side of concrete core	2.5 inches	As tested or thinner
Embedment of hanger tabs into concrete core	3.75 inches	As tested or greater

Parameter	Test	Range of applicability on projects
Steel reinforcing bars added in concrete wall at hanger (in addition to typical wall reinforcement)	2 bars horizontal. #3 18 inches long. Bars must be placed in holes as shown in Figure 1. Top bar must be through hole furthest from supported member. Bottom bar must be through hole closest to supported member. Bars must be centered on hanger. 1 bar vertical. #3 18 inches long. Bar must pass between hanger tabs and between horizontal bars.	As tested or greater
Horizontal edge distance from centerline of supported member to end of concrete wall	10 inches	As tested or greater
Fasteners of supported member to hanger	#10 nails: Simpson Strong-Tie Strong-Drive SCN Smooth Shank Connector Nail	As tested or greater

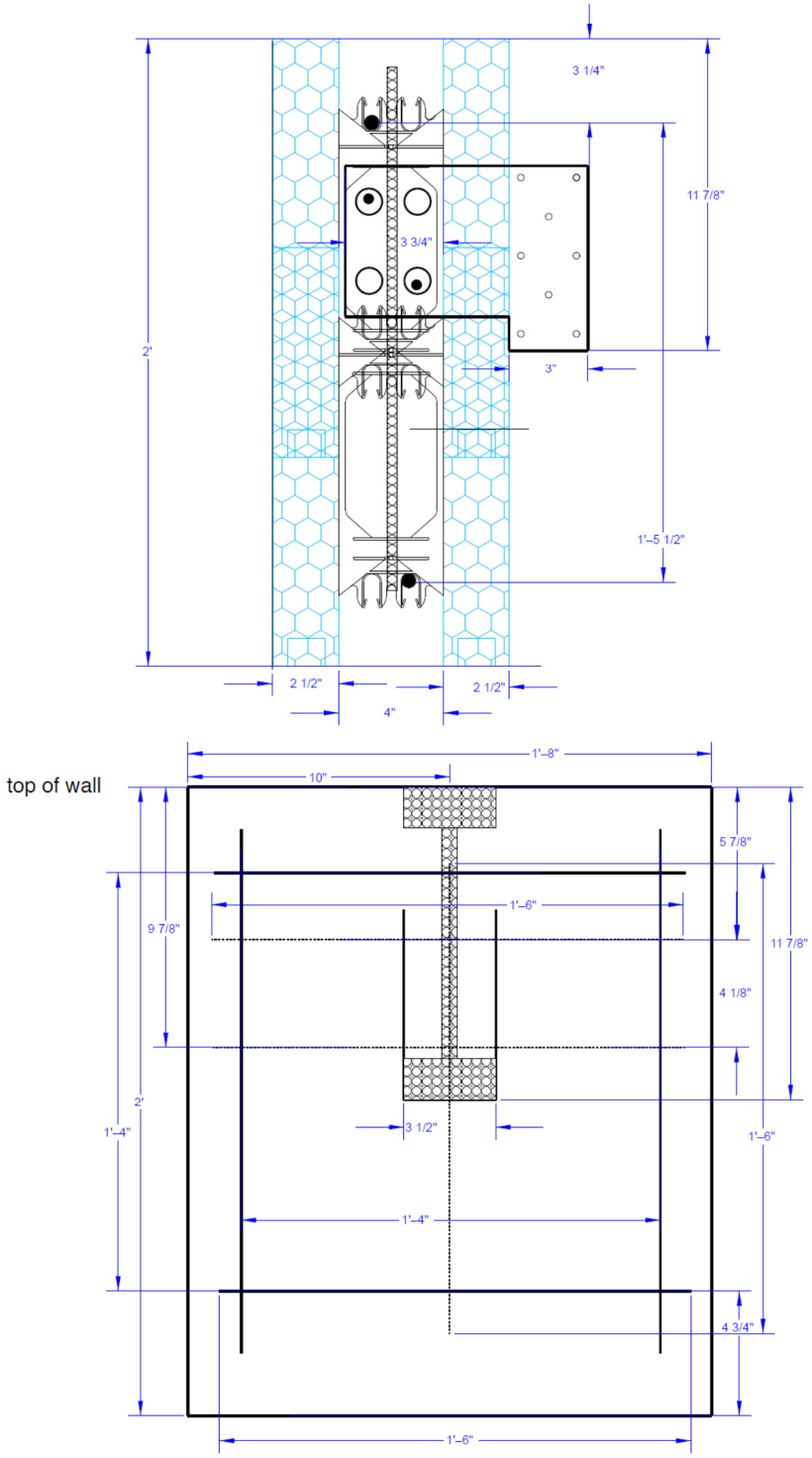


Figure 1 Tested specimen dimensions (drawing by RP Watkins).

