DATASYST
Engineering & Testing Services, Inc.
S14 W33511 Highway 18 • Delafield, WI 53018 • 262 968-4003 • Fax: 262 968-3050 • 800 969-4050

LOAD TESTING

OF

3-3/4 INCH DIAMETER MAGNETS

FOR
METAL & CABLE CORPORATION, INC.

TEST DATES:
JUNE 21, 2016 THROUGH JUNE 24, 2016

DATASYST PROJECT:
M109-17325

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1.0 INTRODUCTION

Metal & Cable Corporation, Inc. of Twinsburg, OH submitted to DATASYST Engineering & Testing Services, Inc. (DATASYST) of Delafield, WI three (3) magnets used in antenna mounts for mechanical load testing. The three magnets were 3-3/4 inches in diameter and ½ inch thick. Testing of the magnets was conducted using the supplied acceptance criteria for magnetic fastening systems AC463-0216-R2 dated February 2016 as a guide. The supplied AC463-0216-R2 dated February 2016 references testing in accordance with the MDFA Pull Test Standard MDFA 101.

The object of the testing was to load the samples with Mylar pads, Poly pads, and no pads, in tension and in sheer, on an unpainted painted surface, and with Mylar pads and Poly pads on a painted surface while measuring the force and displacement where the magnetic mounts release. This testing was performed with the magnets individually: AC463 single magnet tests, and also in a fixture as a group of three for the 3-magnet: AC463 three magnet tests.

2.0 CONCLUSIONS

The magnet samples were exposed to tensile and shear testing under ten different conditions. Those ten conditions were:

1) The magnets were magnetically attached to a bare metal plate 3/8 inch thick ground to a 0.003 inch tolerance with no pads.
2) The magnets were magnetically attached to a bare metal plate 3/8 inch thick ground to a 0.003 inch tolerance with Mylar pads.
3) The magnets were magnetically attached to a bare metal plate 3/8 inch thick ground to a 0.003 inch tolerance with Poly pads.
4) The magnets were magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance on a painted surface 0.013 inches thick with Mylar pads.
5) The magnets were magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance on a painted surface 0.013 inches thick with Poly pads

6) The magnets were mounted into a fixture to hold all three magnets and magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance with no pads.
7) The magnets were mounted into a fixture to hold all three magnets and magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance with Mylar pads.
8) The magnets were mounted into a fixture to hold all three magnets and magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance with Poly pads.
9) The magnets were mounted into a fixture to hold all three magnets and magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance on a painted surface 0.013 inches thick with Mylar pads
10) The magnets were mounted into a fixture to hold all three magnets and magnetically attached to a metal plate 3/8 inch thick ground to a 0.003 inch tolerance on a painted surface 0.013 inches thick with Poly pads.

For each sample, one pull test of each of the ten test conditions was performed in tension and in sheer. On the painted steel plate, no tests were conducted without pads so the paint was not damaged for the following tests, and per Metal and Cable personnel, pads will always be used on a painted surface. A total of forty tests were conducted using the single magnets.

A summary table of the maximum load achieved for each condition before the magnets released from the steel plate is shown in the data section of this report.

3.0 TEST PROCEDURES

Prior to testing any of the magnet samples, two ground steel plates with a 0.003 inch tolerance were purchased. The plates were drilled for mounting to a bedplate for testing. After the drilling was complete one of the plates was painted using a Sherwin Williams, Protective & Marine coatings Macropoxy 646 primer and Acrolon 218HS top coat paint. Paint was applied with rollers in several coats to a dry paint measurement of 0.013. This dry paint measurement was obtained using the customer supplied Fischer dual scope model FMP40C coating thickness gauge. While the paint cured according to the manufacturer's instructions, a load frame and data acquisition systems were setup for the tensile testing. The unpainted

ground plate was attached to the bedplate using ½ inch bolts. An MTS 1.0 kip actuator with an LVDT for displacement was mounted to the load frame. A 500 pound load cell was attached to the actuator, and the load cell and LVDT were run to an MTS 407 controller. According to the test plan, the controller was set to ramp at a rate of 200 lbs. per minute. A Somat data acquisition system was setup to record the load and displacement during the testing.

Magnet sample number 1 was setup with a threaded rod and swivel joint. The actuator had a clevis with pin that would attach to the swivel joint on the magnet. Sample number 1 was then magnetically coupled to the unpainted steel fixture plate directly beneath the actuator. This fixture plate was 12" x 36" x 0.375" thick and was fastened to the bedplate. With the magnet in place, the Data acquisition was started and the first 200 lbs. per minute load ramp was started. Samples 2 and 3 were run next. All three magnets were tested with no pads on them.

All of the magnets provided for the individual magnet testing, were received with no pads on them. Metal and Cable Corporation supplied both Poly pads, and Mylar pads for the testing. The Mylar pads measured 0.002" thick and the Poly pads measured 0.004" thick. Tensile testing continued on the three samples each one being tested with a Mylar pad and a Poly pad. After completing the tensile test on the three samples using the unpainted plate, a fixture was designed and built to hold all three samples. The same actuator and load cell were then used to conduct the tensile test on all three magnets together. Once again the testing was conducted with no pads, with Mylar pads and with Poly pads. All tests were conducted using the 200 lbs. per minute load rate. After completing the tensile test on the unpainted plate the actuator was moved and mounted to the bedplate. Once again a swivel and clevis were used to load the magnet samples pulling them horizontally for the shear testing (see photos section 6.0). After the individual magnet tests completed, the magnets were again mounted to the fixture and all three were tested together. Each magnet and group of three magnets was tested using no pads, the Mylar pads, and the Poly pads.

It should be noted here that whenever damage to one of the pads was seen, and could not be smoothed down per Metal and Cable personnel instructions, the pad was changed using extra pads provided by Metal and Cable Corp.

When the paint was cured per the manufacturer's instructions, the unpainted plate was removed and the painted plate was installed in its place. The above described testing was repeated using the same three magnet samples.

Summary tables of the maximum load achieved for each condition can be found in the data section of this report, along with some setup and results photos.

4.0 DATA

Metal Cable Magnet Tensile load Load Data Ground Steel Plate (no paint)								
Magnet Sample #		Load in tension No Pad		Load in tension Mylar Pad		Load in tension Poly Pad		
		lbs. force		lbs. force		lbs. force		
1		139.2		126.01		133.17		
2		126.28		155.9		131.1		
3		124.4		118.35		108.9		
1, 2, 3		394.65		295.6		270.8		

Summary Table of the tensile load tests on the bare steel plate

Metal Cable Magnet Shear Load Data Ground Steel Plate (no paint)						
Magnet Sample #		Load in shear No Pad		Load in shear Mylar Pad		Load in shear Poly Pad
		lbs. force		lbs. force		lbs. force
1		87.2		54.4		46.4
2		91.7		65.3		63.0
3		96.9		58.0		63.5
1, 2, 3		226.5		151.8		180.0

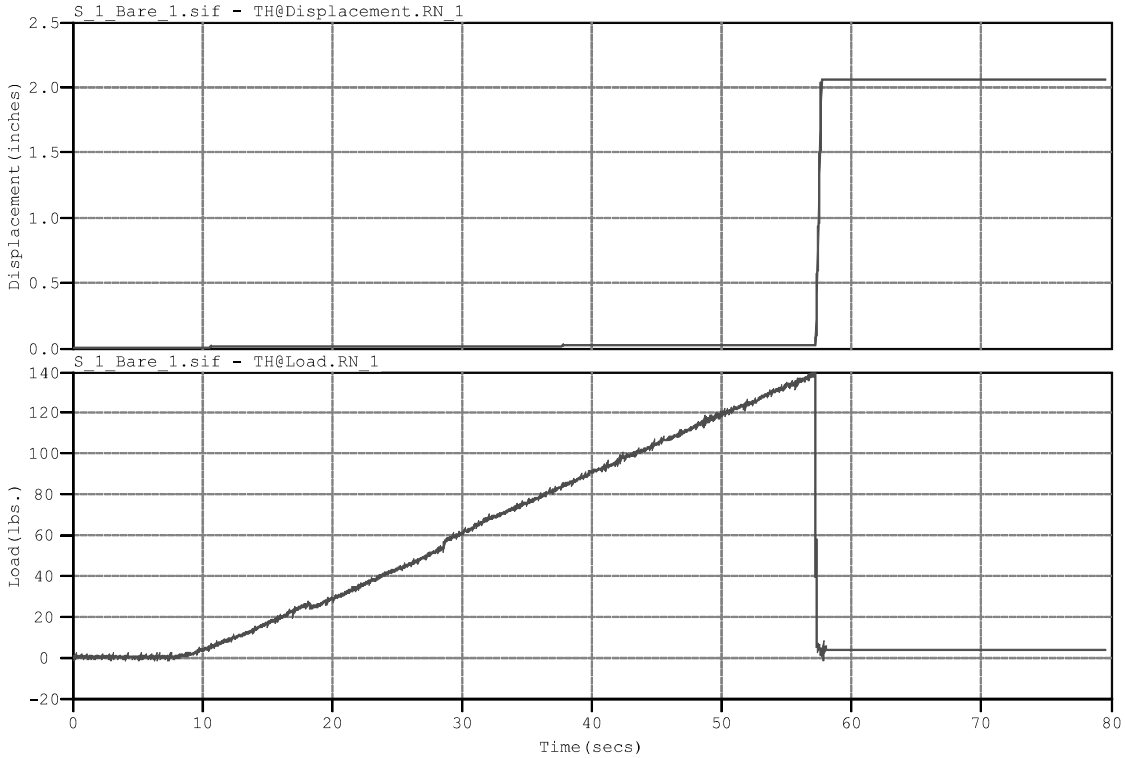
Summary Table of the shear load tests on the bare steel plate

Metal Cable Magnet Tensile Load Data Ground Steel Plate (painted)						
Magnet Sample #	Load in tension No Pad		Load in tension Mylar Pad		Load in tension Poly Pad	
		lbs. force		lbs. force		lbs. force
1		Na		56.1		49.1
2		Na		78.1		75.7
3		Na		50.8		53.3
1, 2, 3		Na		200.3		140.2

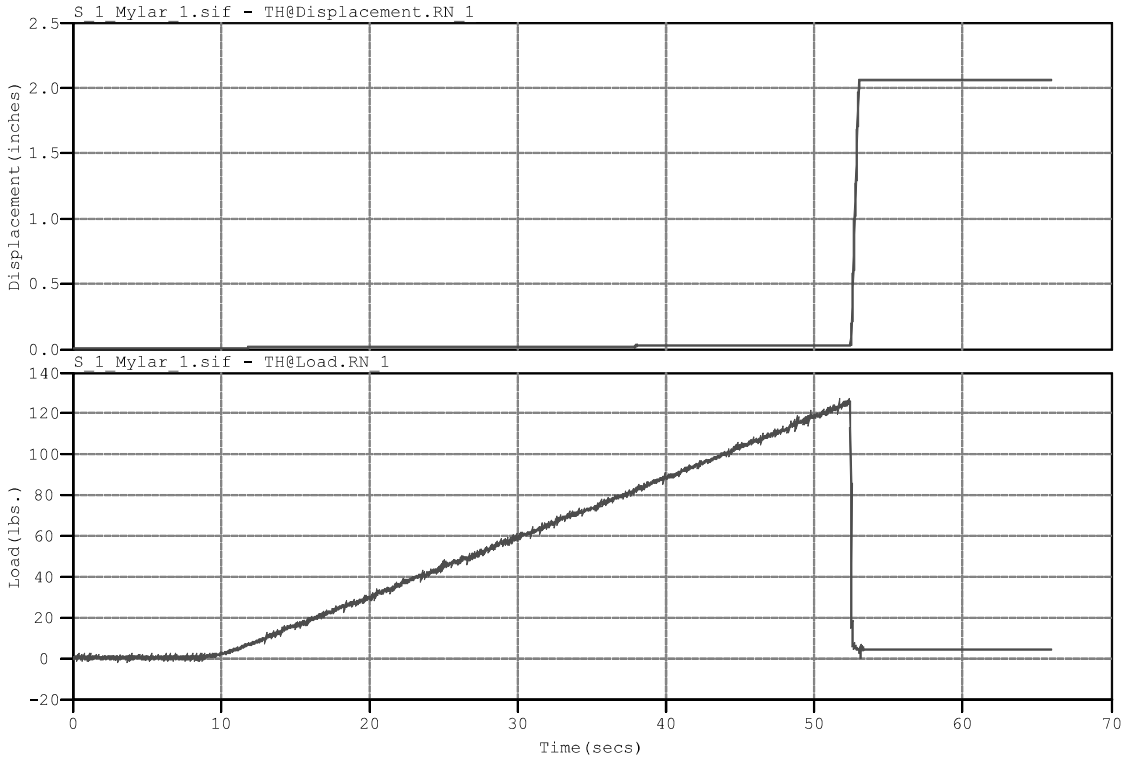
Summary Table of the tensile load tests on the painted steel plate

Metal Cable Magnet Shear Load Data Ground Steel Plate (painted)						
Magnet Sample #		Load in shear No Pad		Load in shear Mylar Pad		Load in shear Poly Pad
		lbs. force		lbs. force		lbs. force
1		Na		18.9		33.0
2		Na		19.5		36.7
3		Na		16.6		35.1
1, 2, 3		Na		61.6		81.5

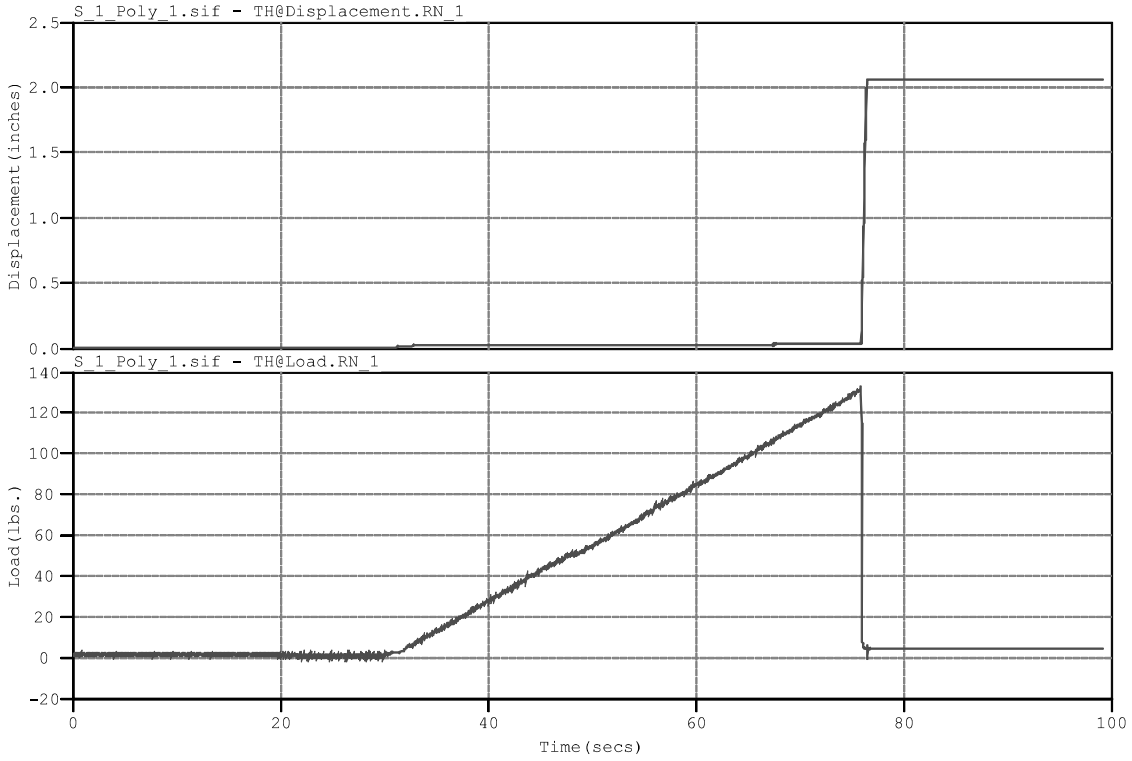
Summary Table of the shear load tests on the painted steel plate



