



Progressive Engineering Inc.

SUPER STUD BUILDING PRODUCTS

ASTM E455 Floor Diaphragm Test on a
10' x 20' Floor using 3/4" DragonBoard Structural Subflooring
Fastened at 6" & 12" to 16 ga. Steel Framing Spaced 24" o.c.

7/17/2019



This test report contains twenty (20) pages, including the cover sheet. Any additions to, alterations of, or unauthorized use of excerpts from this report are expressly forbidden.

2019-6211

1. TITLE

ASTM E455 Floor Diaphragm Test on a 10' x 20' Floor using 3/4" DragonBoard Structural Subflooring Fastened at 6" & 12" to 16 ga. Steel Framing Spaced 24" o.c.

2. OBJECTIVE

The objective of this test was to determine the horizontal diaphragm strength of a floor diaphragm constructed per the enclosed details using 3/4" DragonBoard Structural Subflooring.

This test report pertains only to the specimens tested. It remains the sole responsibility of the manufacturer to provide a product consistent to that which was tested.

3. TESTED FOR

Super Stud Building Products
2960 Woodbridge Avenue
Edison, NJ 08837

4. TESTING ORGANIZATION

Progressive Engineering Inc.

58640 State Road 15
Goshen, IN 46528
www.p-e-i.com

See IAS Evaluation Report TL-178 for ISO 17025 Accreditation.

5. TESTING PERSONNEL

Director of Testing - Jason R. Holdeman



The tests were witnessed by Greg Krause of DragonBoard.

6. REFERENCE STANDARDS

ASTM E455-16 - Standard Test Method for Static Load Testing of Framed Floor or Roof Diaphragm Constructions for Buildings

7. TEST EQUIPMENT

- A. One (1) Norman Equipment Co. Hydraulic Pump
- B. Four (4) Lynair Hydraulic Cylinders, Model No. LH-D401, Bore 3-1/4" and 12" stroke
- C. Four (4) Load Cells (PEI Nos. 1163, 1164, 1165, and 1166)
- D. Four (4) Linear Transducers (PEI Nos. 1081, 1085, 1167, and 1168)
- E. One (1) String Potentiometer (PEI No. 1079)
- F. Data Acquisition System (PEI No. 566)

8. TEST SPECIMEN MATERIALS

- A. Floor Sheathing

3/4" DragonBoard Structural Subflooring Panels 4' x 8' - structural Magnesium Oxide (MgO) board, designed and manufactured for use in fire-rated floor assemblies. It has an interlocking square shiplap edge along the 8' dimension of the 4' x 8' sheets. Material was provided to PEI by the client and identified as Lot # 24259BA and 97750GA. See appendix section for product details.

B. Floor Framing

1. Joists - 16 ga. x 10" deep x 10' long with a 2" flange Joists manufactured by Super Stud. The average tested yield strength was 55.0 ksi. See Appendix pages for details.
2. Rim Track - 16 ga. x 10" deep x 20' long Rim Track manufactured by Super Stud. The average tested yield strength was 48.5 ksi. See Appendix pages for details.

C. Fasteners

1. Sheathing to Frame - #8 x 1-5/8" long self-drilling, self-countersinking Grabber screws, Item No. GCB8238SD.
2. Joists to Track - #10-16 x 3/4" long hex-head, Drivall screws, manufactured by Grabber, ICC-ES Legacy Report No. ER-5280.

9. TEST SPECIMEN CONSTRUCTION

Two (2) test samples were constructed to an overall dimension of 10'-0" x 20'-0" by PEI personnel, per the drawing details provided by Super Stud.

- A. The joists were attached to the track using three (3) hex head #10-16 x 3/4" lg. Drivall screws into the side of the joist through 8" long clip angles fastened to the rim track at 24" o.c. using three (3) hex head #10-16 x 3/4" lg. Drivall screws. A 16 ga. strap, 4" wide, was attached to the bottom of the joists with a single screw along the center of the floor to prevent joist rotation.
- B. The frame was squared and then the 3/4" DragonBoard Structural Subflooring Panels were fastened to it. The panels were fastened at 6" o.c. around the perimeter, inset 2" from the corners, and 12" o.c. in the field with #8 screws. Fasteners were inset 3/4" from all panel edges and ends. Care was taken to insure that the fasteners were kept flush or slightly below the surface of the panels and also did not strip out in the steel framing. See attached drawings for details.
- C. A 1/4" x 4" x 4" steel angle iron was then fastened to the end joists flush to the bottom of the joists to minimize crumpling of the joists at the bearings and to represent the top plate member. See attached drawings and photographs for details.

10. TEST SETUP

The test sample was supported by appliance rollers at 48" o.c. around the perimeter of the test sample on a concrete floor. A bearing support was placed at both ends of the test sample. A 1" thick x 10" tall x 14" wide reaction plate was set against the rim track at each bearing to minimize local deformation. The reaction plates were spaced away from the bearing with a 2" dia. half-round steel rod on both ends. Four (4) loading cylinders were located on the opposite side of the test sample. The load was applied from the cylinders to two (2) 18" loading blocks that were connected with steel tubes to uniformly apply the load to the floor. Four (4) linear transducers and one (1) string pot, were placed along the bearing side of the test sample to measure deflection. See attached fixture drawing no. F1907, and F1908 for details.

11. PROCEDURE

- A. The data acquisition system was initiated and all of the displacement gauges and the load cell were checked to insure the signal was active. The preload file was opened and the program was initiated. A preload of approximately 10% of the expected ultimate load.
- B. The preload was applied at approximately the same rate as is required to attain the anticipated maximum load in not less than ten (10) minutes. The preload was held for approximately 5 seconds and then was released. The data file was saved and then closed. The load was removed for a minimum of one (1) minute.
- C. The "test file" was then opened and then the program was initiated with all measurement devices set to zero. The load was applied using the hydraulic cylinders and manually regulated using flow control valves to maintain a load rate of not less than ten (10) minutes to the maximum load. Observations were recorded throughout the test.
- D. The loads were released at the point where no further gain could be attained. The file was saved and then the maximum load and displacement at the maximum load was recorded by the technician, along with a detailed description of the failure.
- E. The data acquisition system was set to record continuously throughout the test. The data pages found in this report display only ten (10) readings between zero and the maximum load. However, the chart reflects the data as recorded by the acquisition system.

12. TEST RESULTS

See the attached data pages and charts for test results.

13. CONCLUSION

Based on the testing described in this report, when tested per ASTM E455 Simple Beam Test Method, an average ultimate shear strength of 954 PLF for a 6" x 12" fastener spacing can be attained when using the following:

- A. 3/4" DragonBoard Structural Subflooring Panels fastened in accordance with the drawing in this report.
- B. 3/4" DragonBoard Structural Subflooring Panels fastened using #8 x 1-5/8" long self-drilling, self-countersinking screws manufactured by Grabber.
- C. Super Studs 16ga. x 10" Joists spaced 24" o.c. and 16ga. x 10" Rim Track attached in accordance with Section 9 and the drawings in this report.

Progressive Engineering Inc.

ASTM E 455 Simple Beam Diaphragm Test

Date: 7/17/2019

Client: Super Stud

Specimen: 3/4" Dragon Board Subfloor, shiplap edge, fastened to 16 ga. x 10" deep joists with a 2" flange, set 24" o.c., with #8 x 1-5/8" lg. screws spaced 6" o.c. around each panel perimeter and 12" o.c. in the field.