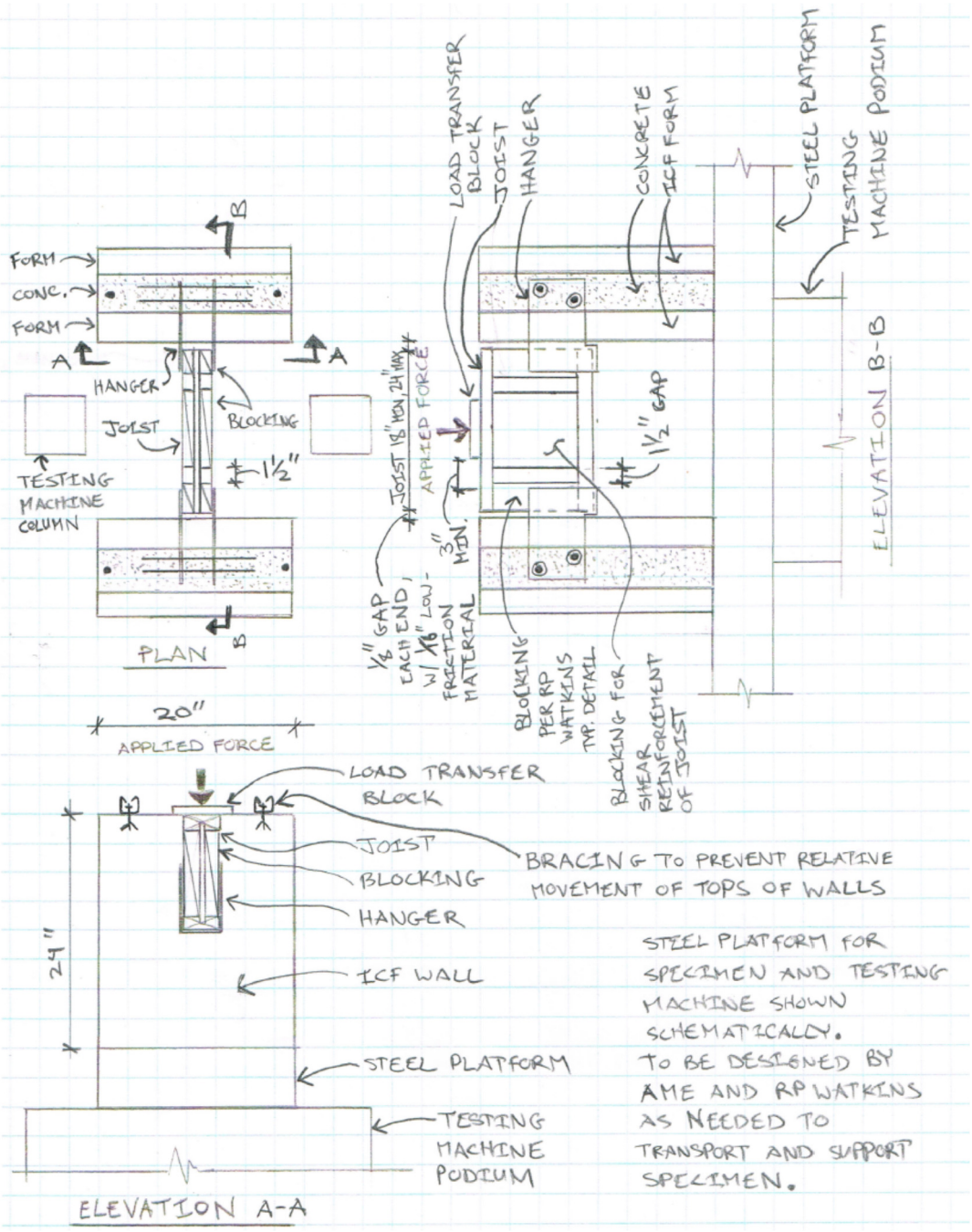


Figure 2 Test setup. Joist length is 24 inches.

Appendix 1: Testing report

APPLIED MATERIALS & ENGINEERING, INC.
980 41st Street
Oakland, CA 94608
Tel: (510) 420-8190
FAX: (510) 420-8186
e-mail: info@appmateng.com

January 13, 2017

Mr. Michael Summers
RP Watkins LLC
13401 S 226th Street
Gretna, NE 68028

Project Number 1160644C

Subject: Original Watkins Joist Hanger Load Testing

Dear Mr. Summers:

As requested, Applied Materials & Engineering, Inc. (AME) has completed load testing the RP Watkins Original Watkins Joist Hanger, referred to as Original Watkins Hanger. The intent of the testing was to determine the vertical downward load capacity of the Original Watkins Hanger attached to mockup ICF walls.