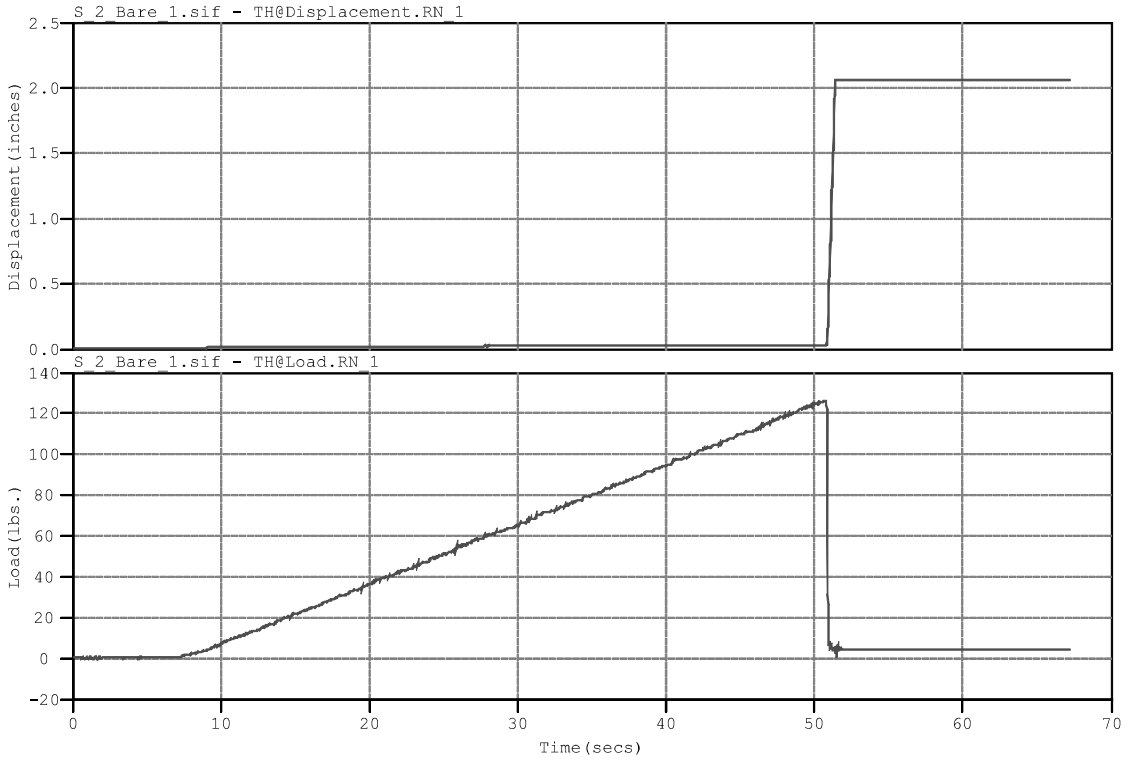
Sample 1 tensile no pad unpainted plate



Sample 1 tensile Mylar pad unpainted plate



Sample 1 tensile Poly pad unpainted plate



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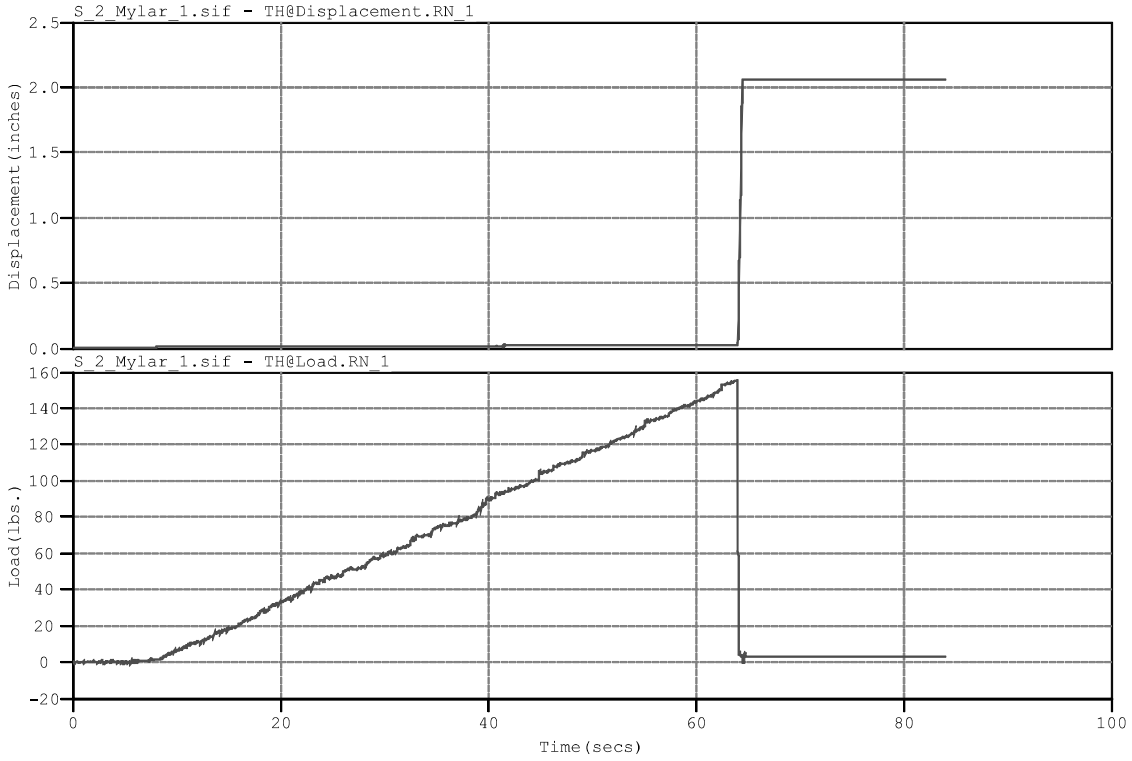

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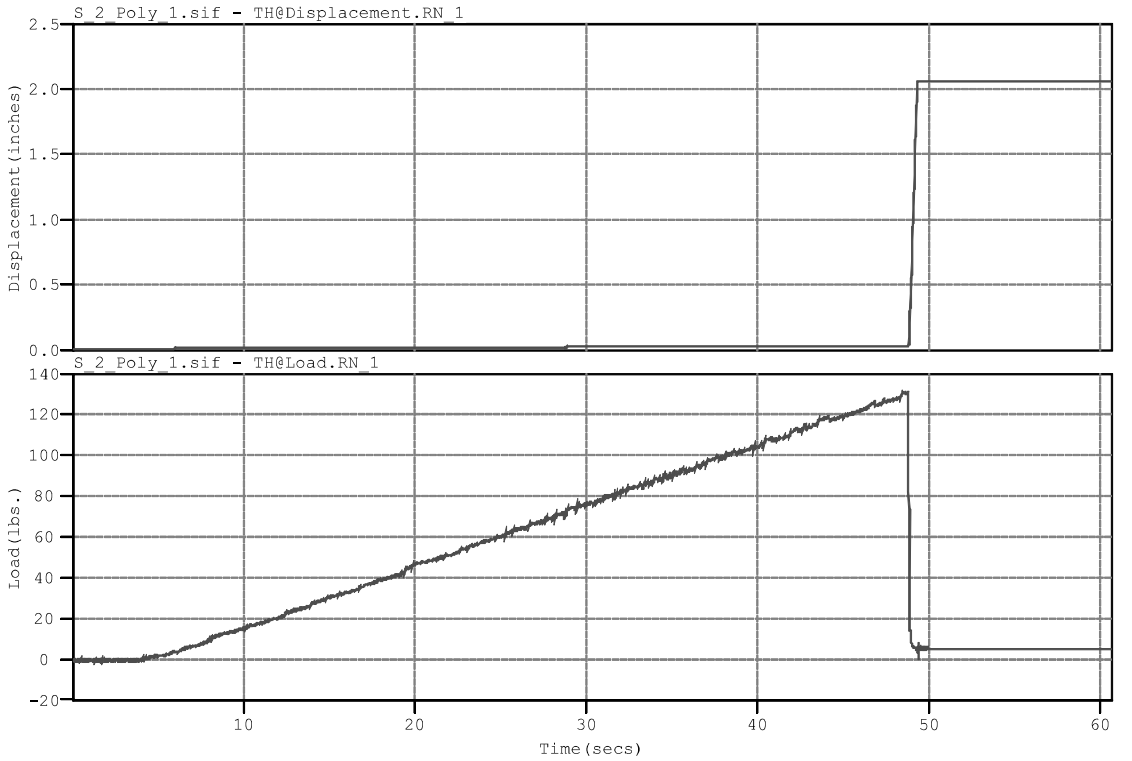

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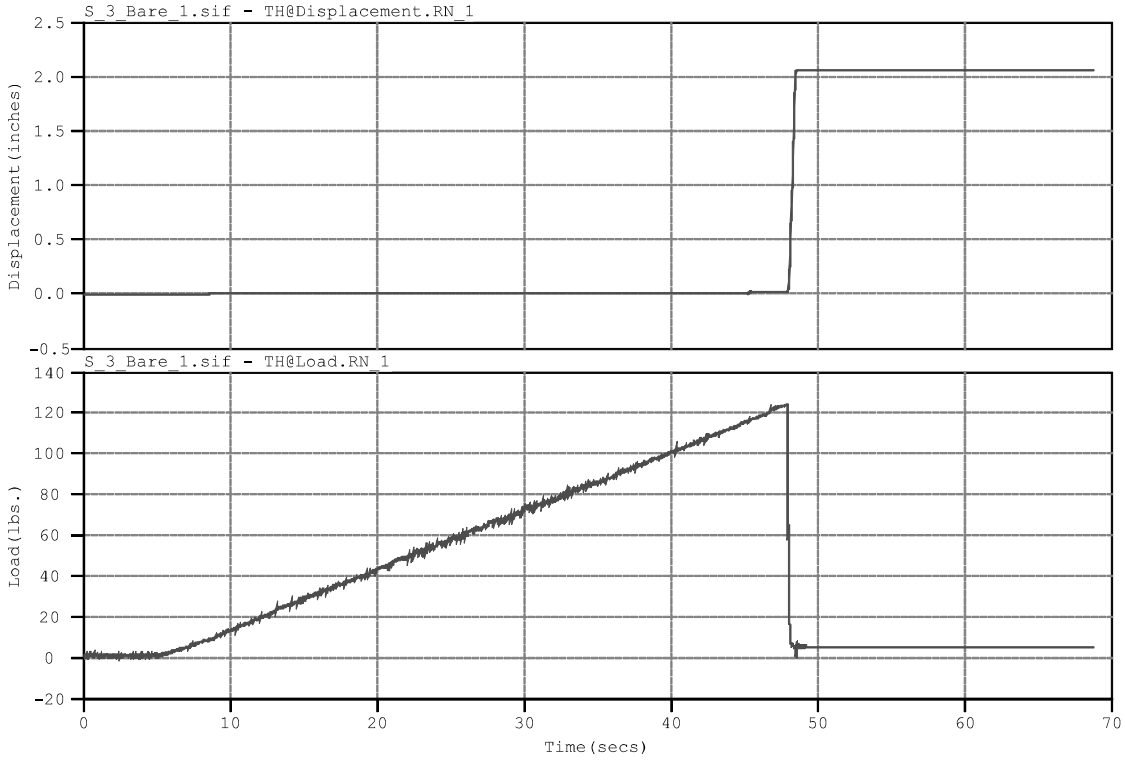

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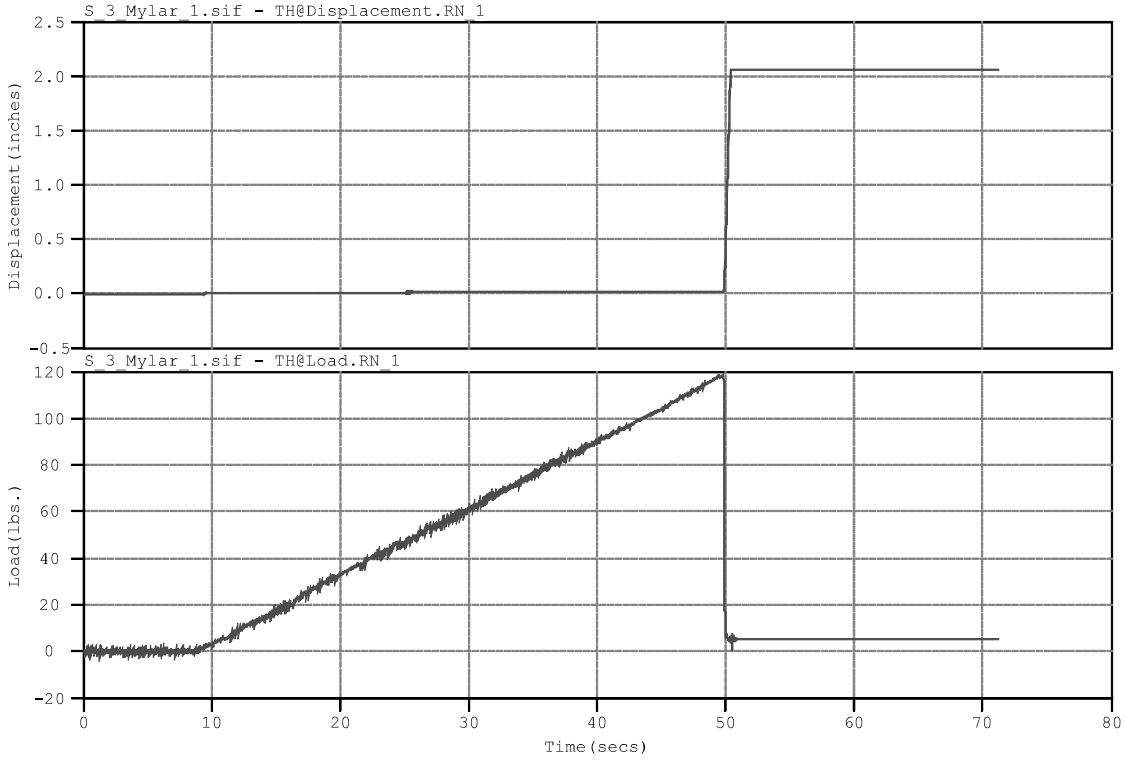

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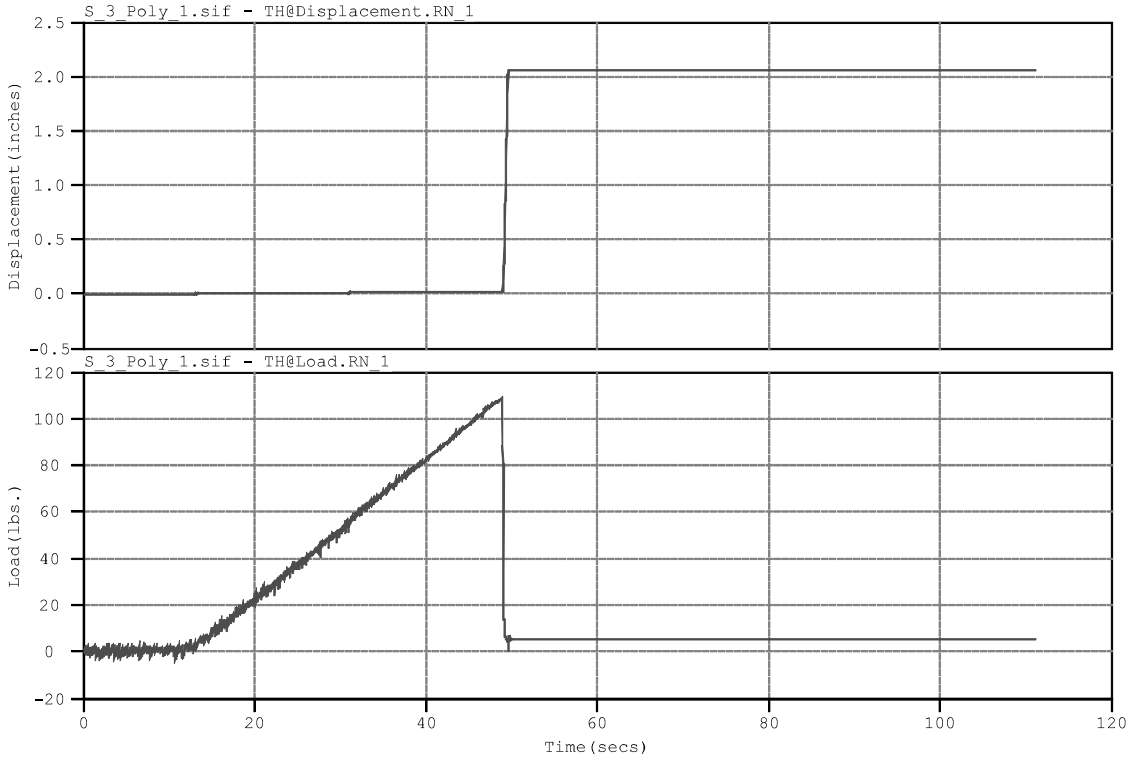