Test Conditions

Temperature: (°F): 71

Relative Humidity (%): 50

Preload (lbf): 1,990

Diaphragm Length a (in): 240

Diaphragm Depth b (in): 120

Load Duration to R_u (min:sec): 37:14

Test No. **19-6211-6/12@24oc-1**

	Deflection (in)						Δ^{**}
	Load (lbf)	Location 1	Location 2	Location 3	Location 4	Location 5	
0	0	.000"	.000"	.000"	.000"	.000"	.000"
.1 R_u	1,909	.042"	.050"	.048"	.037"	.025"	.017"
.2 R_u	3,817	.075"	.098"	.101"	.085"	.052"	.038"
$R_u/3$	6,362	.106"	.163"	.182"	.163"	.081"	.088"
.4 R_u	7,634	.120"	.195"	.224"	.202"	.094"	.117"
.5 R_u	9,543	.144"	.249"	.296"	.269"	.113"	.168"
.6 R_u	11,451	.171"	.312"	.381"	.346"	.137"	.227"
.7 R_u	13,360	.203"	.396"	.483"	.437"	.163"	.300"
.8 R_u	15,268	.253"	.540"	.666"	.593"	.202"	.438"
.9 R_u	17,177	.332"	.769"	.974"	.883"	.283"	.667"
1 R_u	19,086	.456"	1.155"	1.395"	1.278"	.405"	.964"

Ultimate Load (R_u) = **19,086** lbf

Shear Strength (S_u) = **954** plf

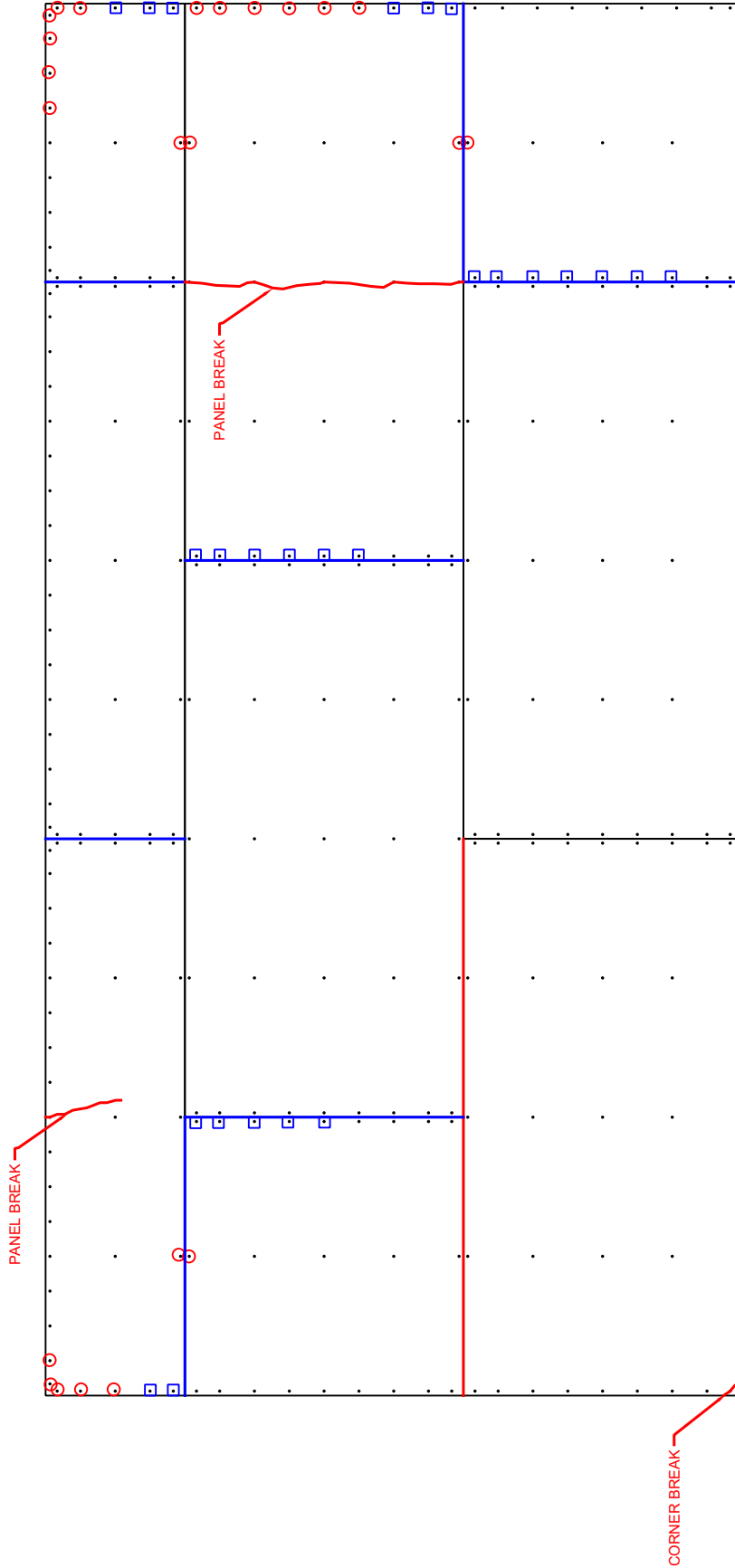
Design Load ($R_u/3$) = **6,362** lbf

Design Shear Strength = **318** plf


Failure: **Row #1**, Joist #2 - Fastener rotation at T&G, Joist #3 - Butt-joint separation >3/4" with edge breakout @ 7 fasteners on 4' sheets, Joist #7 - ~1/2" Butt-joint separation with edge breakout @ four (4) locations. T&G 1-2 shifted 1/2" from Joist #7 to #11 with fastener rotation @ T&G on Row #1 side. Rolled end joist at T&G. **Row #2**, Joist #1 - Panel break out @ four (4) fasteners and fastener rotation @ five (5) locations. Joist #3 - panel split broke thru the fastener locations from T&G 1-2 to T&G 2-3, Joist #5 - ~1/2" butt-joint separation with edge breakout @ six (6) locations, Joist #9 - ~3/8" separation of butt-joint with edge breakout @ five (5) locations, Joist #11 - Edge breakout @ three (3) locations from T&G 1-2. **Row #3**, Joist #1 - Edge breakout @ three (3) locations and fastener rotation along bearing track corner @ seven (7) locations, Joist #3 - Butt-joint separation ~1/4", Joist #9 - Panel cracked from Rim Track to center fastener ~1-1/2" from screw, Joist #11 - Edge breakout @ two (2) locations and fastener rotation @ three (3) locations with two (2) locations at rim track corner.

Notes: Butt-joint separation started at approximately 10,000 lbf.

** Δ is derived by subtracting the average bearing movement from the maximum point of deflection



- ◇ = SHEATHING FRACTURES @ FASTENERS
- XXX = SURFACE SPALLING
- = FASTENER ROTATION
- = SHEATHING PULL-OVER / BREAKOUT
- △ = FASTENER SHEAR
- (blue) = SEPARATION OR SHIFTING (>1/4")
- (red) = SEPARATION OR SHIFTING (<1/4")



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THIS DRAWING IS A PART OF TEST REPORT No. 2019-6211

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DOWN BY: J. HOLDEMAN	REVISED ON:	CLIENT:	SUPER STUD
DATE: 8/2/19			
SCALE:			
JOB NO. 2019-6211		TITLE:	CONFIGURATION 19-6211-1
DWG. NO. B1			

Progressive Engineering Inc.