SAMPLE DESCRIPTION

Three mockup samples were received on November 15, 2016. Mockup configuration consisted of two 20"x24"x9" thick ICF walls. A wood I-joist spanning 24" in length was nailed to the two Original Watkins Hangers cast into the ICF walls. Specimen details are based on the test protocol from Maffei Structural Engineering dated July 28, 2016. Material test results for the materials used to construct the specimens are provided in Appendix A.

TEST PROCEDURE

Three samples were tested on November 28 and 29, 2016 using a calibrated universal testing machine. Samples were tested in general accordance with applicable procedures outlined in ASTM D7147-11, “Standard Specifications for Testing and Establishing Allowable Loads of Joist Hangers”, ASTM International. Samples were tested when (ICF) concrete reached a compressive strength of 2470 psi (see Appendix B). A vertical compressive load was applied to the center of the web stiffened I-joist via a steel load transfer block at a constant rate of axial deformation of 0.1 in. /min. without shock until the joist hanger could not support any further loading and load-deflection curve showed that the vertical load resistance was no longer increasing with increased deflection.

A pre-load of 1000 lbf was applied before uniform loading began. Deflection of each joist hanger was continuously recorded using two calibrated LVDT’s. Test setup is provided in Appendix C.

TEST RESULTS

Based on our testing, the average load at 0.125" deflection of the Original Watkins Hanger was determined to be 7145 lbf, 6807, lbf and 6518 lbf for the three samples, respectively. Detailed results of our testing are provided in Table I. Load-deflection curves are shown in Figure 1, 2 and 3.
The typical failure mode observed at ultimate strength of the specimen was flexural cracking and splitting of the I-joist flanges. Failure modes are provided in Appendix D.

If you have any questions regarding the above, please do not hesitate to call the undersigned.

Respectfully Submitted,

APPLIED MATERIALS & ENGINEERING, INC.

1/17/17

Joseph Gapuz
Laboratory Manager

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
ARMEN TAJIRIAN
No. 35535
Exp. 9/30/17
CIVIL
STATE OF CALIFORNIA

Armen Tajirian, Ph.D., P.E.
Principal

TABLE I

ASTM D7147-11
ORIGINAL WATKINS JOIST HANGER

PROJECT NUMER 1160644C

Test Number	**1**	**2**	**3**	**Average**
Load at 0.125" Deflection of Right Hanger, lbf	6613	7432	7446	..
Load at 0.125" Deflection of Left Hanger, lbf	7677	6181	5589	..
Average Load at 0.125" Deflection, lbf	7145	6807	6518	6823
Maximum Load at Failure, lbf	13039	12520	12383	12647
Specific Gravity of I-Joist, %	0.464	0.476	0.465	..
Moisture Content of I-Joist, %	7.1	6.8	7.4	..