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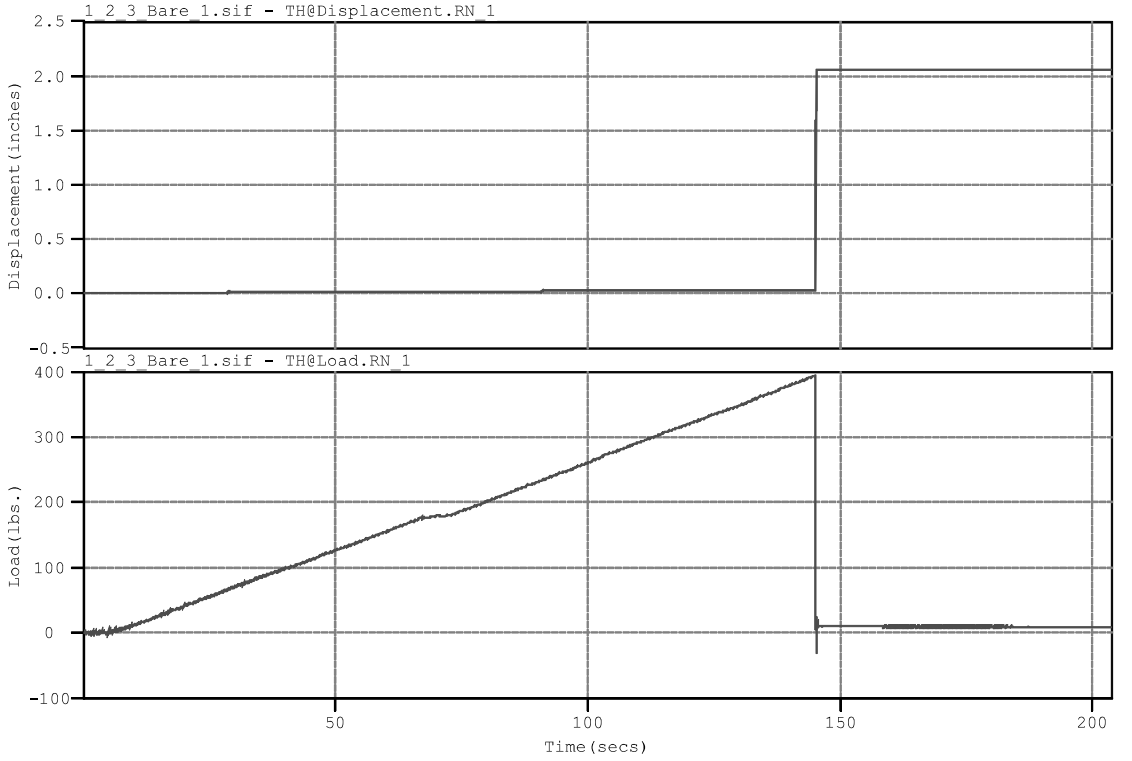
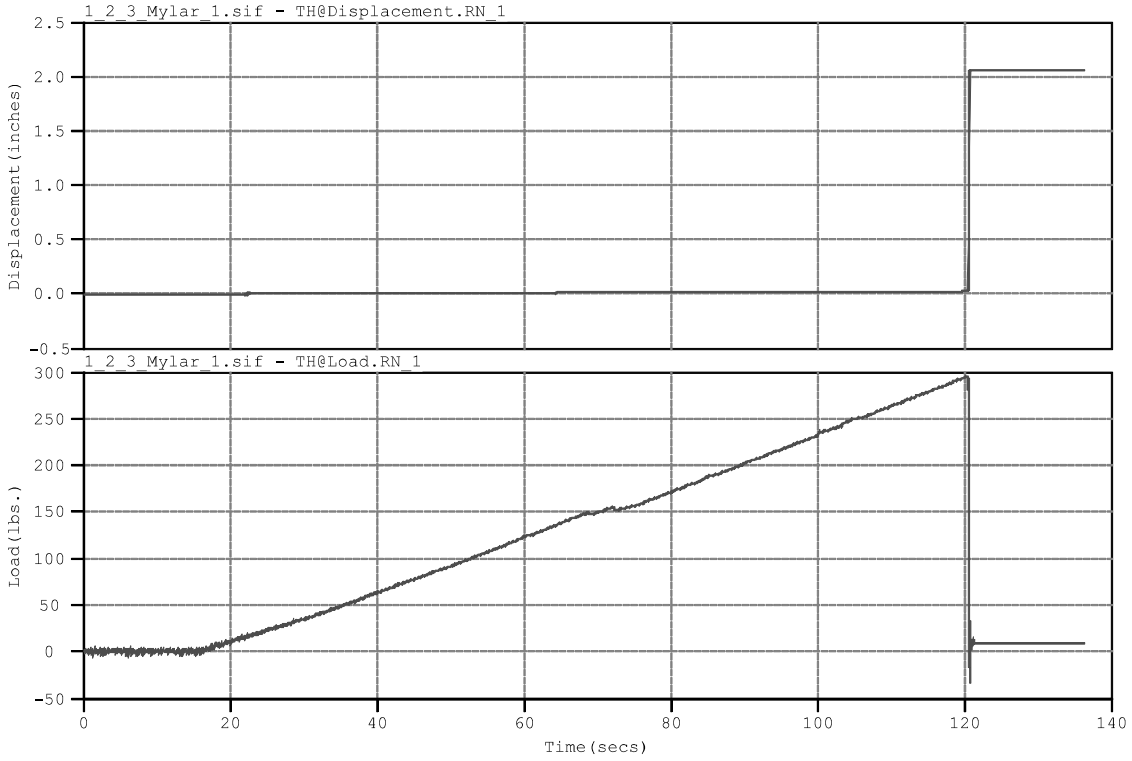


Sample 1, 2, and 3 tensile no pad unpainted plate



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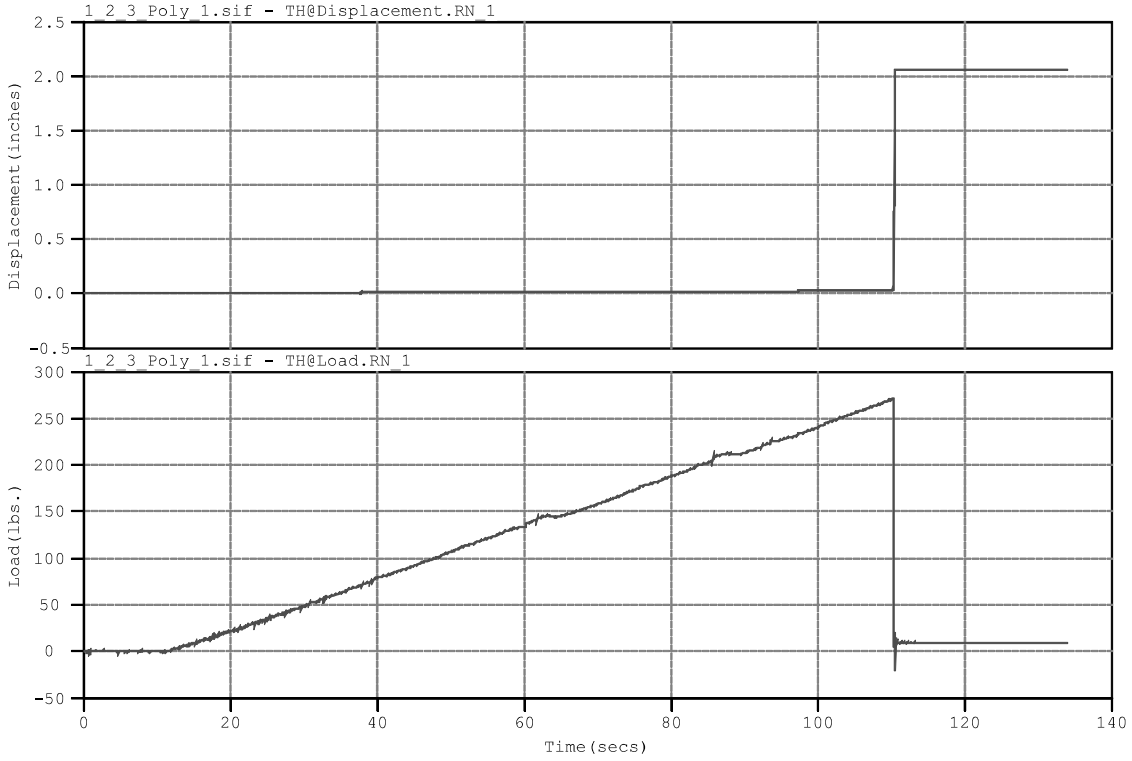

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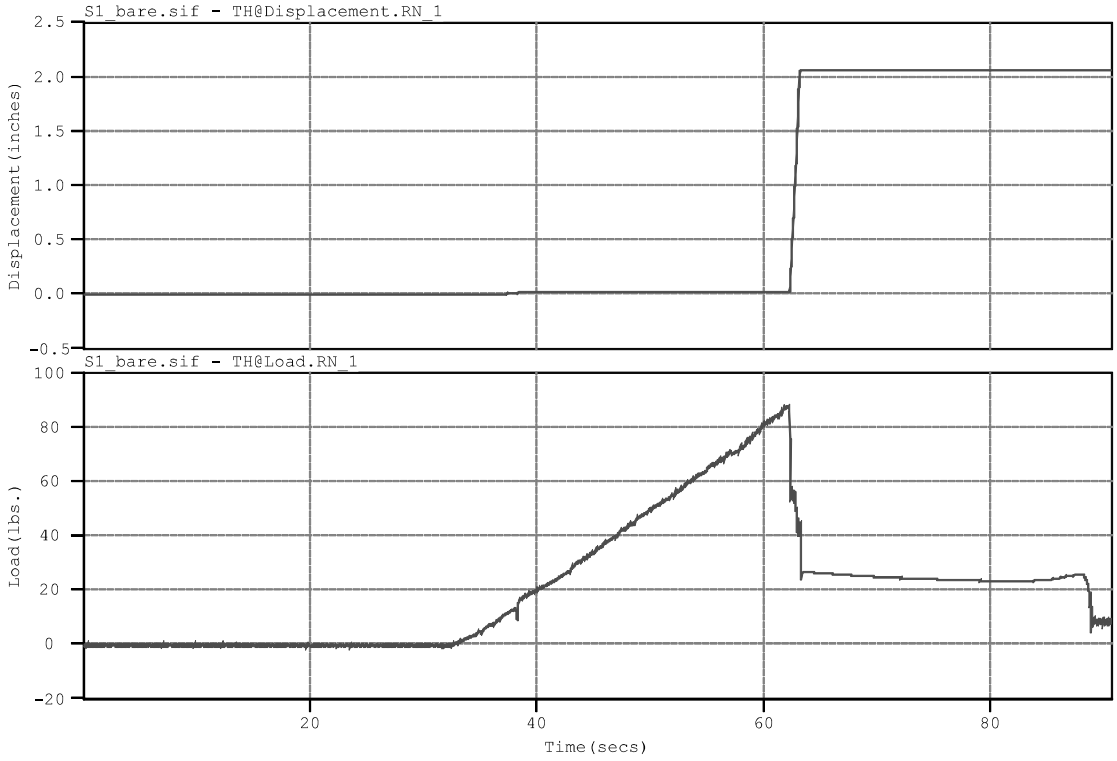

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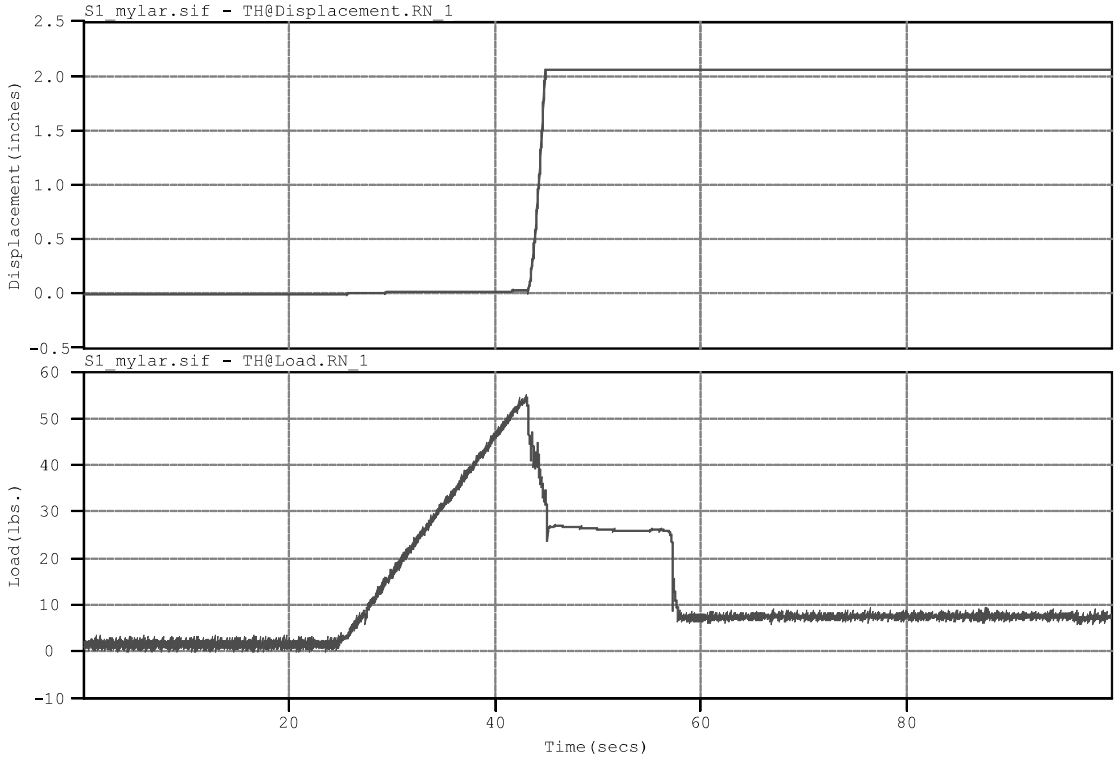

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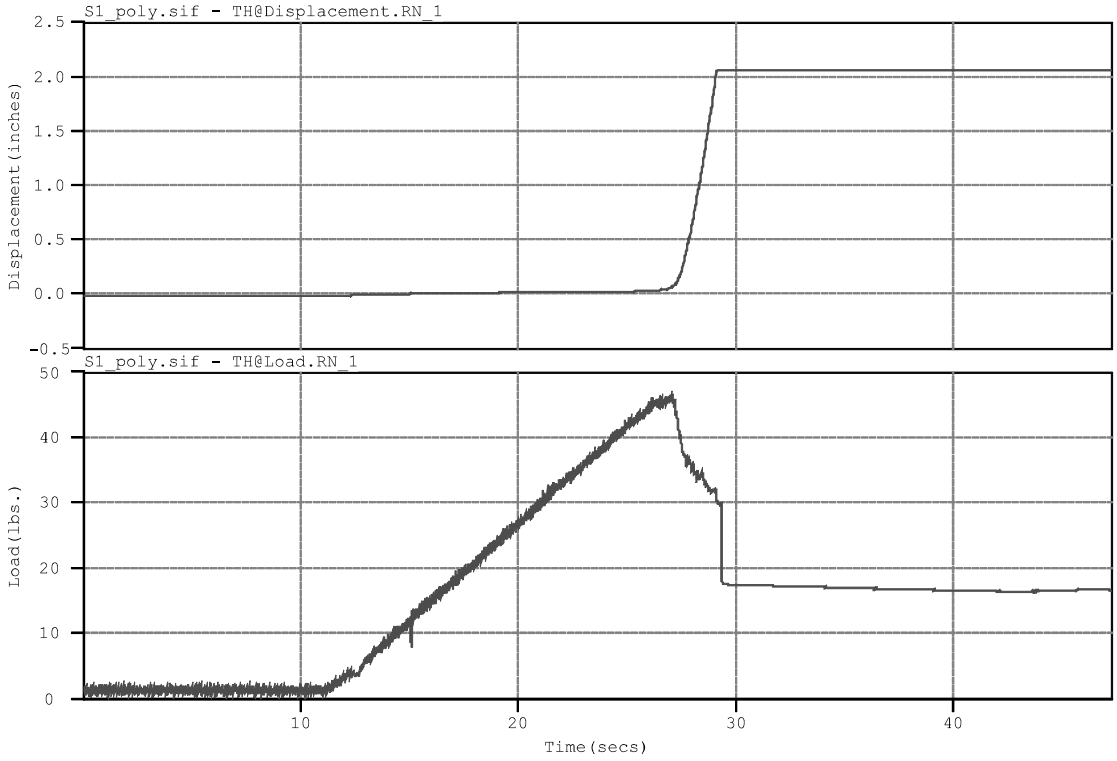