ASTM E 455 Simple Beam Diaphragm Test

Date: 7/17/2019

Client: Super Stud

Specimen: 3/4" Dragon Board Subfloor, shiplap edge, fastened to 16 ga. x 10" deep joists with a 2" flange, set 24" o.c., with #8 x 1-5/8" lg. screws spaced 6" o.c. around each panel perimeter and 12" o.c. in the field.

Test Conditions

Temperature (°F): 71

Relative Humidity (%): 50

Preload (lbf): 1,990

Diaphragm Length a (in): 240

Diaphragm Depth b (in): 120

Load Duration to R_u(min:sec): 25:44

Test No. **19-6211-6/12@24oc-2**

	Deflection (in)						Δ**
	Load (lbf)	Location 1	Location 2	Location 3	Location 4	Location 5	
0	0	.000"	.000"	.000"	*	.000"	.000"
.1*R _u	1,763	.022"	.026"	.026"	*	.010"	.011"
.2*R _u	3,526	.045"	.063"	.067"	*	.030"	.030"
R _u /3	5,877	.076"	.124"	.138"	*	.060"	.070"
.4*R _u	7,052	.090"	.158"	.176"	*	.074"	.094"
.5*R _u	8,815	.114"	.216"	.245"	*	.112"	.132"
.6*R _u	10,579	.142"	.283"	.329"	*	.146"	.185"
.7*R _u	12,342	.180"	.374"	.449"	*	.209"	.255"
.8*R _u	14,105	.224"	.492"	.599"	*	.232"	.371"
.9*R _u	15,868	.277"	.634"	.785"	*	.231"	.531"
1*R _u	17,631	.356"	.930"	1.162"	*	.350"	.809"

Ultimate Load (R_u) = **17,631** lbf

Shear Strength (S_u) = **882** plf

Design Load (R_u/3) = **5,877** lbf

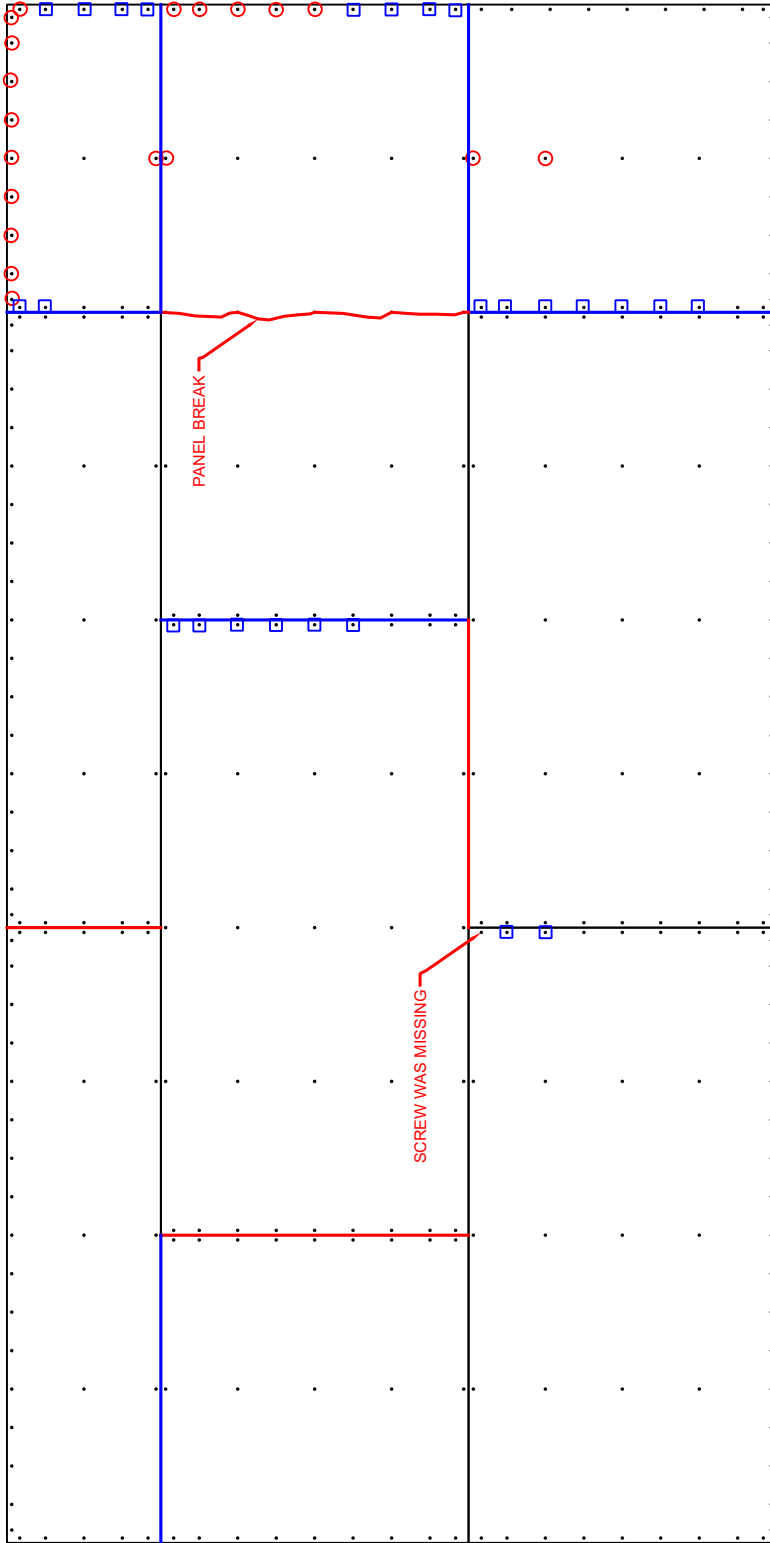
Design Shear Strength = **294** plf

Failure: Row #1, Joist #2 - Fastener rotation at T&G, Joist #3 - Butt-joint separation >1/2" with edge breakout @ 7 fasteners on 4' panel, Joist #7 - ~3/8" Butt-joint separation with edge breakout @ two (2) locations. Row #2, Joist #1 - Panel break out @ four (4) fasteners and fastener rotation @ five (5) locations. Joist #3 - panel split broke thru the fastener locations from T&G 1-2 to T&G 2-3, Joist #5 - ~1/2" butt-joint separation with edge breakout @ six (6) locations. Row #3, Joist #1 - Edge breakout @ four (4) locations and fastener rotation along bearing track corner @ nine (9) locations, Joist #3 - Butt-joint separation ~1/4", Joist #9 - Panel cracked from Rim Track to center fastener ~1-1/2" from screw, Joist #11 - Edge breakout @ three (3) locations.

Notes: Butt-joint separation started at approximately 10,000 lbf.