FIGURE 1

ASTM D7147
ORIGINAL WATKINS JOIST HANGER

PROJECT NUMER 1160644C

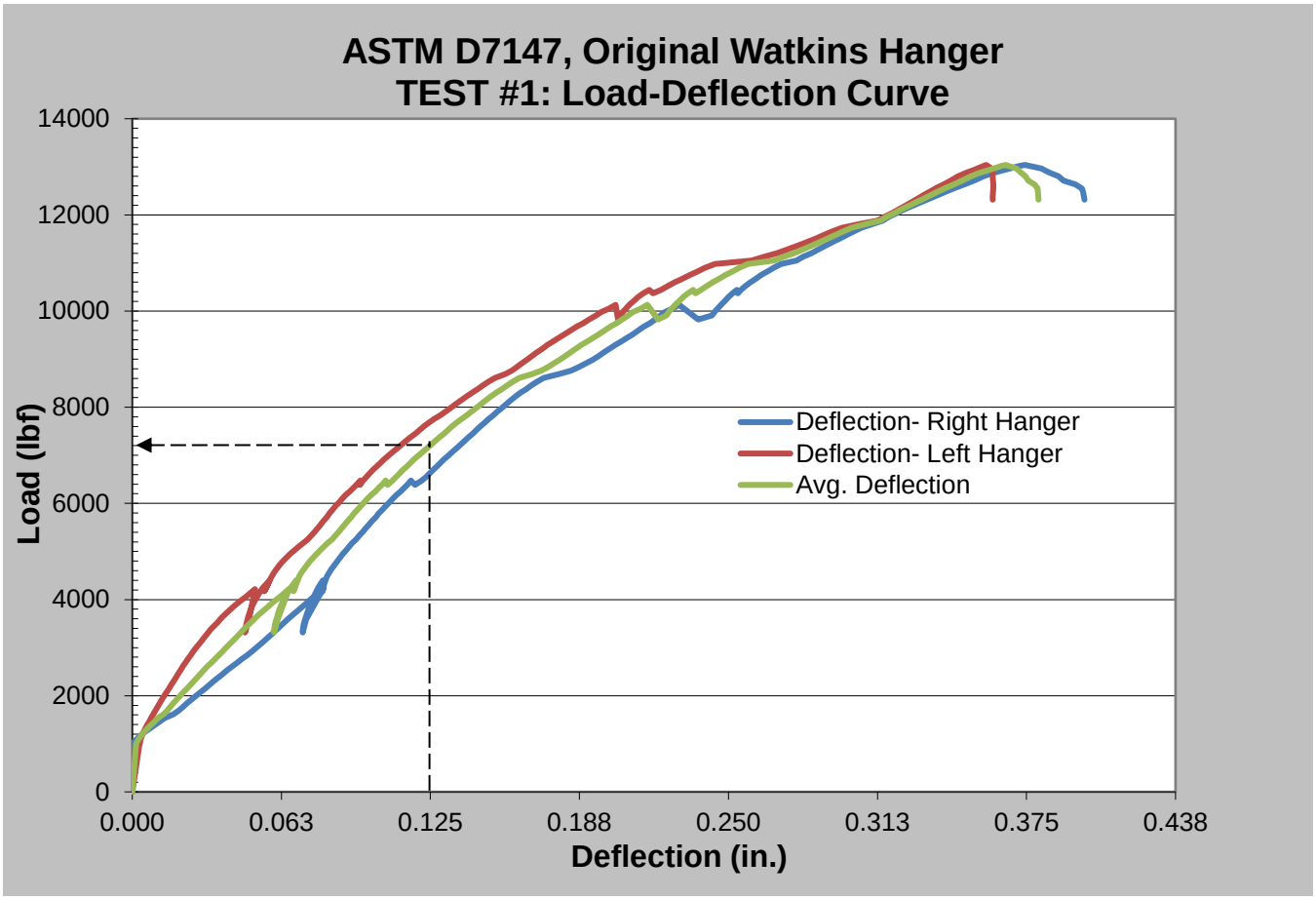


FIGURE 2

ASTM D7147