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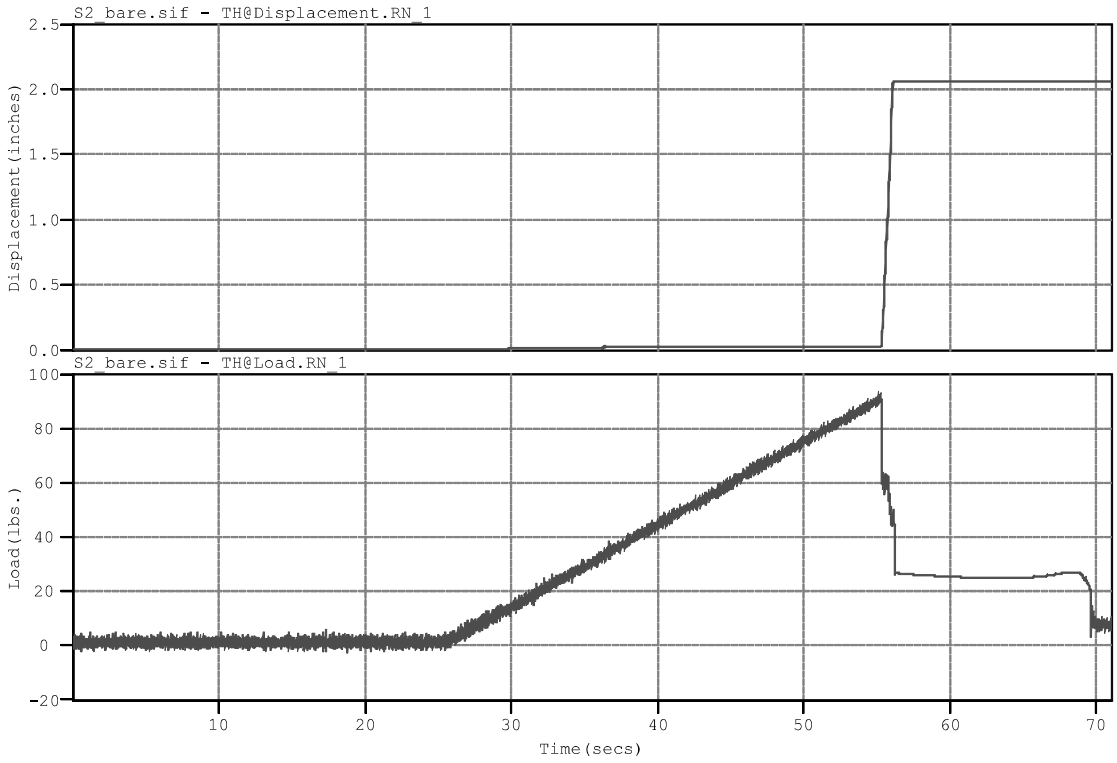

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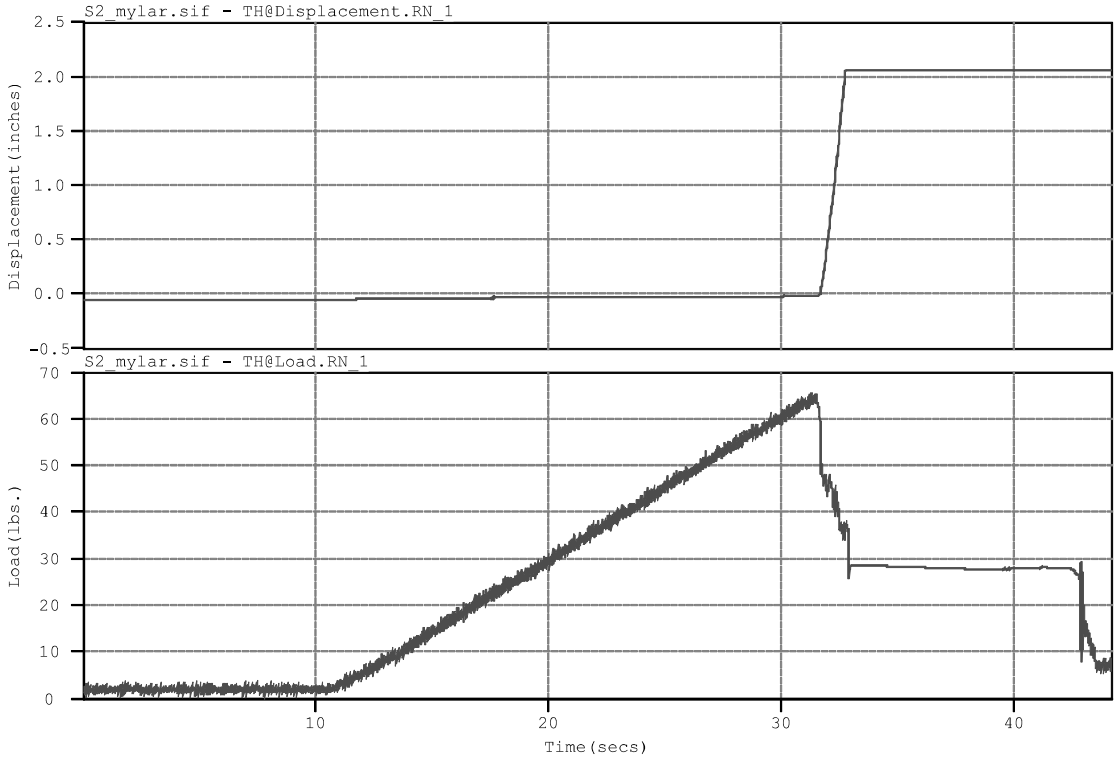

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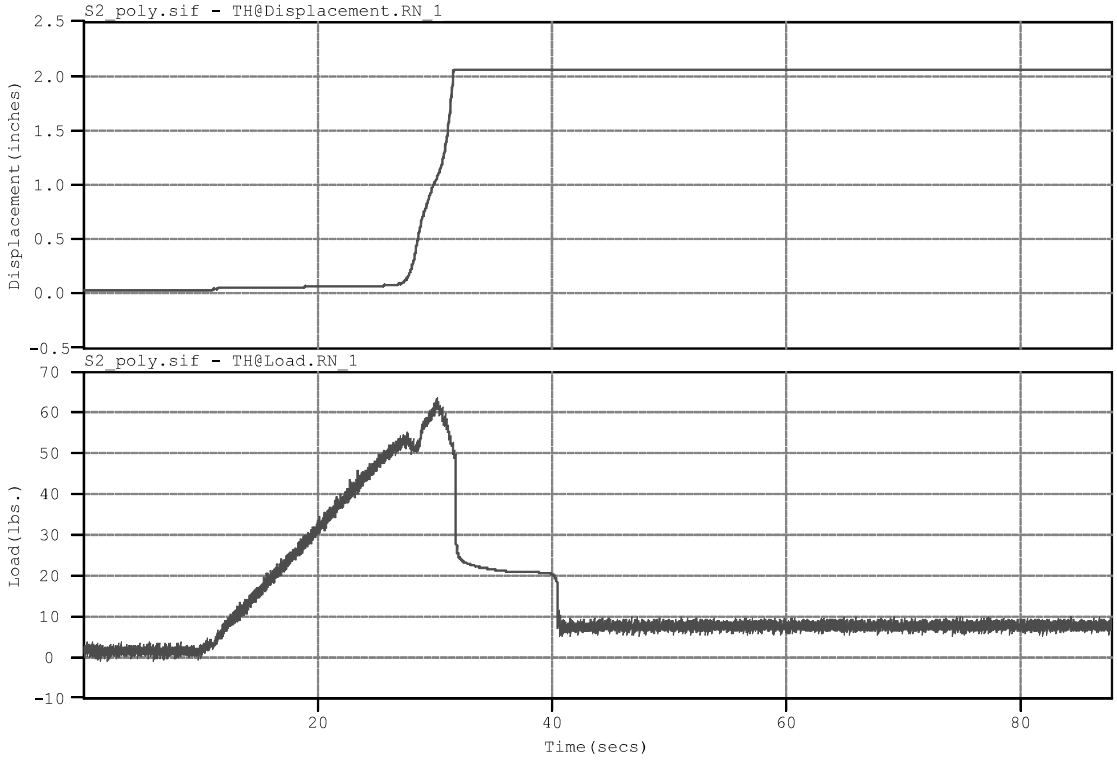

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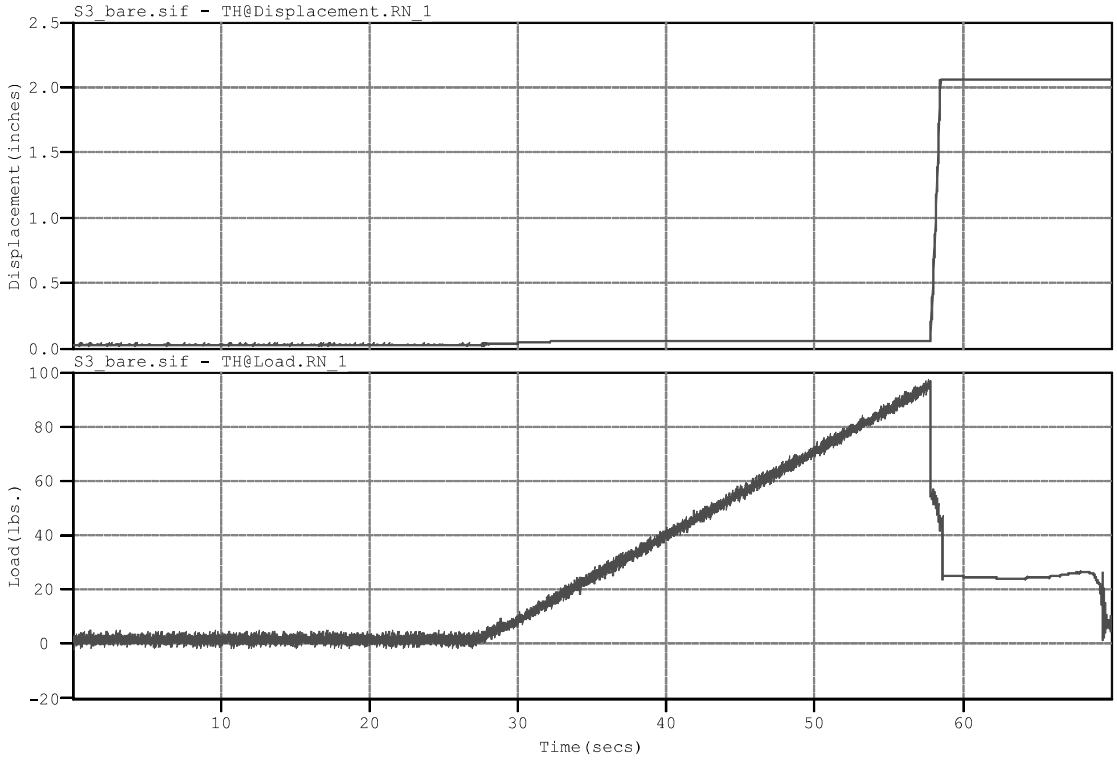

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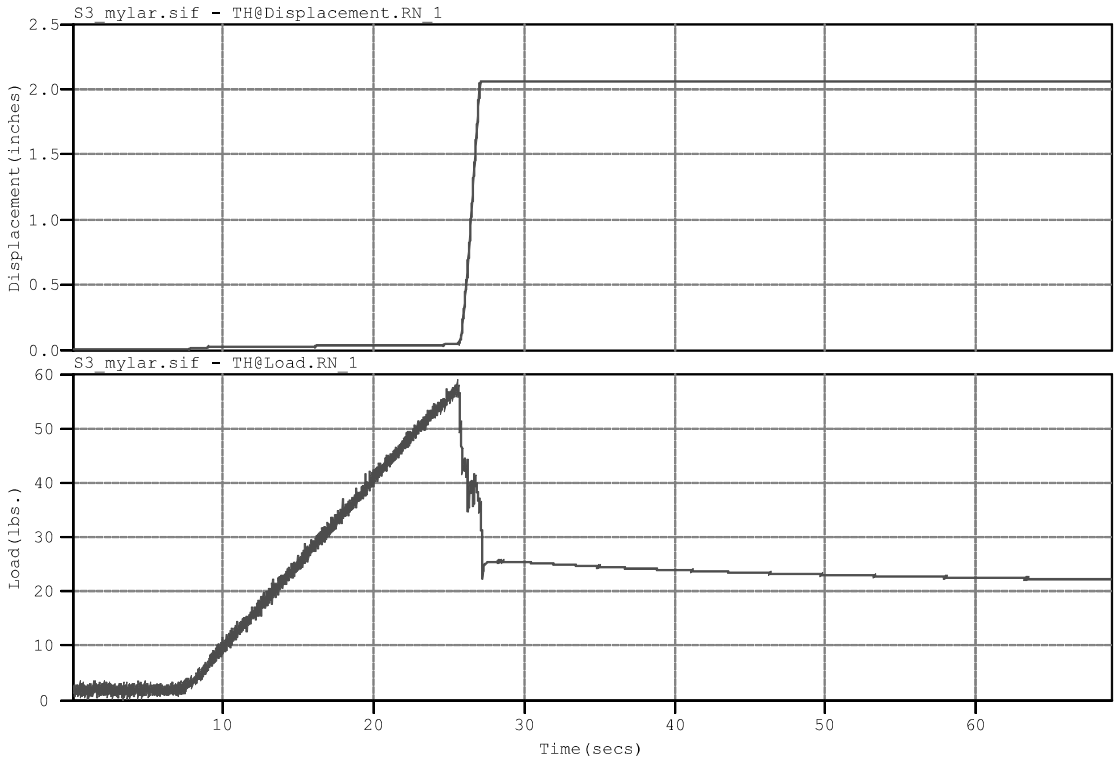

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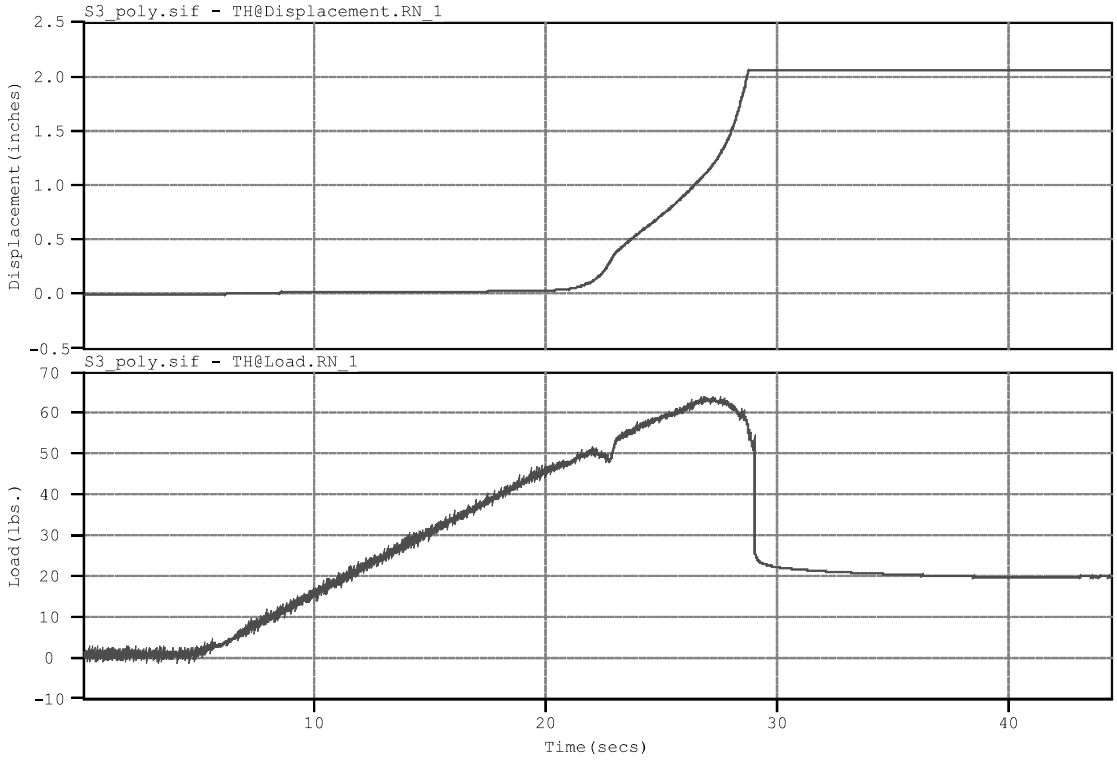