* - This gauge was not reading properly during the test

** Δ is derived by subtracting the average bearing movement from the maximum point of deflection



- ◇ = SHEATHING FRACTURES @ FASTENERS
- ⊗ = SURFACE SPALLING
- = FASTENER ROTATION
- = SHEATHING PULL-OVER / BREAKOUT
- △ = FASTENER SHEAR
- (Blue) = SEPARATION OR SHIFTING (>1/4")
- (Red) = SEPARATION OR SHIFTING (<1/4")

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DWN BY: J. HOLDEMAN	REVISED ON:	CLIENT:
DATE: 8/2/19		SUPER STUD
SCALE:		CONFIGURATION
JOB NO.: 2019-6211		19-6211-2
DWG. NO.: B2		

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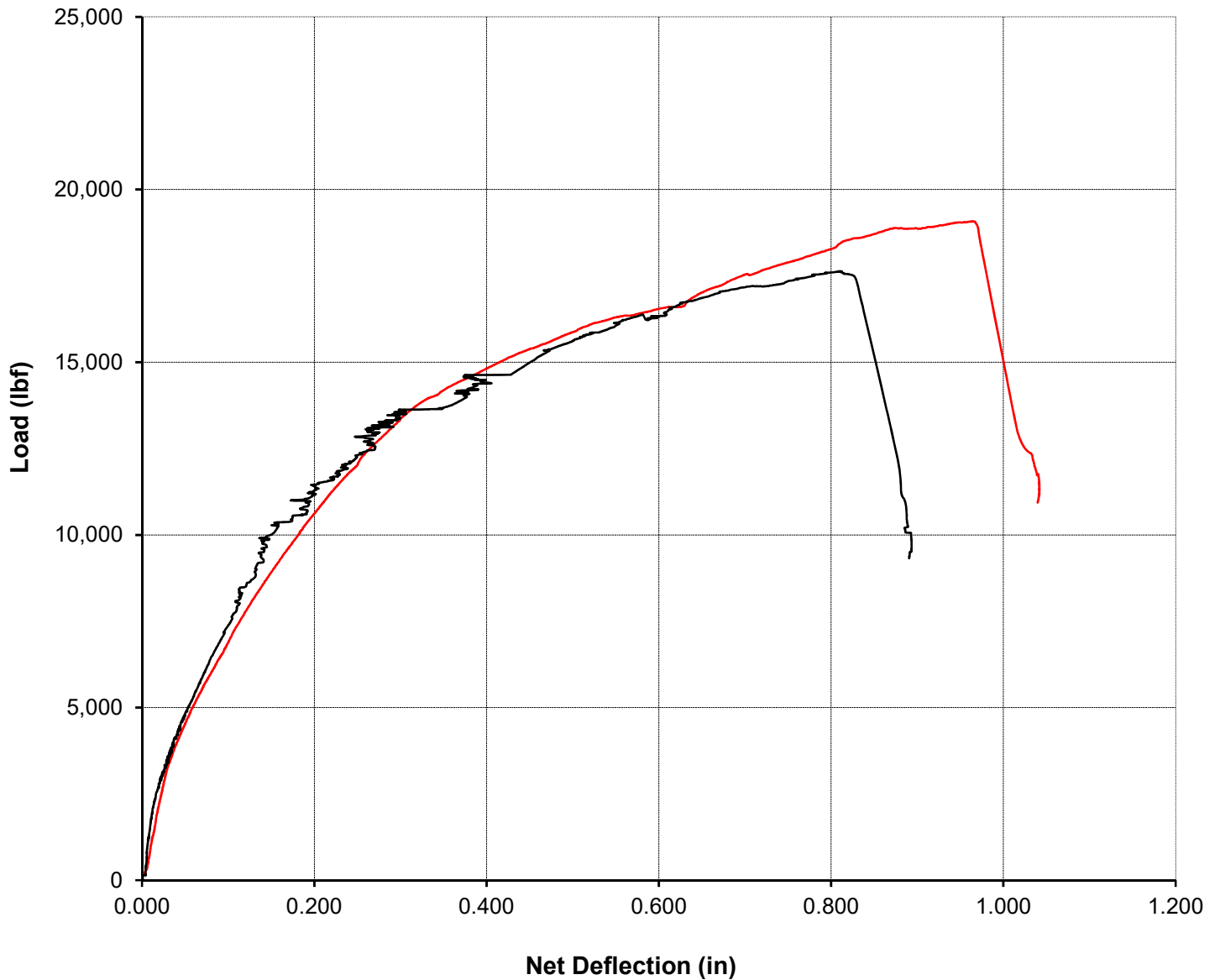
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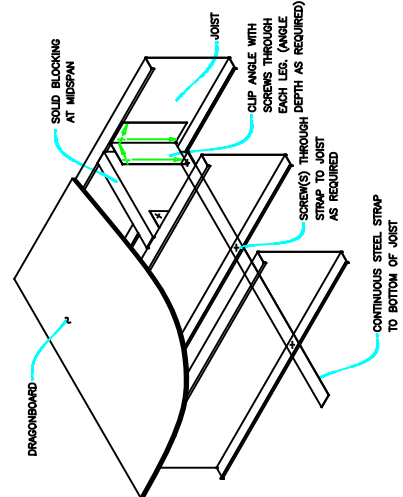
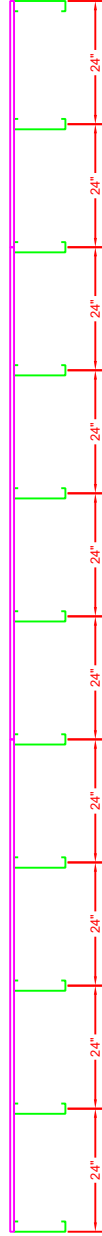
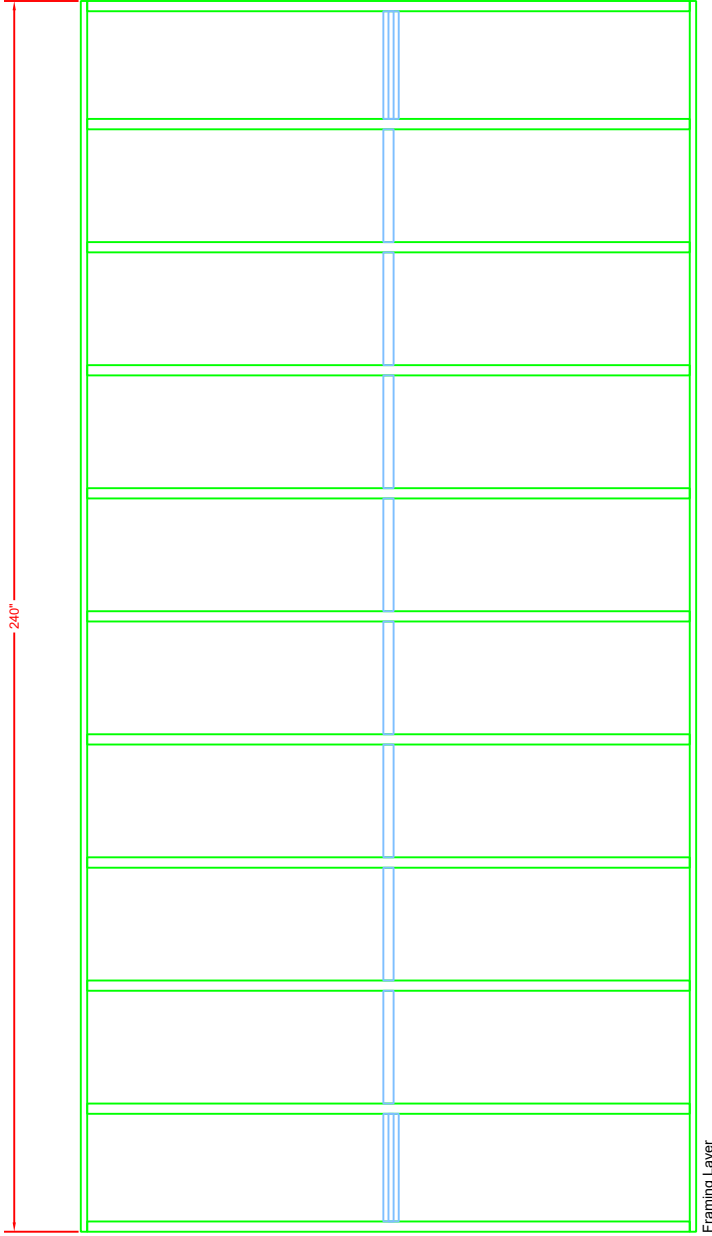
Progressive Engineering Inc.