ORIGINAL WATKINS JOIST HANGER

PROJECT NUMER 1160644C

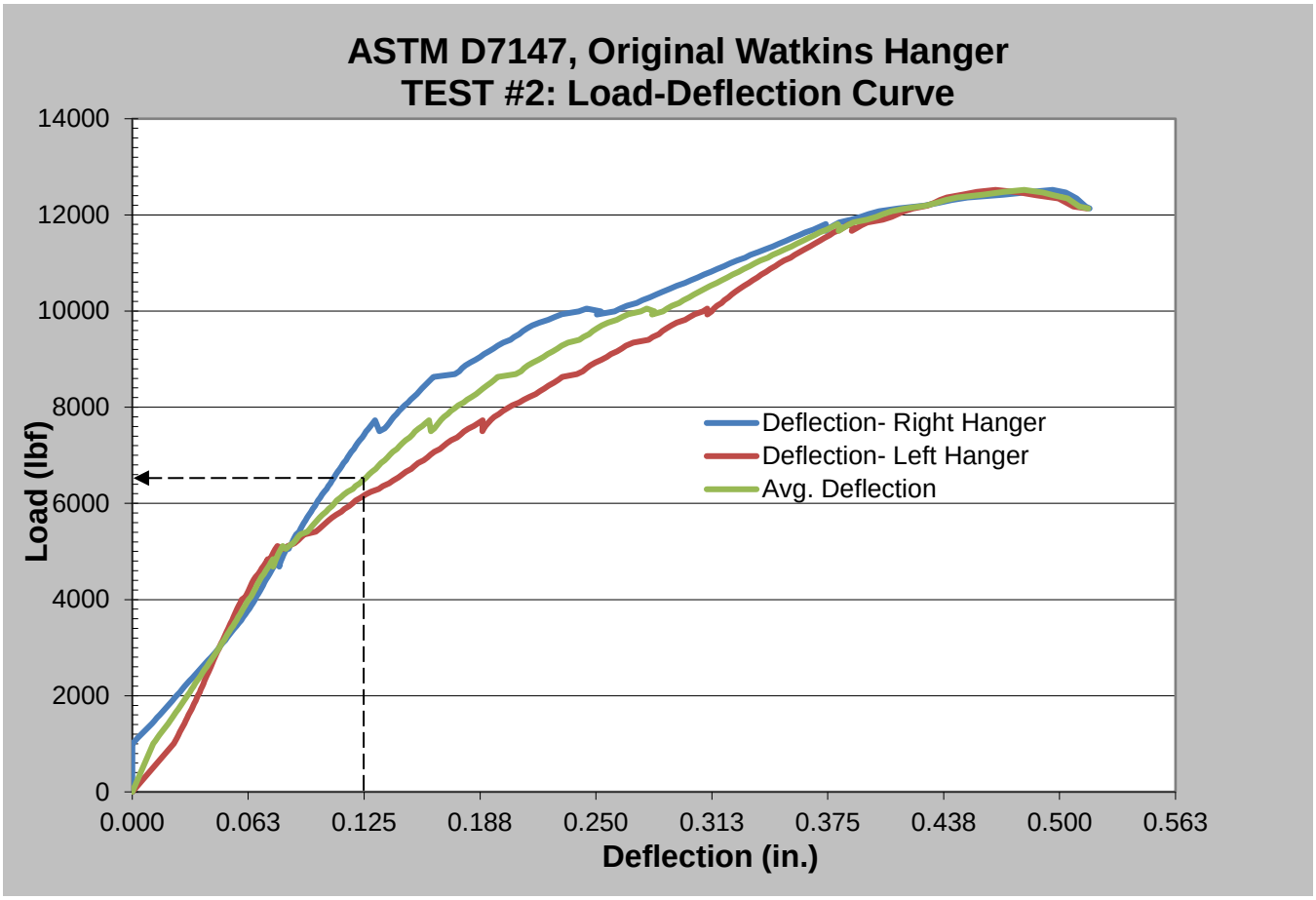
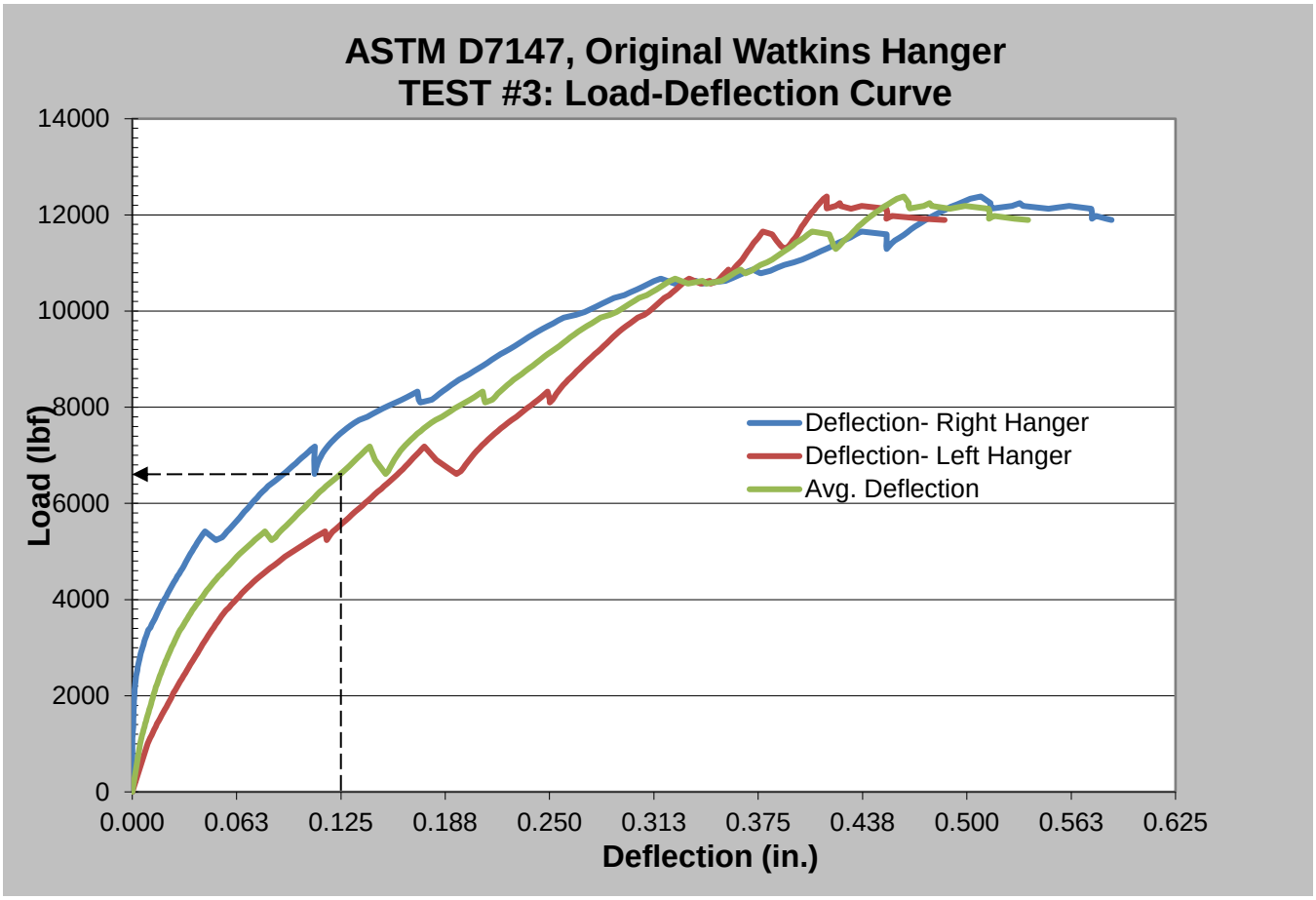