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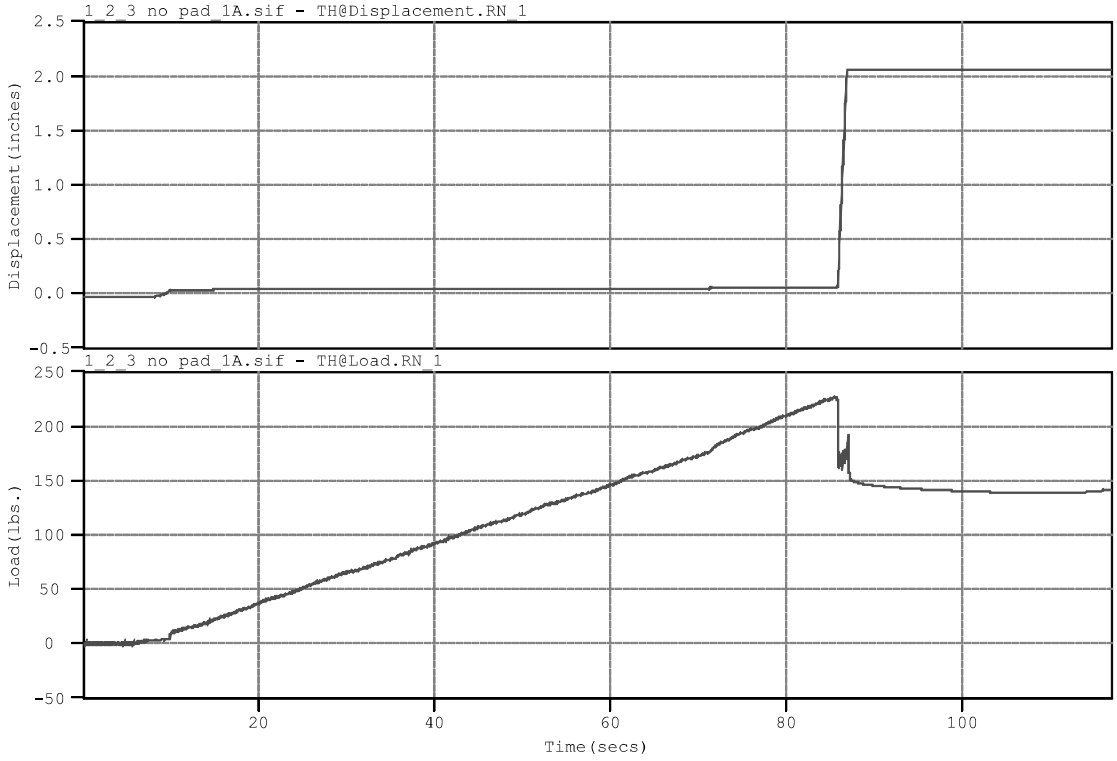

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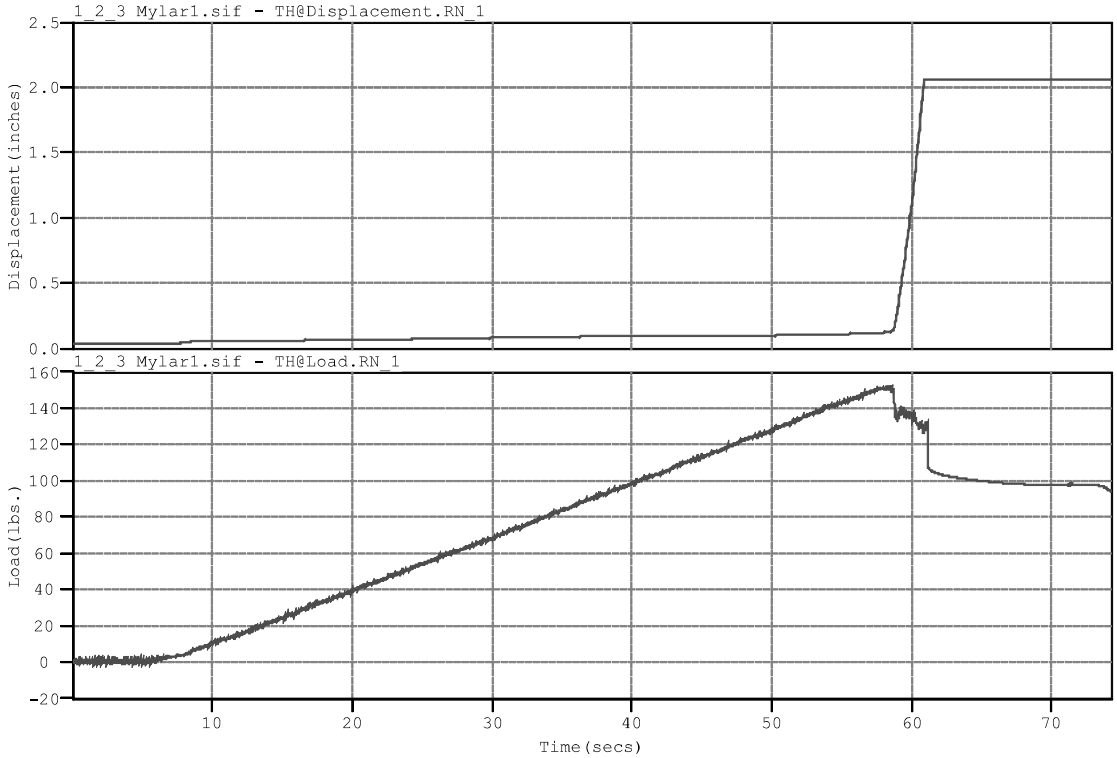

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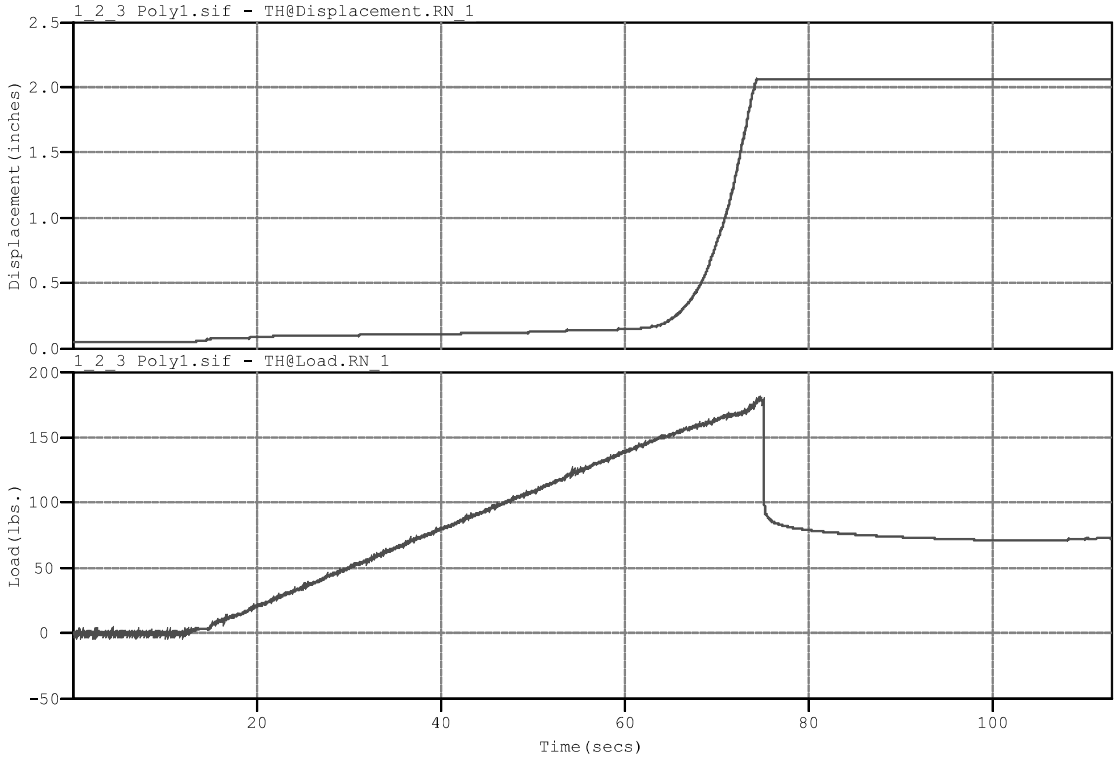

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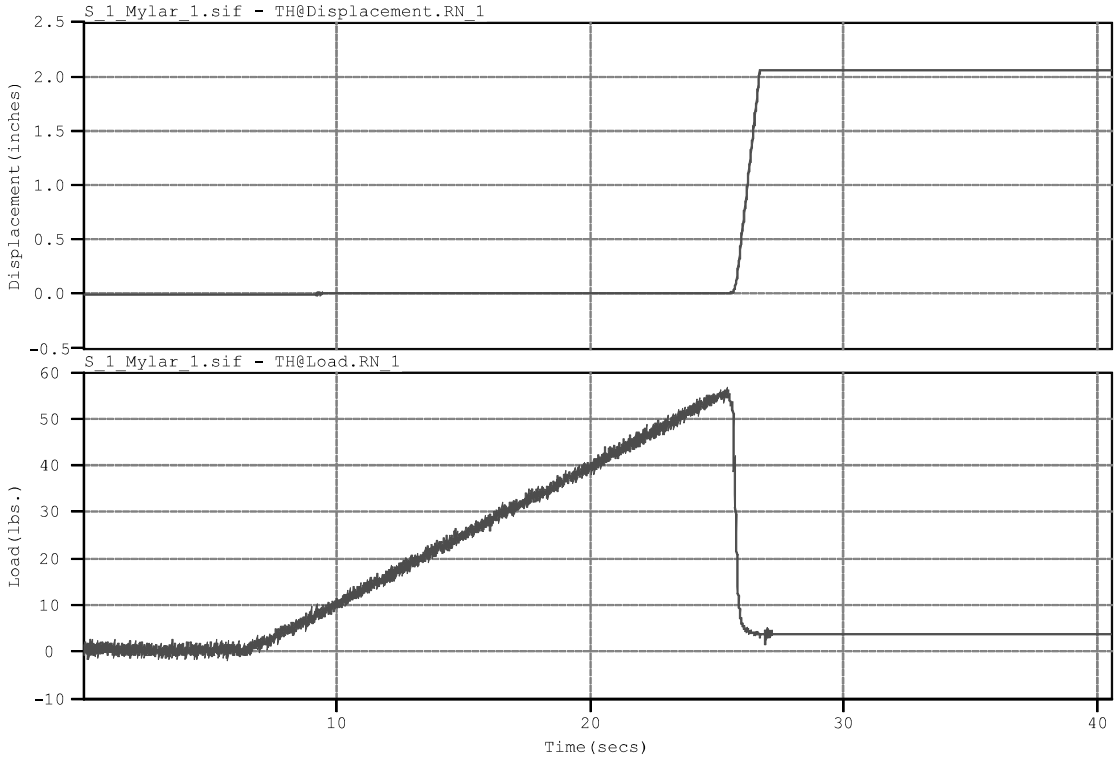

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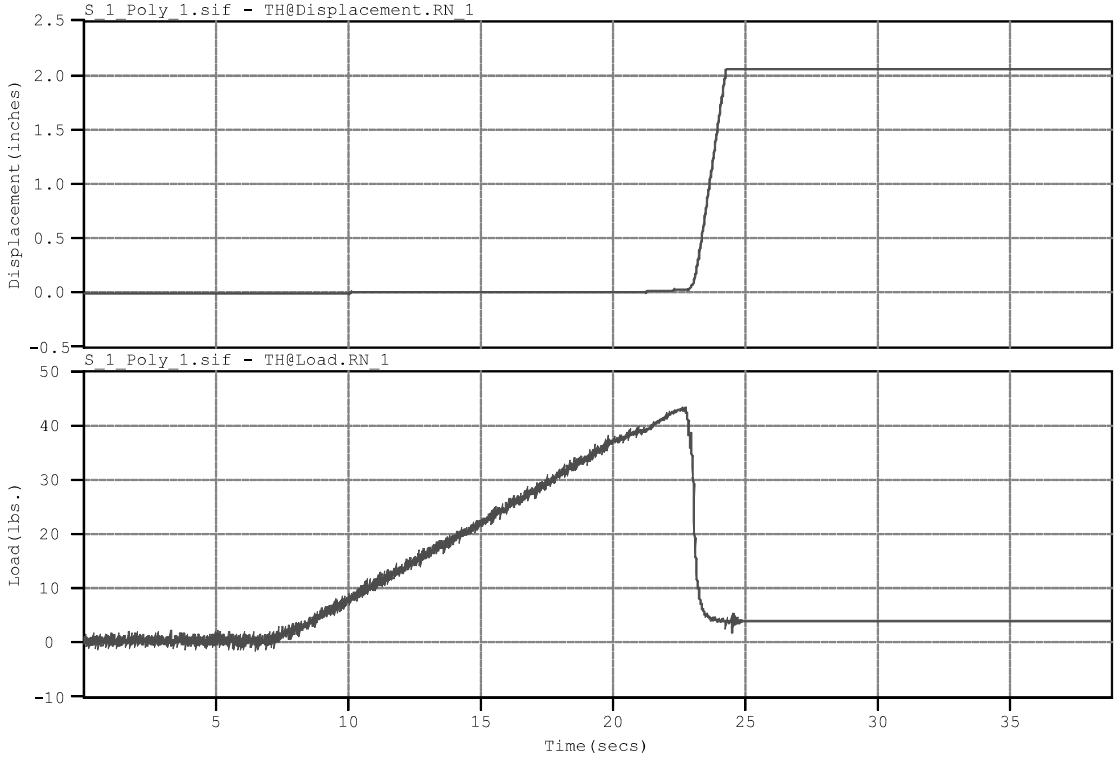

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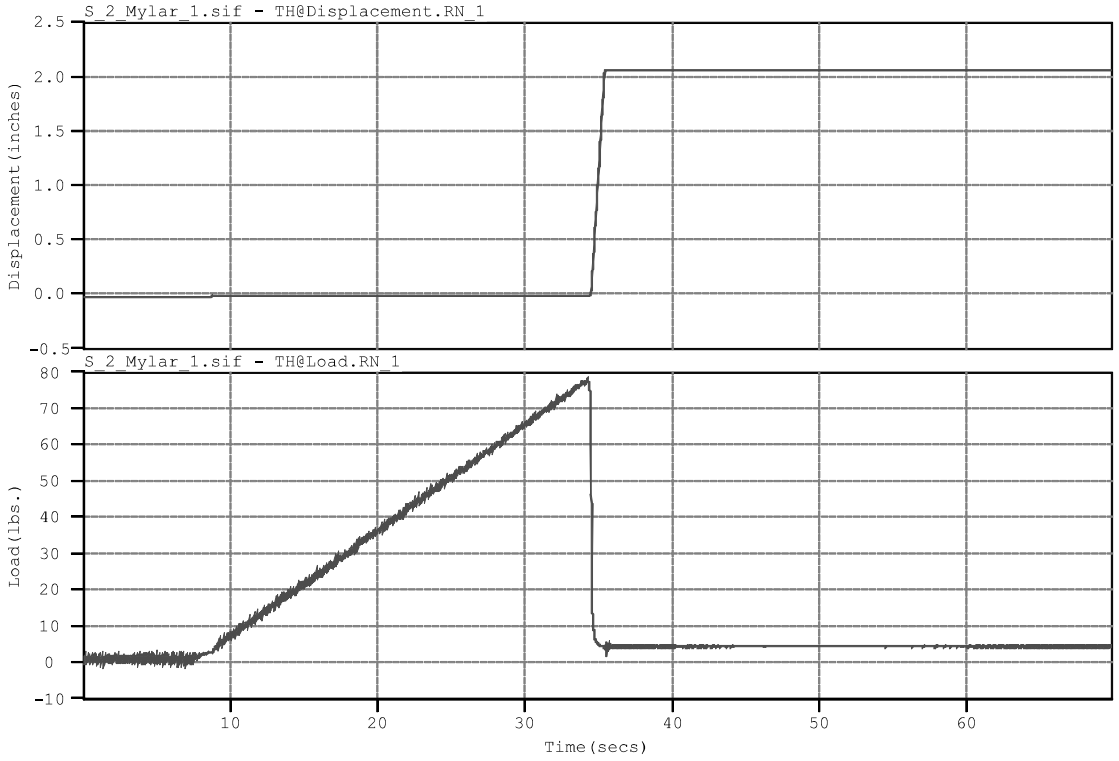