**Super Stud
ASTM E455 Simple Beam Floor Diaphragm Test
using 3/4" Dragon Board
with a 6"-12" Fastening Schedule to 24" o.c. 16 ga. Framing**

— 19-6211-6/12@24oc-1

— 19-6211-6/12@24oc-2





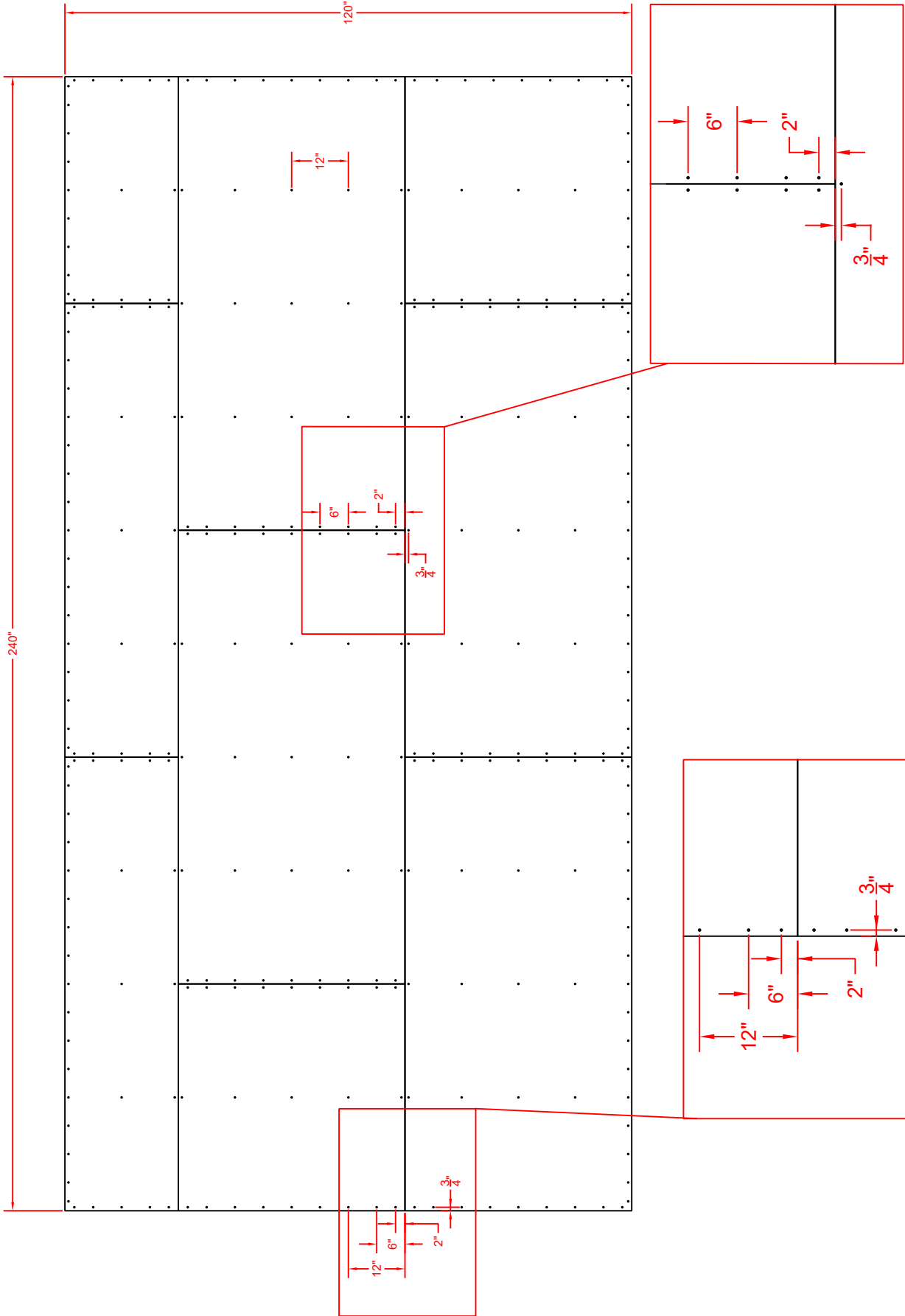
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DWN. BY: J. HOLDEMAN	CLIENT: SUPER STUD
DATE: 8/2/19	REVISED ON:
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JOB NO. 2019-6211	DWG. NO. B3