FIGURE 3

ASTM D7147
ORIGINAL WATKINS JOIST HANGER

PROJECT NUMER 1160644C



APPENDIX A

Dolese - Dolese Quality Control
20 NW 13th St.
Oklahoma City, OK 73101
Tel : 405-297-8720

Date : **7/27/2016**

Mix Code : **A9204** Description : **3000 3/8" ICF FA/AEA/WRA**

Revision Number : 134 Creation Date : 25 Apr 2016 Customer :

Plant : Yukon Batch Plant Created By : sbrewer Project :

Specifications

Consistence Class : 5.00 Max W/C : 0.58 Max Agg Size : 3/8"

Strength Class : 3000 PSI Min Cement : Air Class : 4.00

Exposure Class :

Material Type	Material Code	Description	Supplier Source	<DEFAULT>	Design Quantity	Specific Gravity	Volume ft3
Cement	70101A	Cement Type I/II	Ashgrove Cement Co-C		346 lb	3.15	1.76
Fly Ash	70000A	Fly Ash	LaFarge-Sooner Red F		148 lb	2.65	0.90
Water	90307	Water	CITY-City of Yukon		32.3 gal	1.00	4.32
Coarse Aggregate	30107B	3/8" #2 Cover	Dolese Bros Co-Richar		1200 lb	2.68	7.18
Fine Aggregate	50101B	Concrete Sand	Dolese Bros Co-Dover		1933 lb	2.63	11.78
Admixture	70516	Water Reducing Agent(WRA)	BASF Construction Che		14.8 lq oz	-	-
Admixture	70515	Air Entrainment Agent(AEA)	BASF Construction Che		2.5 lq oz	-	-
Admixture	70925	Mid-Range WRA (Poly 1020)	BASF Construction Che		0.0 lq oz	-	-
			Air Content		**4.00 %**	**--**	**1.08**
			Yield		**3896 lb**	**--**	**27.01**

Design Properties

W/C Eq : 0.55 Density : 144.3 lb/ft3 Grading Specification :

Cement Eq : 494 Chloride/Cem : % Actual Dmax : 0 mm

Prepared By :

Element Materials Technology
3100 North Hemlock Circle
Broken Arrow, OK
74012-1115 USA

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Laboratory Report - EAR-Controlled Data

Attn: **Michael Summers**
RP Watkins
2904 N Harvard Ave.
OKLAHOMA CITY, OK 73127 US

Report No: **B16080219**
Date Reported: **8/11/2016**
P.O. No: **Verbal**

Material: **Steel**

Description: **(2) 16 GA G90 Samples**

Room Temperature Tensile Testing ASTM E8/E8M-15a, Not Specified, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, ksi	Yield (0.2% Offset), ksi	Elongation After Fracture (4D), %	Location of Fracture
Sample 1	0.498	0.0588	55	46	33	Inside Middle Half of Gage

Room Temperature Tensile Testing ASTM E8/E8M-15a, Not Specified, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, ksi	Yield (0.2% Offset), ksi	Elongation After Fracture (4D), %	Location of Fracture
Sample 2	0.499	0.0590	55	46	33	Inside Middle Half of Gage

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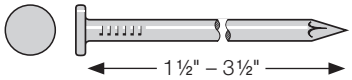
Approved by:

Maurice Cochran
Mechanical Testing Team Leader

Strong-Drive® SCN SMOOTH-SHANK CONNECTOR Nail

Simpson Strong-Tie® Connectors

For More Product Information, see pages 103, 152



Simpson Strong-Tie connectors have been designed and tested with specific types of nails, which are generally referred to as Structural Connector Nails (SCN). The specified nail size, type and quantity must be installed in the correct holes of the connector or strap to achieve the published loads for the hardware. The dimensions and bending yield strength characteristics needed for nails used in Simpson Strong-Tie connectors and hardware are given in the table SCN smooth-shank connector nails and common nails approved for use with Simpson Strong-Tie connectors. The designer and installer must be sure that the correct Simpson Strong-Tie fastener is specified and installed. In cases where the installed nail matches the criteria of the nail specified for the hardware, full hardware design values result.