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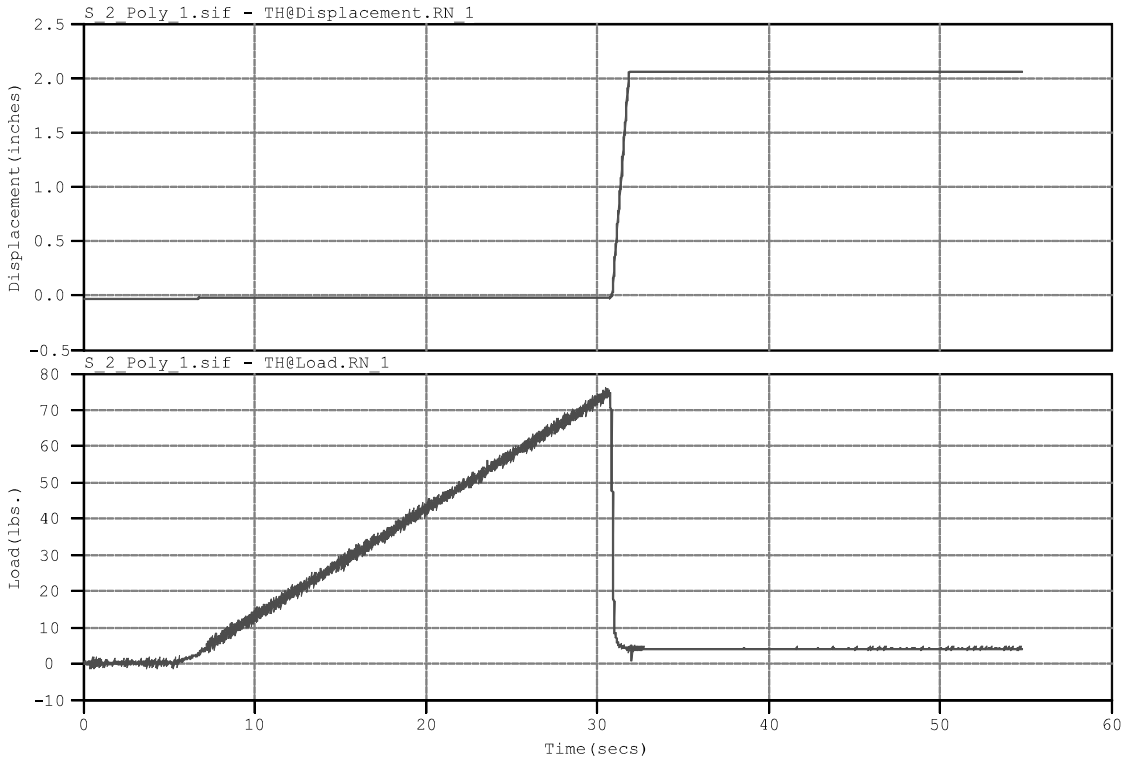

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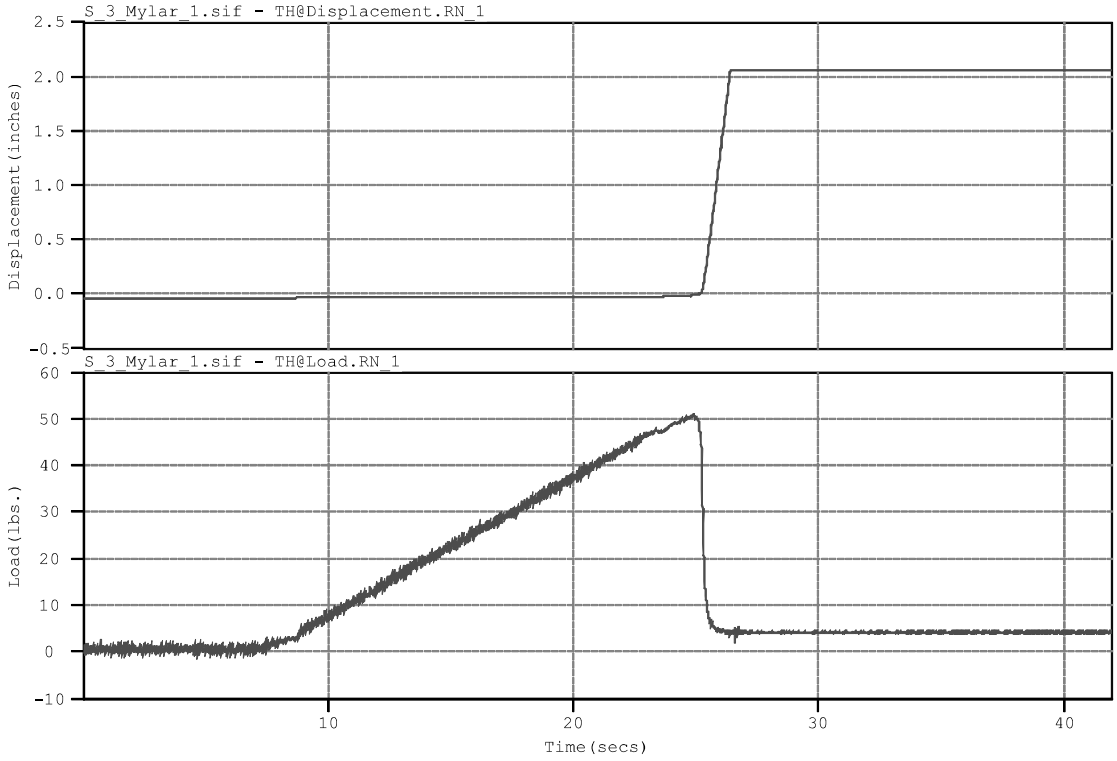

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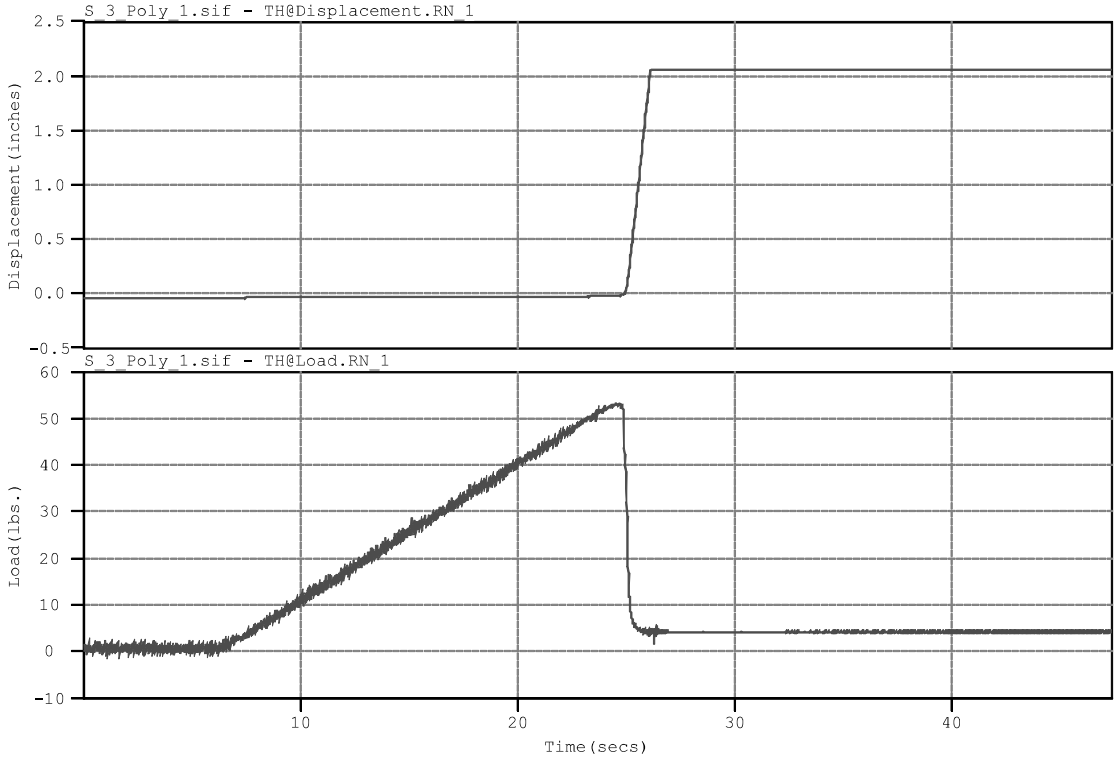

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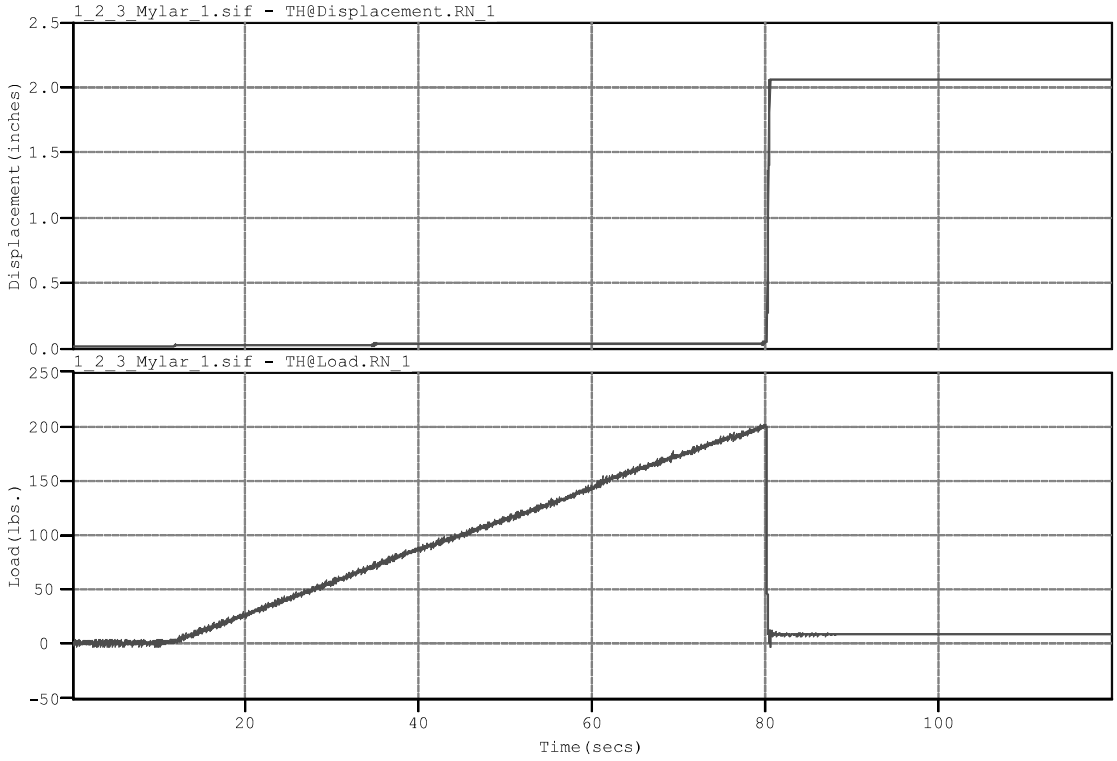
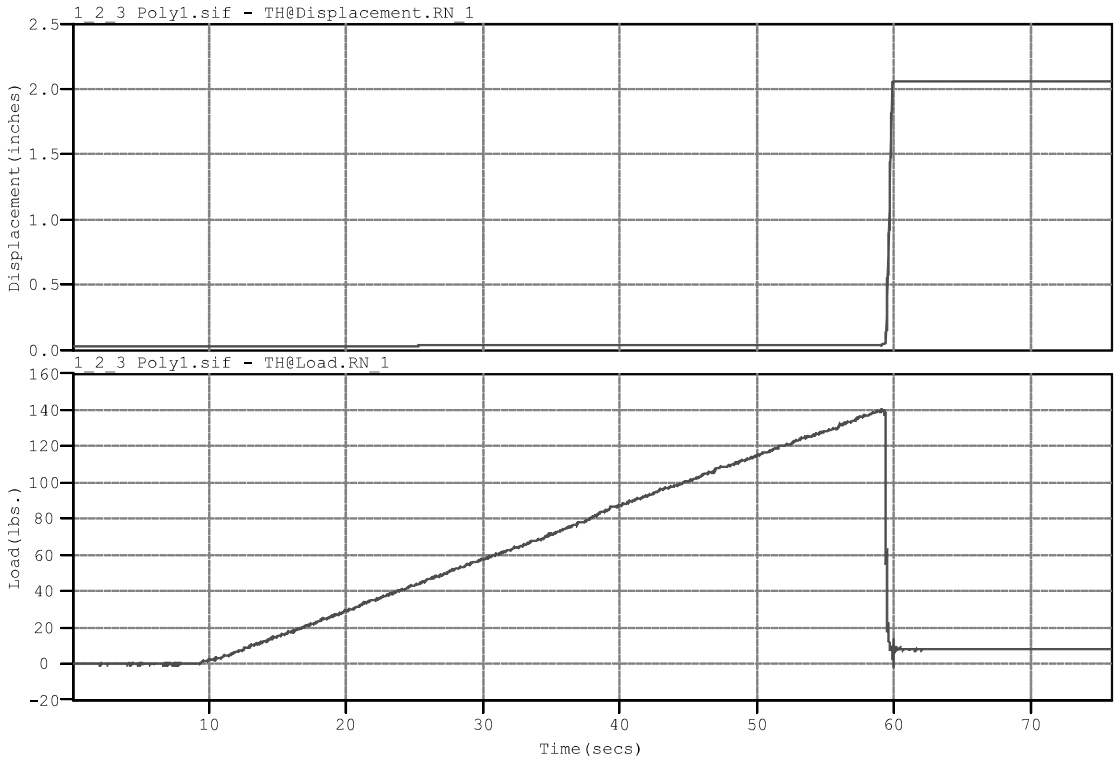


Sample 1, 2, 3 tensile Mylar pad painted plate



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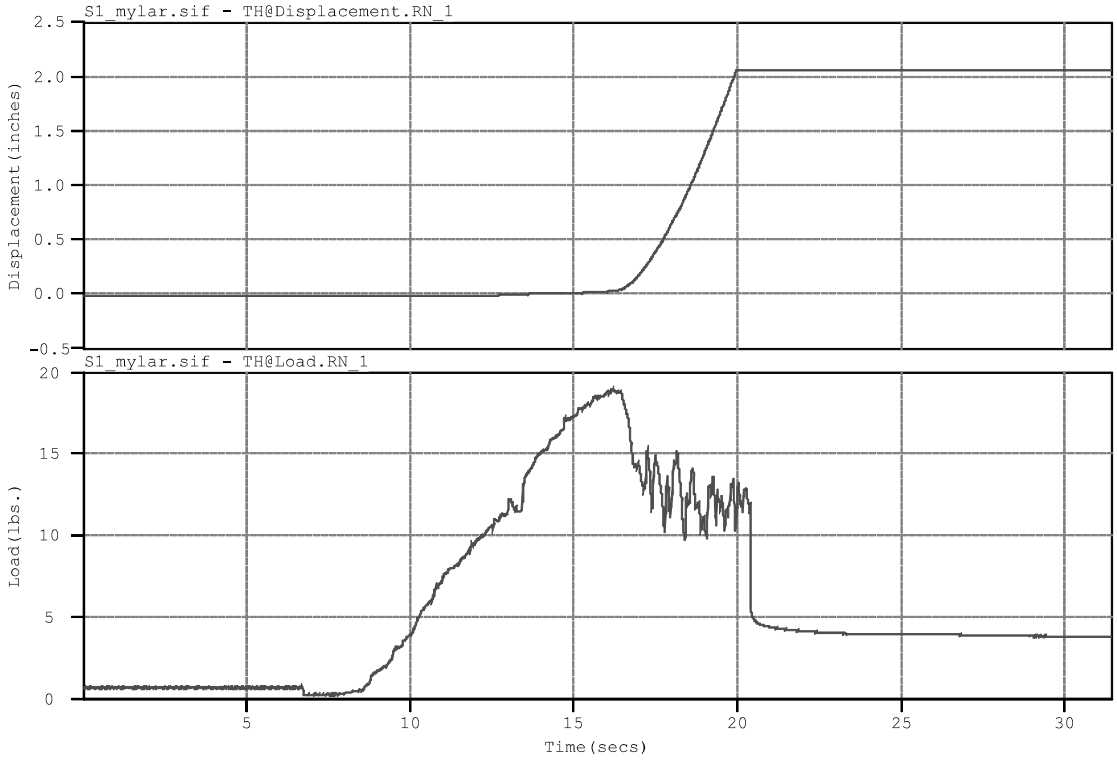
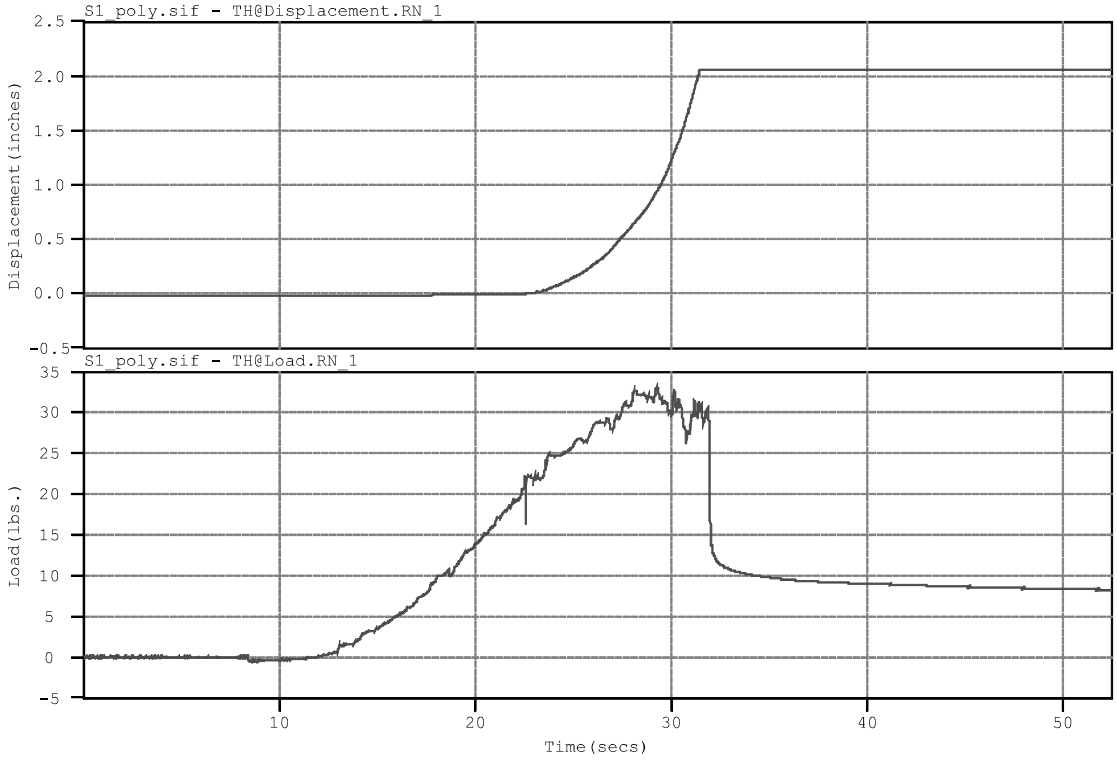