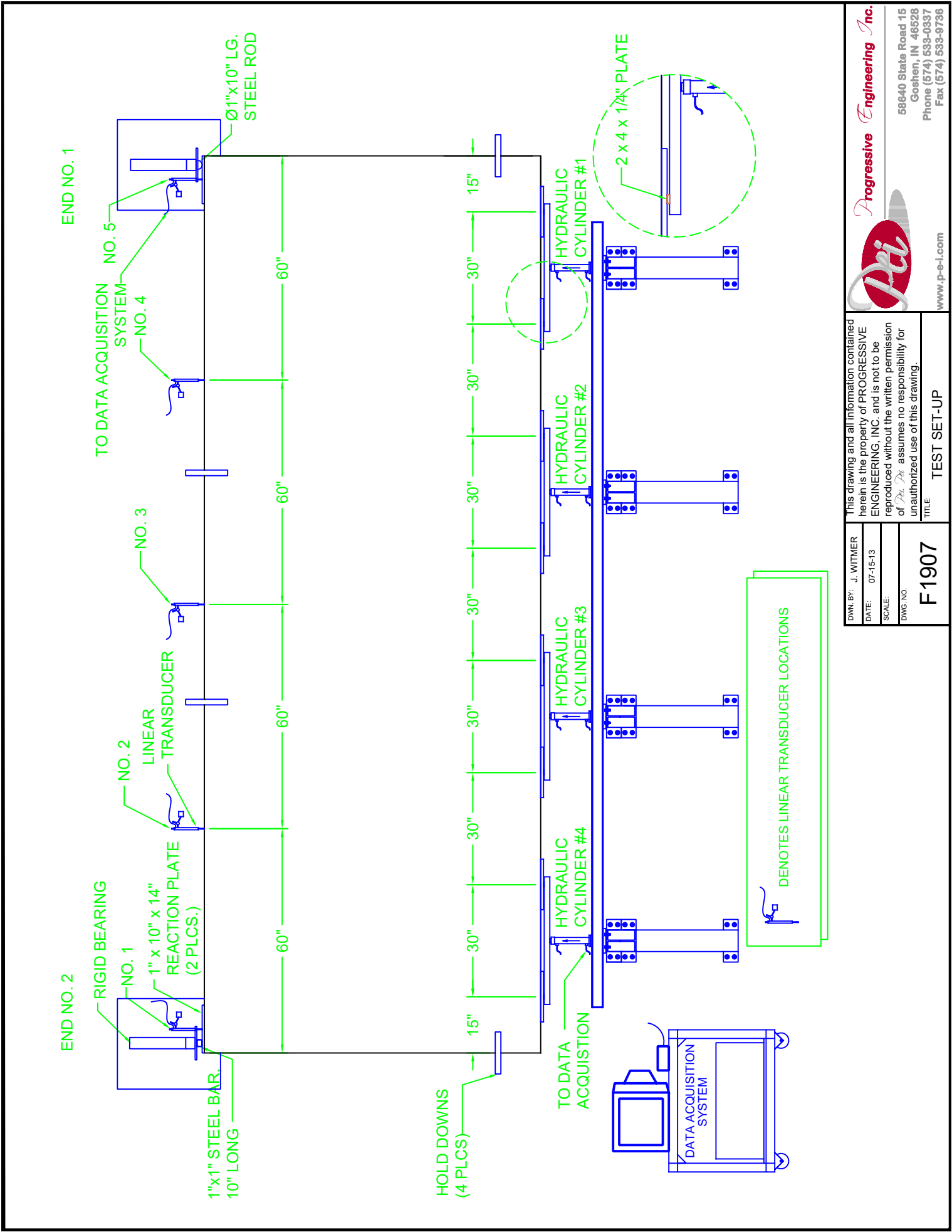


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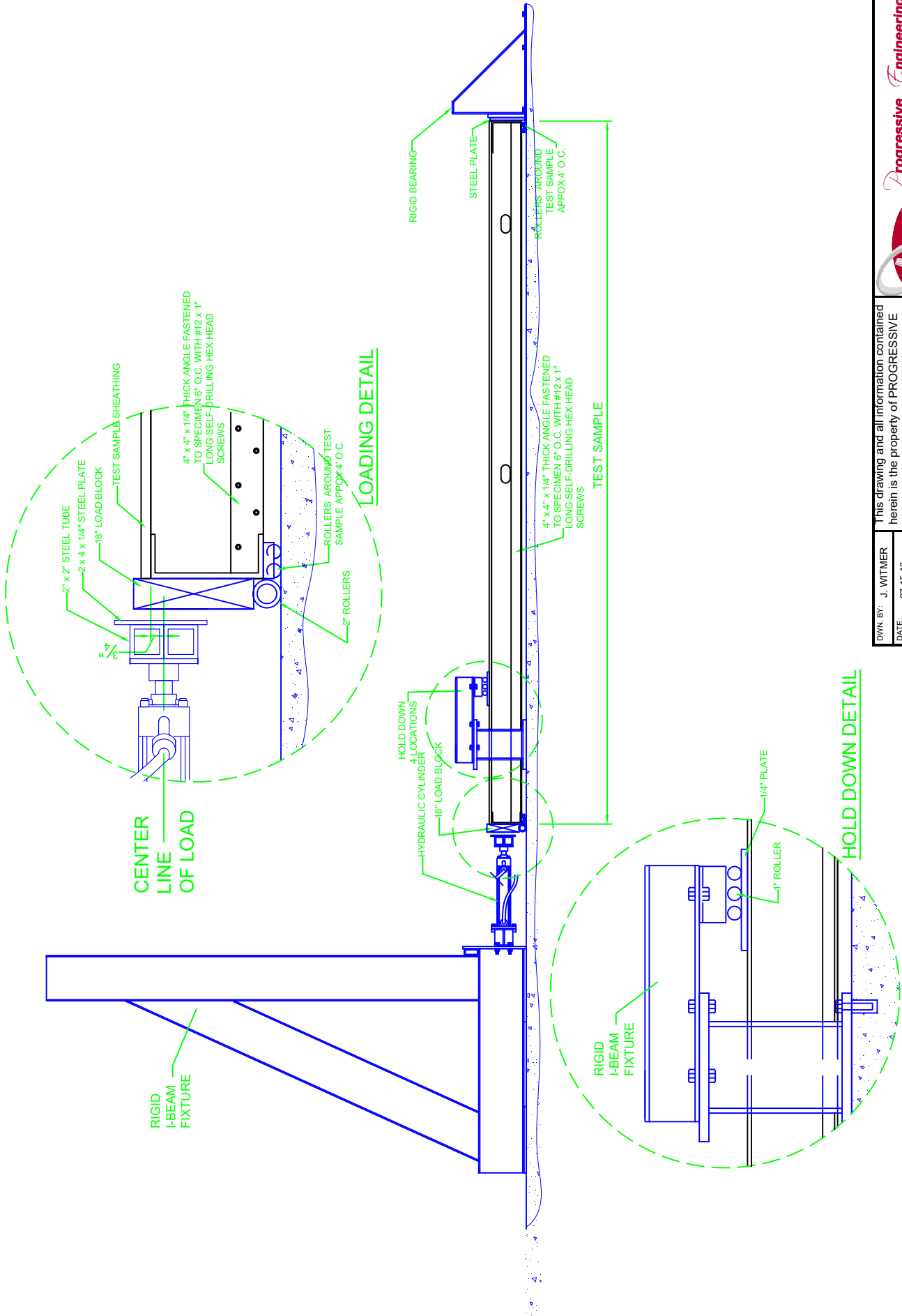
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DATE: 8/2/19	TITLE: DRAGONBOARD FASTENING
SCALE:	
JOB NO. 2019-6211	
DWG. NO. B4	



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F1907			



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DWN. BY: J. WITWER DATE: 07-15-13 SCALE: DWG. NO.	TITLE: TEST SET-UP	

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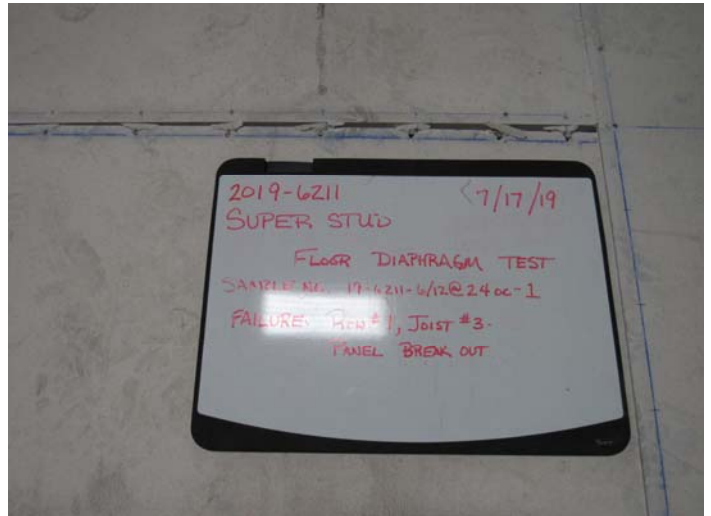
F1908