SCN Smooth-Shank Connector nails and common nails approved for use with Simpson Strong-Tie connectors[1,2,3]

Fastener	Diameter (in.)	Length (in.)	Head Style	Head Diameter (in.)	Minimum Bending Yield Strength (psi)[4]
N8	0.131	1.5	round	0.281	100,000
8d common	0.131	2.5	round	0.281	100,000
N10	0.148	1.5	round	0.281	90,000
N10D	0.148	2.5	round	0.281	90,000
10d common	0.148	3	round	0.281[5]	90,000
N16	0.162	2.5	round	0.281	90,000
16d common	0.162	3.5	round	0.281[5]	90,000

1. Tolerance on diameter and length per ASTM F1667.
2. Tolerance on head diameter (±0.0015 in.)
3. All dimensions are prior to coating.
4. Tested in accordance with ASTM F1575.
5. Minimum head diameter shown; actual head diameters on 10d and 16d common nails are larger.

Power-driven SCNs are often used to install Simpson Strong-Tie connectors and straps. Power-driven nails must have the same dimensions and bending yield strength as hand-driven nails. Dedicated power nailers are designed to drive nails of specific lengths that may be less than the length required to achieve full design values for the connector or strap hardware. When connectors and straps are installed with power-driven nails or hand-driven nails that are a different type or size than those called out in the connector and strap specifications, adjustment factors as given on **www.strongtie.com** must be applied to the allowable loads for the connector or strap.

Over-driven Nails in Connectors and Straps

A nail that is installed such that the head deforms the steel of the connector or strap is considered over-driven. Extra care to prevent over-driven nails should be taken when installing power-driven nails. Simpson Strong-Tie has evaluated the effect of over-driven nails in connectors and straps. No load reductions for connectors or straps apply as a result of over-driven nails if all of the following conditions are met:

- Connectors and straps are 14-, 16-, or 18-gauge steel.
- The top of the nail head is not driven past flush with the face of the metal hardware.
- The nail goes through an existing fastener hole without enlarging it.
- The steel around the hole is not torn or damaged other than denting caused by the nail head.

APPENDIX B

APPLIED MATERIALS & ENGINEERING, INC.
980 41st Street
Oakland, CA 94608
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e-mail: info@appmateng.com

COMPRESSION TEST REPORT

Project Number:	1160644C	Report Date:	11/29/16
Project Name:	Load Testing of Original Watkins (Joist) Hanger	Type of Sample:	Concrete Cylinder C39
		Size of Sample:	4"x8" Cylinder
		Capping Method:	ASTM C1231
		Specimens Made By:	Client
Client Name:	RP Watkins LLC	Date Sampled:	11/01/16
		Time Sampled:	..

Field Test Conditions and Results

Supplier:	Dolesse	Slump, inch:	..	ASTM C143
Mix Number:	A1181	Air Temperature, °F:	..	
Ticket Number:	..	Mix Temperature, °F:	..	ASTM C1064
Truck Number:	..	Air Content, %:	..	ASTM C231
Location in Structure:	..	Fresh Unit Weight, PCF:	..	ASTM C138

Laboratory Test Results

Test Schedule	**11/28/16**	**11/28/16**	**11/28/16**			
Identification	**1A**	**1B**	**1C**			
Diameter, in.	**4.00**	**4.00**	**4.00**			
Length, in.	**8.00**	**8.00**	**8.00**			
Width, in.						
Correction Factor	**1.00**	**1.00**	**1.00**			
Area, in.^{2}	**12.56**	**12.56**	**12.56**			
Ultimate Load, lbs	**31,500**	**31,180**	**30,330**			
Ultimate Strength, psi	**2510**	**2480**	**2410**			
Average Strength, psi			**2470**			
Fracture Type	**5**	**1**	**1**			
Age Tested, days	**27**	**27**	**27**			
Specified Strength, psi	**2500**	**2500**	**2500**			

Specimens not scheduled for testing will be discarded after 28 days

Remarks:

Cc: michael@watkinshanger.com
karl@maffei-structure.com

Reviewed by

Joseph Gapuz

Joseph G Gapuz
Laboratory Manager

Form CTR Rev 0 3/25/05

APPENDIX C

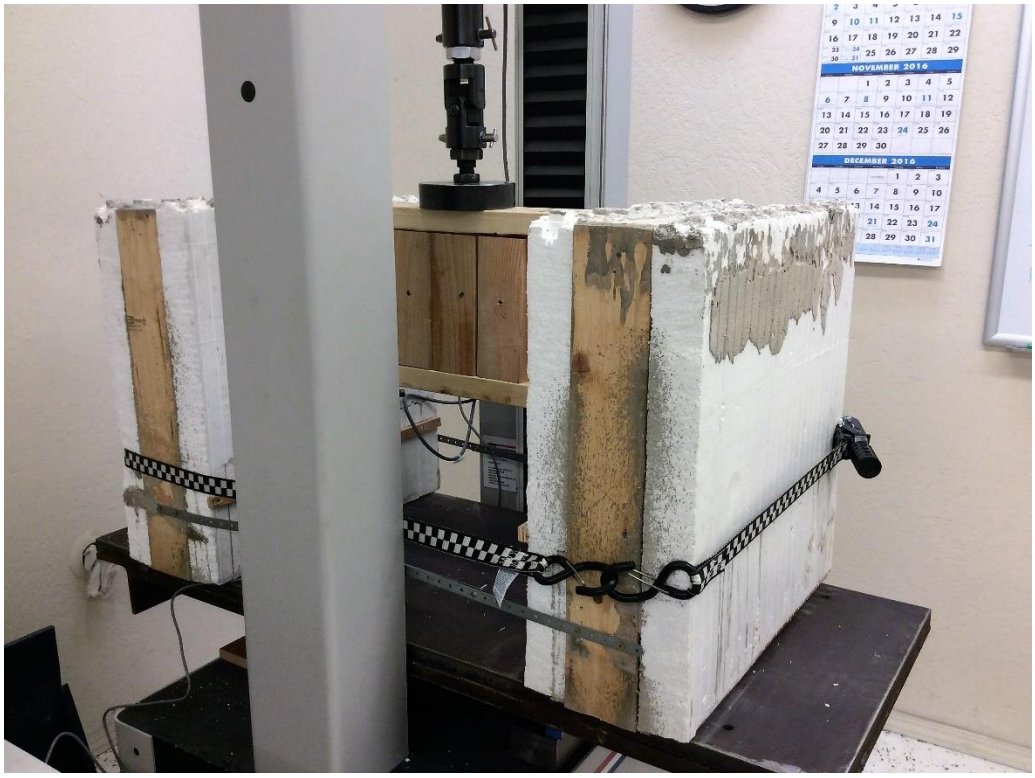

Figure 1. Test Setup

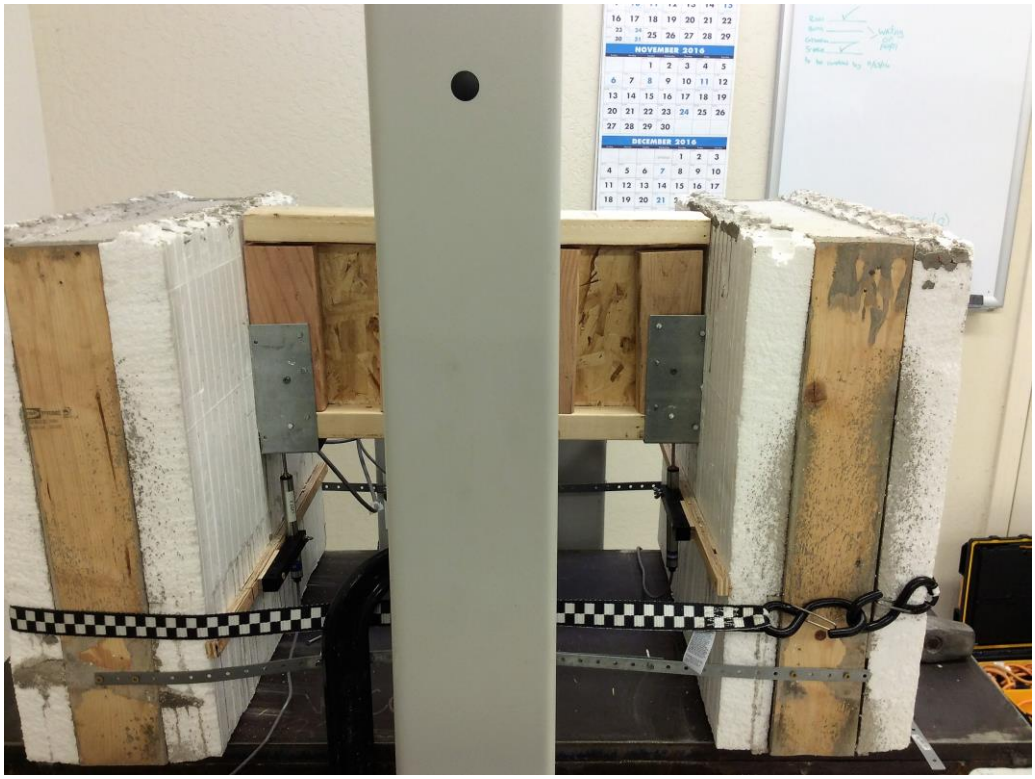

Figure 2. Test Setup Close-up

Figure 3. Test Setup- Right Joist Hanger

Figure 4. Test Setup- Left Joist Hanger

APPENDIX D

Figure 1. Typical failure mode of specimen at ultimate load

Figure 2. Typical failure mode of specimen at ultimate load.