Sample 1 shear Mylar pad painted plate



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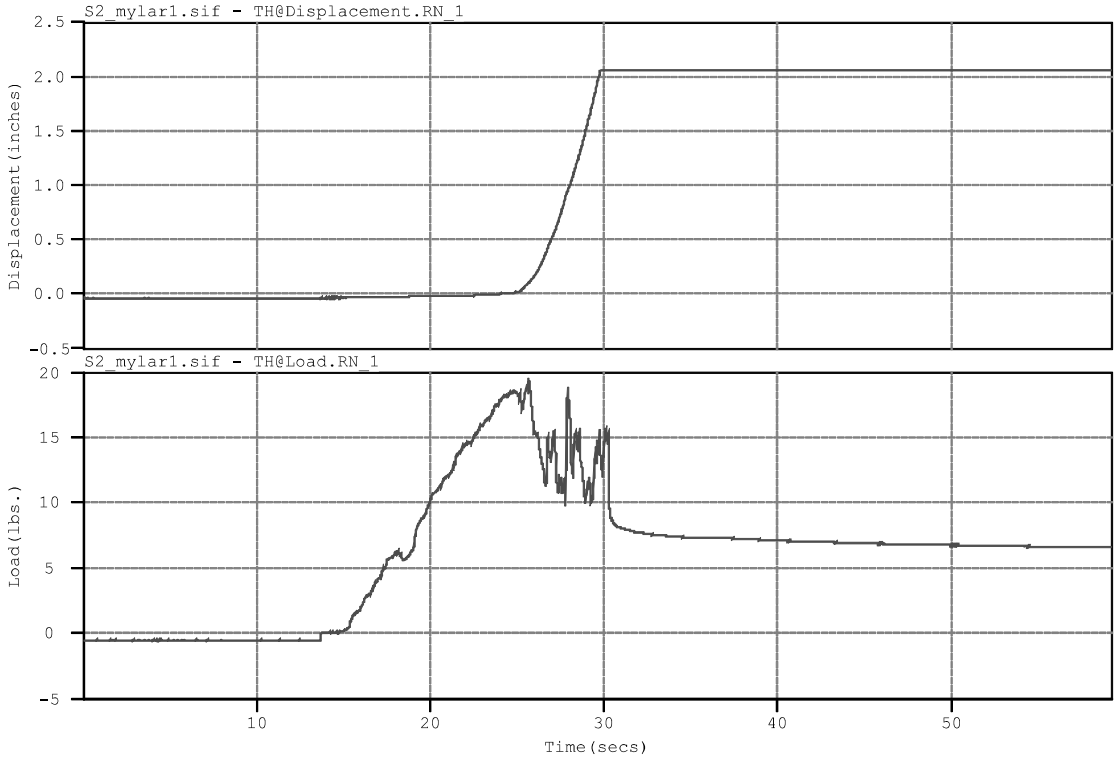

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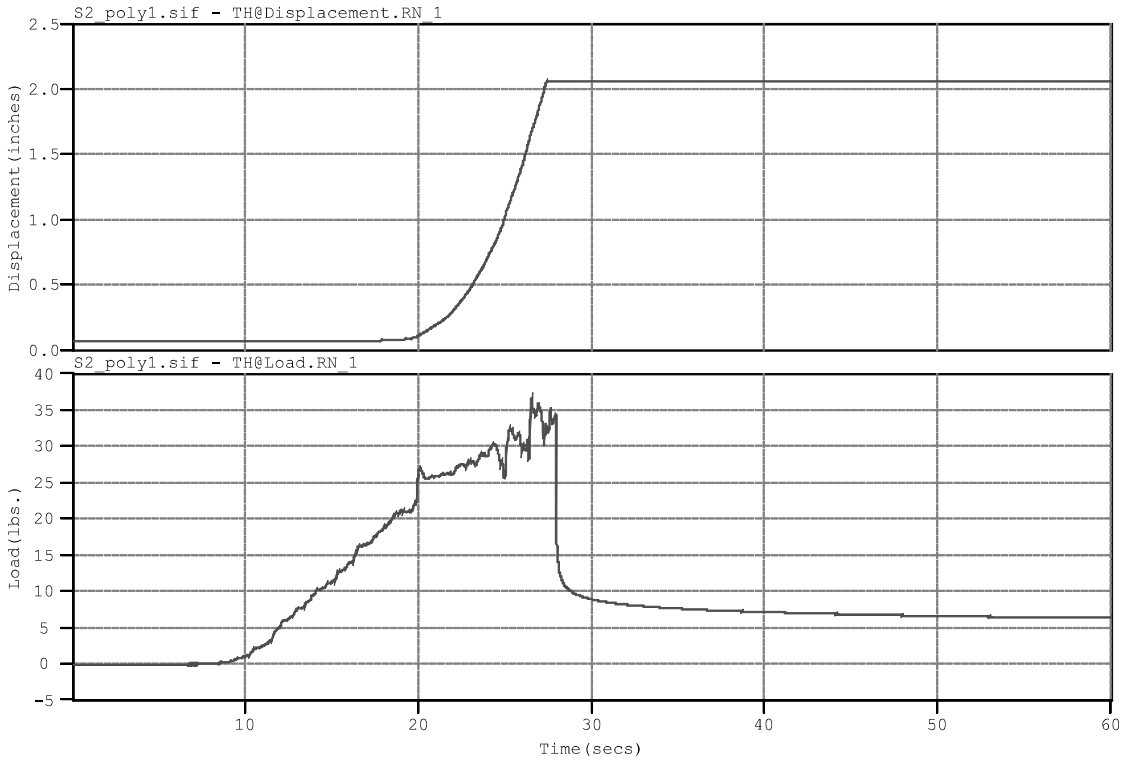

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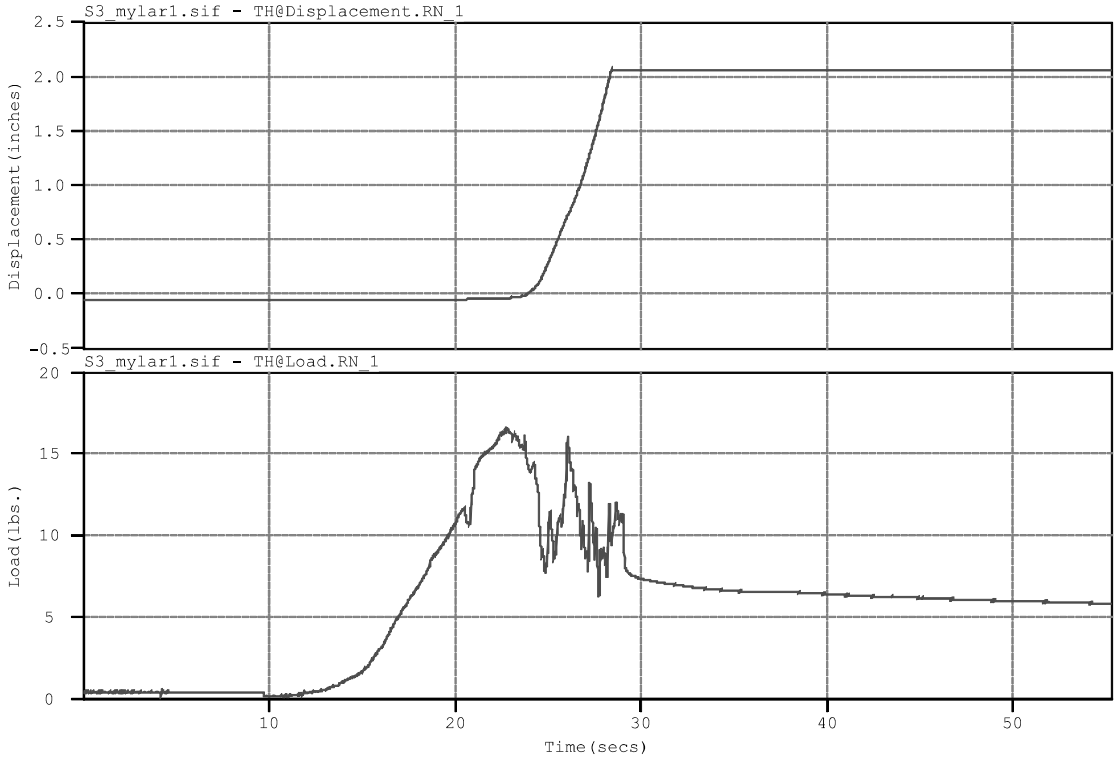

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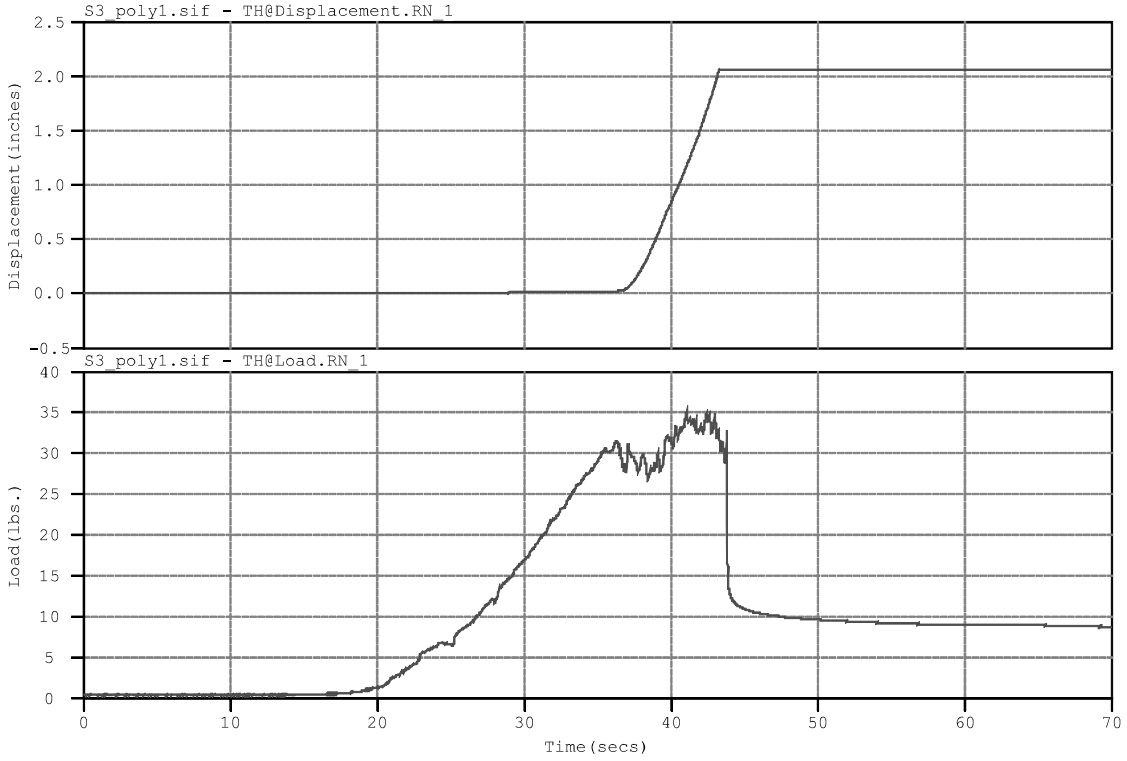

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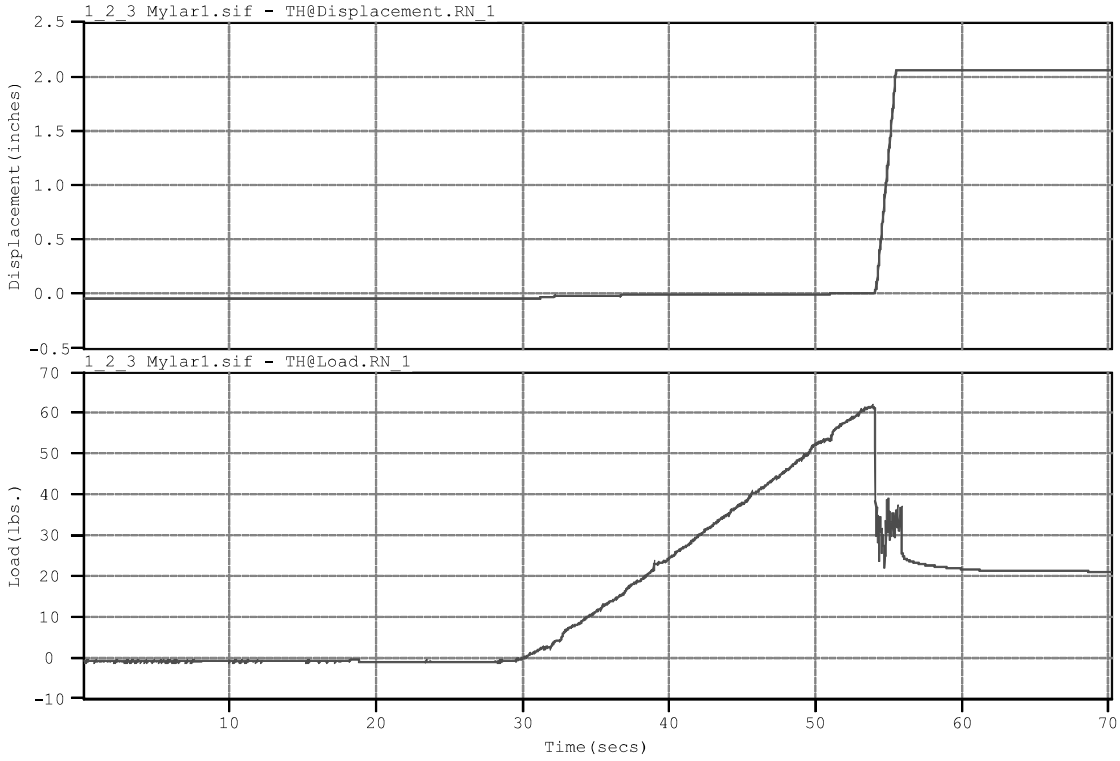

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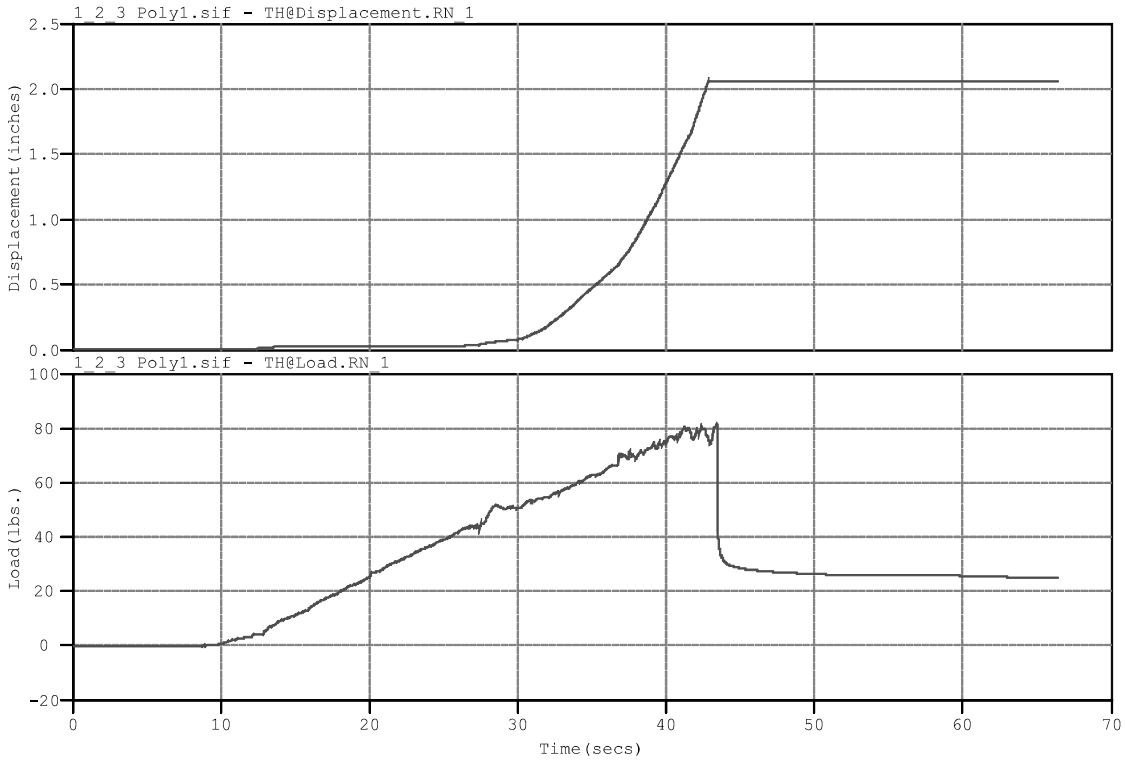