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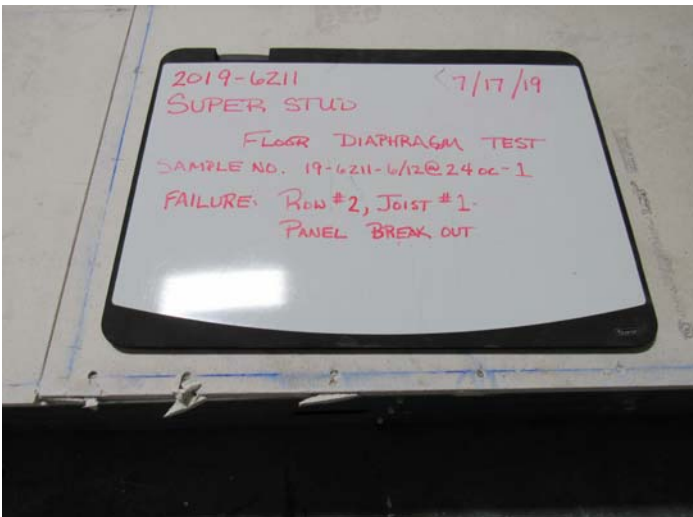
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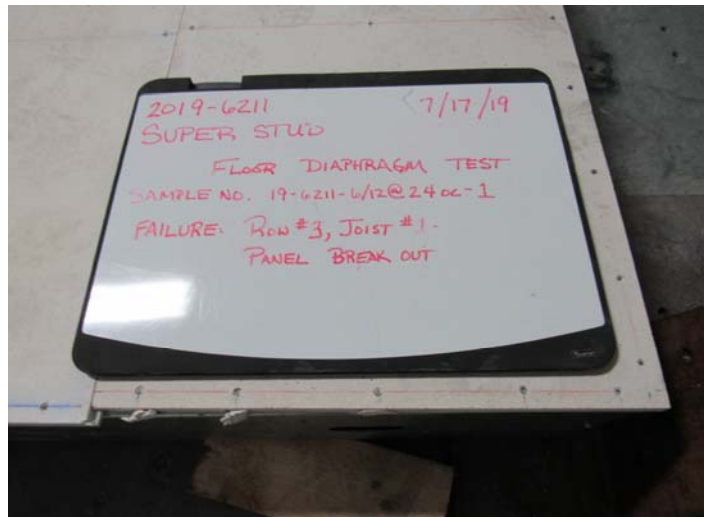
Test Setup



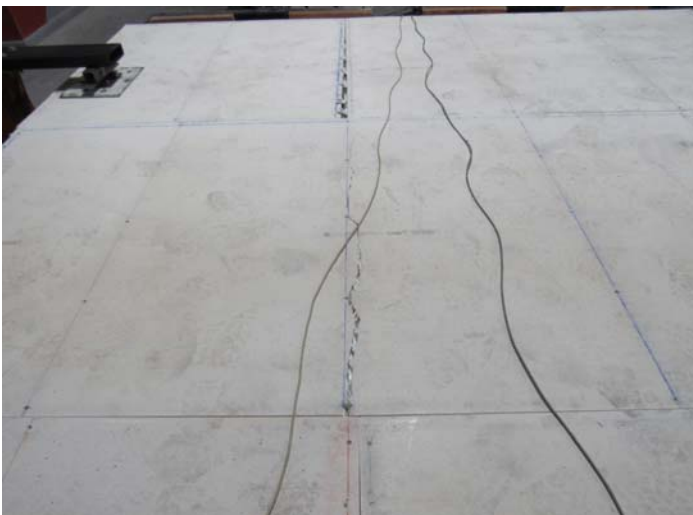
Separation Between Panels (Row 1 Joist 3)



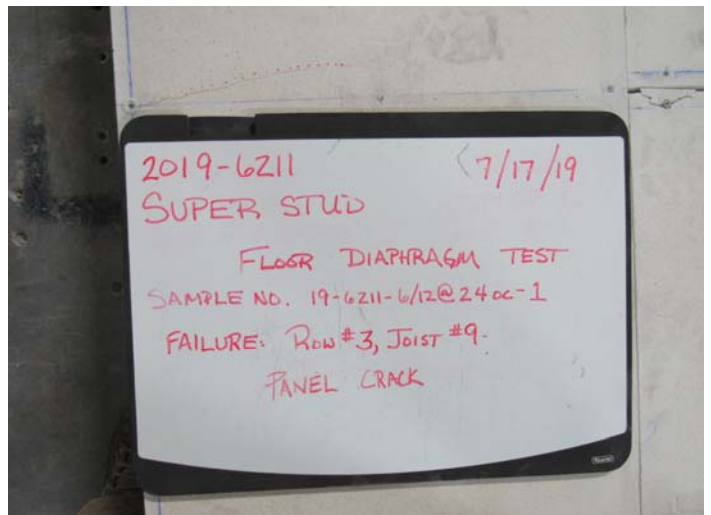
Panel Breakout (Row 2 Joist 1)



Panel Breakout (Row 3 Joist 1)



Panel Break/Split (Row 2 Joist 3)



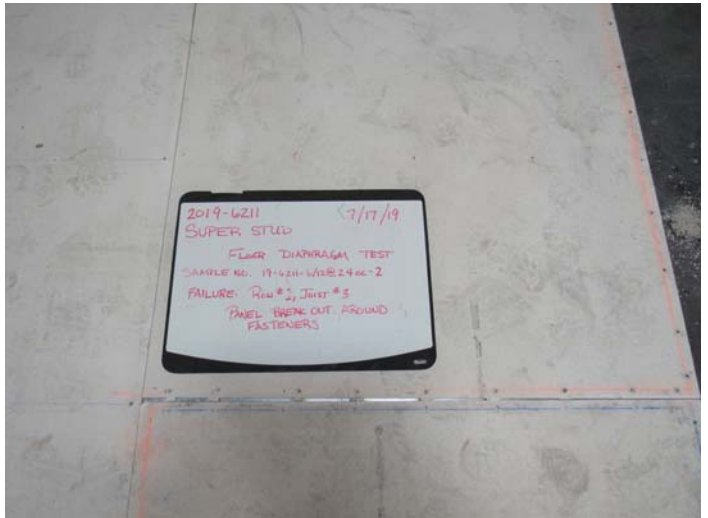
Panel Break/Split (Row 3 Joist 9)

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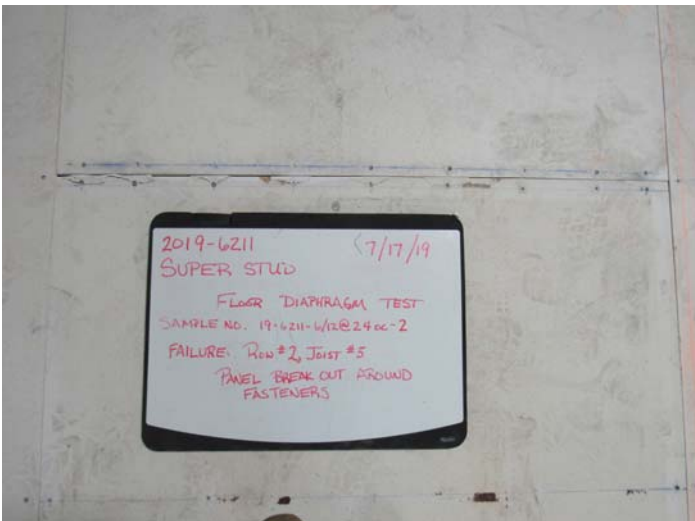
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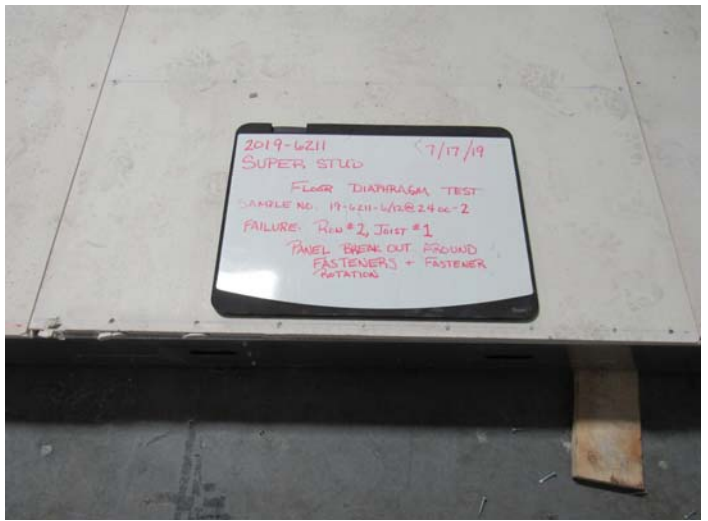
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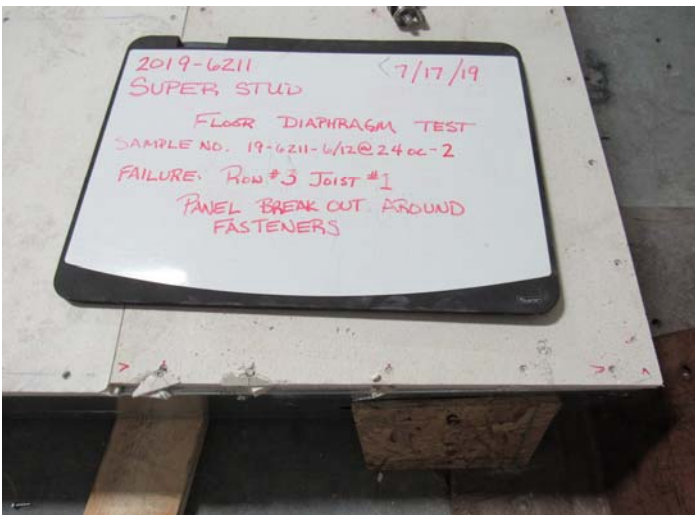
Separation Between Panels (Row 1 Joist 3)