Sample 1, 2, 3 shear Poly pad painted plate

5.0 EQUIPMENT LIST

S14 W33511 Highway 18 • Delafield, WI 53018 • 262 968-4003 • Fax: 262 968-3050 • 800 969-405C

Test Equipment List

Test Title: Load Testing
Project Number: M109-17325
Specimen: 31/2 inch diameter magnets
Customer: Metal and Cable Corp.
Sample Quantity: 3
Start / End Date: 21-Jun-2016 | 24-Jun-2016

Equipment	Manufacturer	Model Number	Serial Number	Calibration	
				Last	Due
Hydraulic Actuator	MTS	242.01	1295180	N/A	N/A
Hydraulic Controller	MTS	407	#1	N/A	N/A
Data Acquisition	Somat	MSBRG	MSBRG.01-1310	19-May-2016	9-Jun-2018
Load Cell	Lebow	3132-500	14341	30-Oct-2015	9-Jun-2017
Dial indicator	Mitutoyo	999-390	999-390	31-Oct-2015	1-Mar-2017
Decade Resistor	General Radio	1432-P	20915	15-Jan-2016	28-Jan-2018

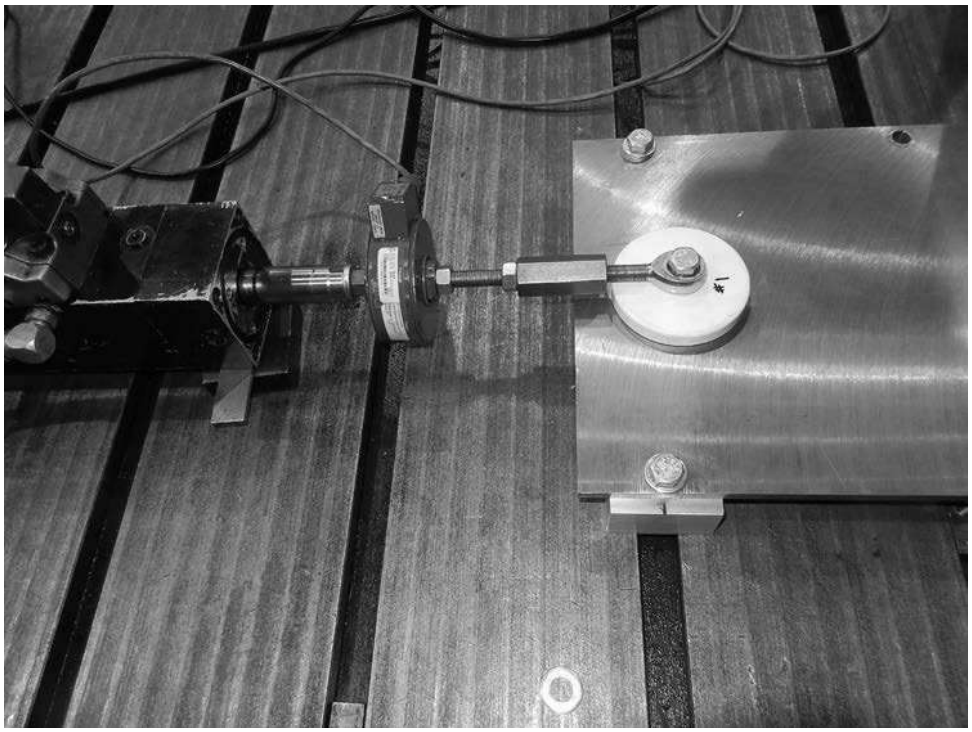
Certificates and reports of all calibrations are retained in the DATASYST Engineering & Testing Services, Inc. files and are available for inspection upon request.

6.0 PHOTOGRAPHS

Data acquisition for test

Control and data acquisition for test

Single magnet tensile test setup on bare steel plate

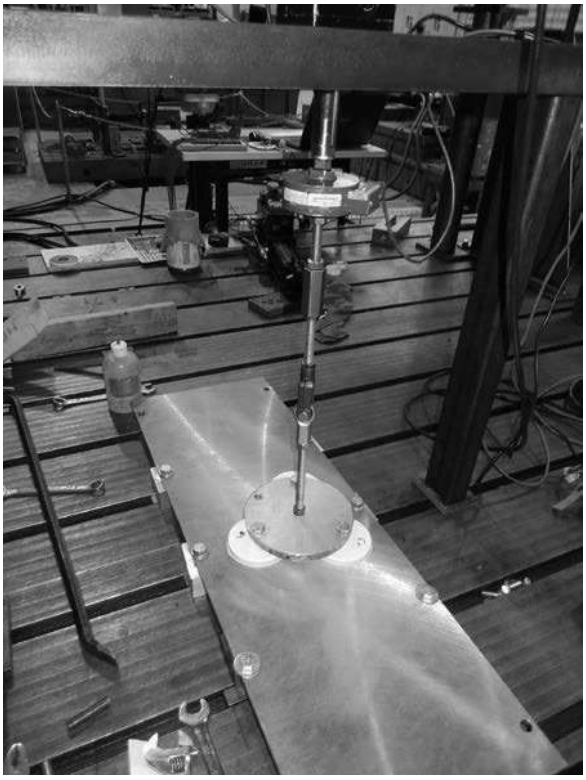


Single magnet shear test setup on bare steel plate

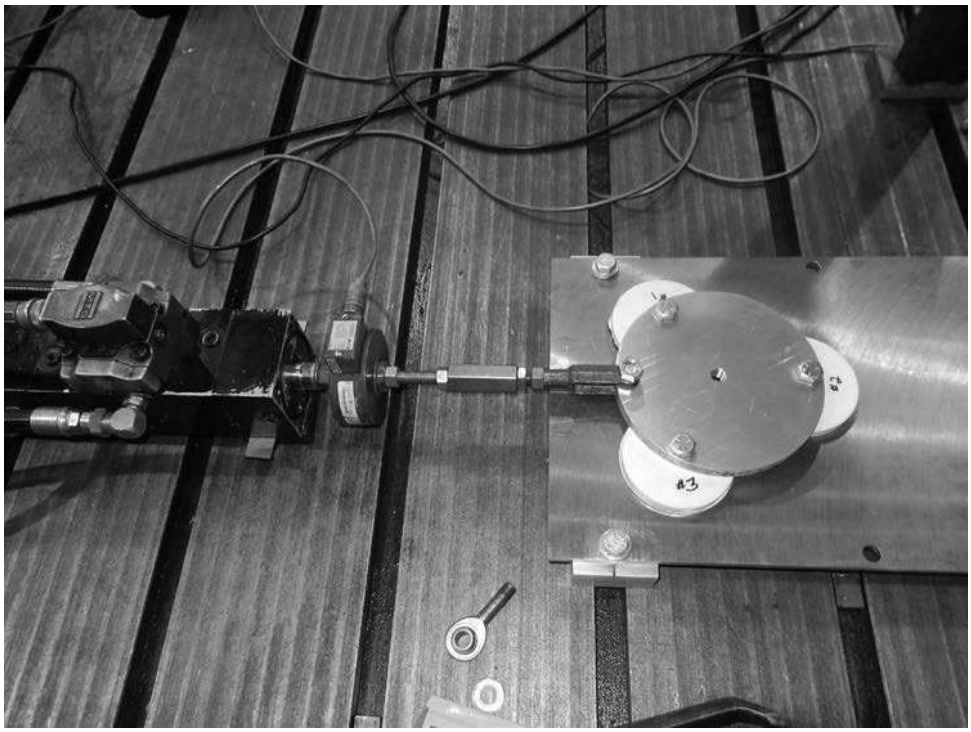
Magnet with Mylar pad


Magnet with Poly pad

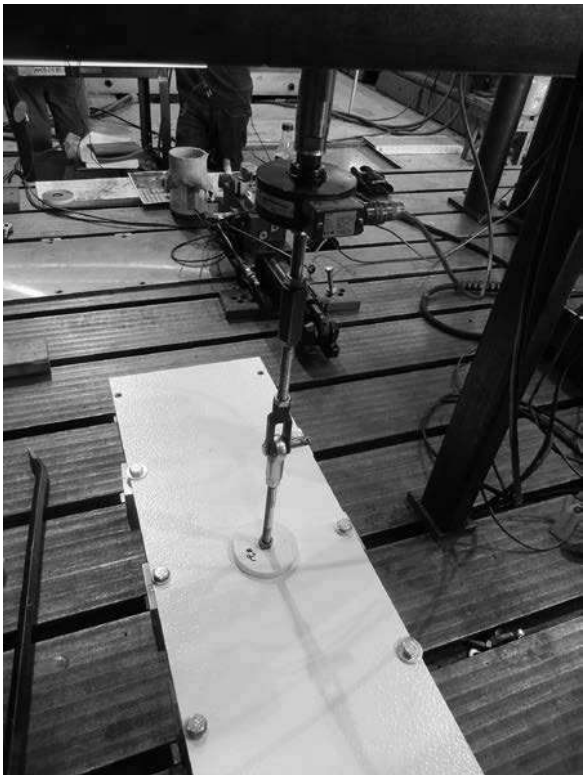
Poly pad after shear test



3 magnet tensile setup bare steel plate

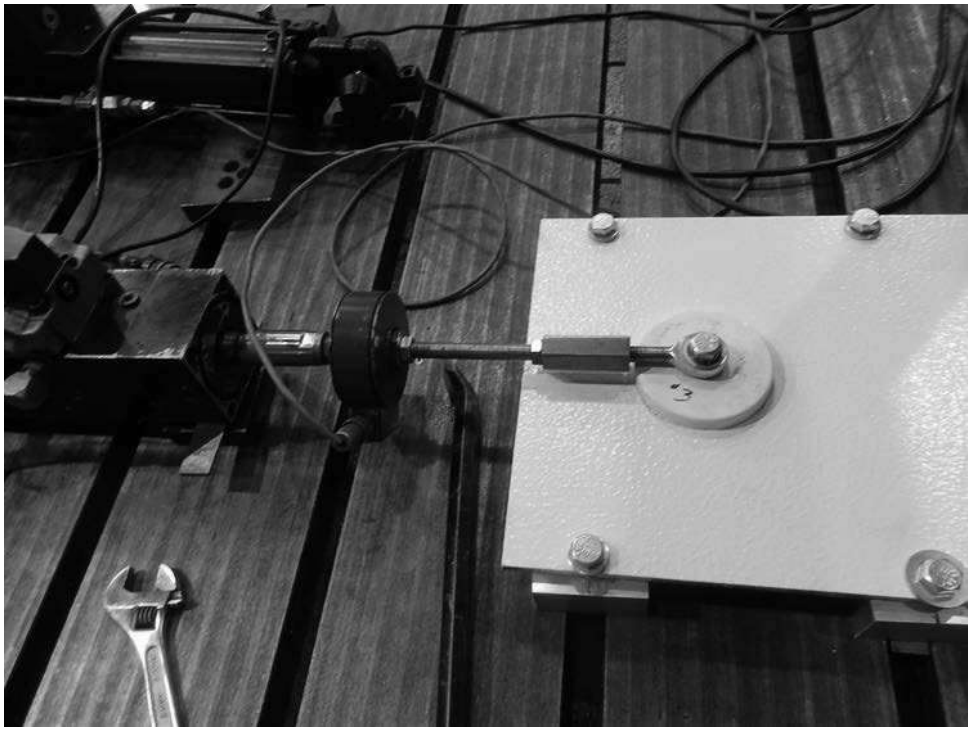


3 magnet shear setup bare steel plate

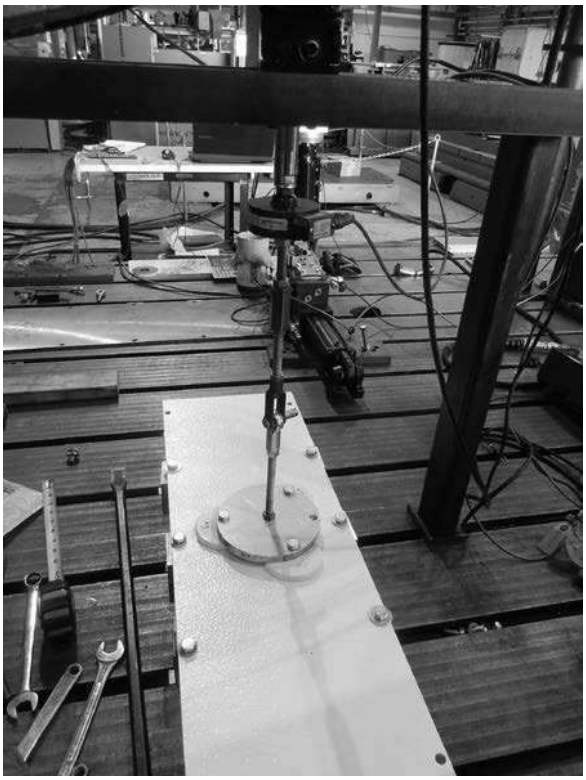


Single magnet tensile test setup on painted steel plate

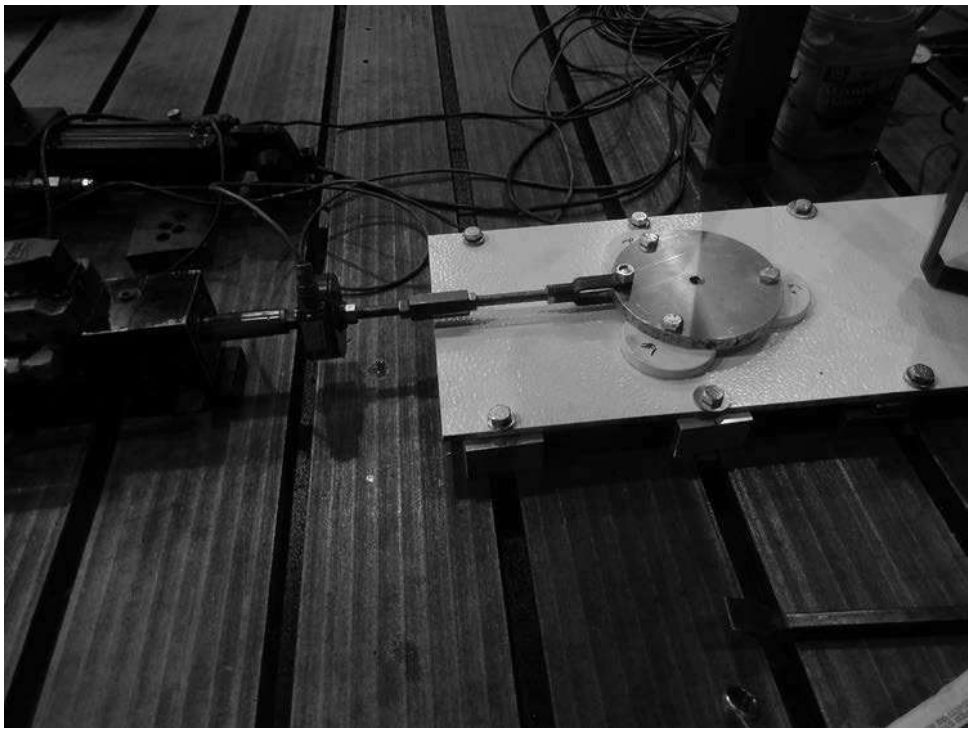
Mylar pad after tensile test



Single magnet shear test setup on painted steel plate



3 magnet tensile setup painted steel plate



3 magnet shear setup painted steel plate

Poly pads after shear test