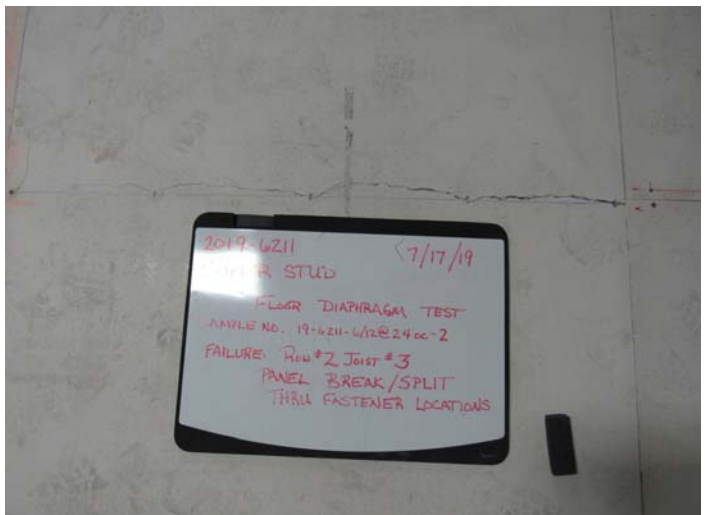
Separation Between Panels (Row 2 Joist 5)



Panel Breakout (Row 2 Joist 1)



Panel Breakout (Row 3 Joist 1)



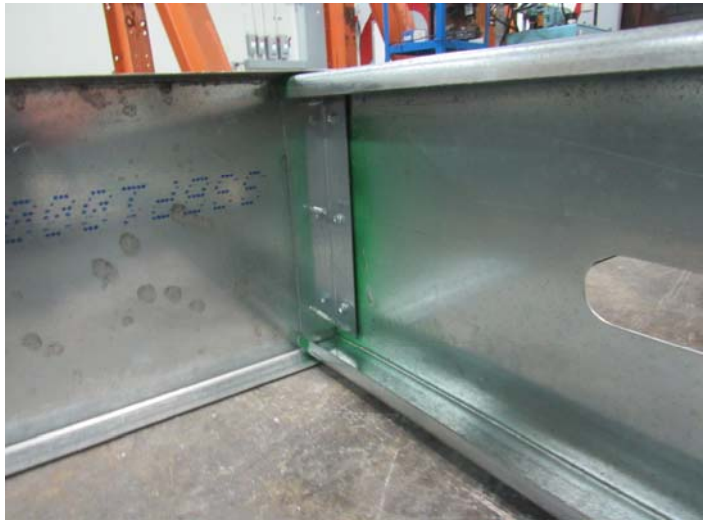
Panel Break/Split (Row 2 Joist 3)

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Sample Details



Test Frame



Joist to Track Connection



End Blocking Connection



Strap Bracing Connection



Sheathing Fastener Edge Distance and Shiplap



Sheathing Fastener Spacing



Progressive Engineering Inc.

APPENDIX

SUPER STUD BUILDING PRODUCTS

2019-6211

Progressive Engineering Inc.

ASTM E8-16a Tensile Test (Rectangular)

Date: 8/1/2019

Client: Super Stud

Specimen: **Track and Joist From Shear Diaphragm Test**

Temperature: 72°F

Humidity: 53% R.H.

Load Rate (in/min): 0.125

Specimen No.	Sample		Cross-Sectional Area (in ²)	Load at		Yield Strength 0.2% offset (ksi)	Ultimate Strength (ksi)	Elongation at Break (%)	Failure Mode
	Width	Thick.		0.2% offset (lbf)	Max Load (lbf)				
19-6211-T1	0.509"	0.0553"	0.02815	1,361	1,938	48.4	68.8	32.0%	b
19-6211-T2	0.507"	0.0544"	0.02758	1,343	1,874	48.7	67.9	32.2%	a
19-6211-T3	0.508"	0.0544"	0.02764	NA	1,844	NA	66.7	NA	d
Average	0.508"	0.0547"	0.02779	1,352	1,885	48.5	67.8	32.1%	

Specimen No.	Sample		Cross-Sectional Area (in ²)	Load at		Yield Strength 0.2% offset (ksi)	Ultimate Strength (ksi)	Elongation at Break (%)	Failure Mode
	Width	Thick.		0.2% offset (lbf)	Max Load (lbf)				
19-6211-J1	0.510"	0.0540"	0.02754	1,502	2,020	54.5	73.4	28.6%	d
19-6211-J2	0.509"	0.0543"	0.02764	1,529	2,067	55.3	74.8	28.2%	d
19-6211-J3	0.509"	0.0542"	0.02759	1,525	2,063	55.3	74.8	28.4%	d
Average	0.509"	0.0542"	0.02759	1,519	2,050	55.0	74.3	28.4%	

Failure Codes

a - Specimen broke perpendicular to edge near center of reduced section.

b - Specimen broke at an angle near center of reduced section.

c - Perpendicular break between radius and center of reduced section

d - Specimen broke at an angle between radius and center of reduced section

e - Specimen broke at an angle near radius.

f - Specimen broke perpendicular to edge near radius.

g - Specimen broke perpendicular to edge near grips.

Progressive Engineering Inc.

Board Weight and Thickness

Date: 7/17/2019

Temperature: 71°F

Client: Super Stud Building Products

Humidity: 49% R.H.

Specimen: 3/4" DragonBoard Structural Subflooring

Sample No.	Weight (lbs)	Thickness (in)	Board Code
6211-1	112.4	0.742	Not Available
6211-2	113.6	0.751	
6211-3	114.2	0.746	
6211-4	115.4	0.752	
6211-5	113.7	0.751	

Progressive Engineering Inc.



Materials As-Received



Joist Tag



DragonBoard Pallet #1 Tag



DragonBoard Pallet #2 Tag



DragonBoard Markings



DragonBoard Markings