Translation

STRENGTH TESTING OF
CONCRETE TUBE FORMS

CRIQ File 670-44635

Technical Report

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MONTREAL, DECEMBER 22, 2011

Centre de recherche industrielle Québec

CRIQ DECLARATION

Samples of the products mentioned herein were received at the CRIQ on November 14, 2011. Testing took place on December 13, 2011.

Testing was completed and supervised by the undersigned; they attest to the accuracy of the results.

Performed by: Marc Danjou, technician

Supervised by: Umberto Muzzo, eng., project manager

This report was written by: Umberto Muzzo, eng.

Une version française de ce rapport est également disponible.

Total number of pages: 26 including 21 pages in appendices.

The results presented in this report refer only to the products described in this report.

The equipment and instrumentation used during this test were verified and/or calibrated. The calibration certificates are retraceable to the National Research Council of Canada (NRC) and/or to the American National Institute of Standards and Technology (NIST) standards and can be provided on request. For standards identified in our scope of accreditation, the existing reports identifying measurement uncertainty are available upon request.

CRIQ is registered ISO 9001, certificate no. 008999, and this testing laboratory is accredited ISO 17025 by the Standards Council of Canada for specific tests as listed on www.scc.ca.

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1. INTRODUCTION

At the request of ABZAC CANADA INC (the Client), testing was performed to determine the strength resistance of ECOFORM concrete tube forms. The report details the test methodology and presents the obtained results. Pictures and loading curves are included in appendices.

2. SAMPLE DESCRIPTION

Twenty-four (24) inch diameter (ID) concrete tube forms were supplied for the tests, in thicknesses of 1/8, 1/4, 3/8 and 1/2 inch. The 1/8 and 1/4 inch thick samples were supplied in widths of 5 inches. The 3/8 and 1/2 in thick samples were supplied in widths of 3 inches. The samples are shown in pictures A.1 to A.5. Three (3) samples were provided for each thickness. CRIQ numbers E28548 to E28559 were assigned to the samples.

3. TEST METHOD

The test bench is shown in pictures A.6 to A.8. The cylindrical wood form, fabricated for the test project, has a diameter of 23.5 inches. It consists of a 270^{o} section (three quarter round) and a 90^{o} section (quarter round). The three quarter round section is bolted down to the test bench structure and the quarter round section is linked to a hydraulic actuator equipped with a load cell. The test consists in installing the concrete tube form sample on the wood form and pulling on the quarter round section with the hydraulic actuator at a rate of 0.02 inch/sec. The parameters measured and recorded during the test are the force and the actuator rod position. The data is recorded at 50 Hz frequency.

4. EQUIPMENT LIST

- MTS 244.21s hydraulic servo-actuator, 11 000 lb capacity, 6 in stroke, serial no 10291840A, with an integrated LVDT position sensor;

- TOVEY ENGINEERING FR20-11K-BD00 load cell (double bridge), 11 000 lb load capacity, serial no 108027, calibration certificate expiry date 2012-10-11;

- FCS hydraulic servo-actuator control system, channel 4-5, SCU card serial no 8235250083. The readings of the position sensor were calibrated in the controller channel by the test technician using a MITUTOYO 192-656 height gage serial no 8518126, calibration certificate expiry date 2012-09-10;

- EDAQ data acquisition system, number 3.75.244.160, calibration certificate expiry date 2013-11-02.

5. TEST RESULTS

The breakage force recorded for each test sample is provided in Table 1. The table also indicates the breakage force per unit width and the breakage stress based on the cross-section area (width x thickness) of the test sample.

Sample No	Nominal thickness (in)	Sample width (in)	Breakage force (lb)	Breakage force par unit width (lb / in)	Breakage stress (lb/in^2)
E28548	0.125	5	4079	816	6526
E28549	0.125	5	4008	802	6413
E28550	0.125	5	3940	788	6304
E28551	0.250	5	7331	1466	5865
E28552	0.250	5	7643	1529	6114
E28553	0.250	5	7882	1576	6306
E28554	0.375	3	6346	2115	5641
E28555	0.375	3	6670	2223	5929
E28556	0.375	3	6583	2194	5852
E28557	0.500	3	8244	2748	5496
E28558	0.500	3	8316	2772	5544
E28559	0.500	3	8283	2761	5522

Table 1 – Test Results

Pictures A.9 et A.10 show a typical concrete tube sample installation in the test bench prior to testing and pictures A.11 et A.12 show the typical deformation of the tube occurring at the edges of the quarter round form under loading. In all tests, the tube broke at the edges of the quarter round form, as shown typically in pictures A.13 and A.14.

The recorded test data is presented in the loading curves of appendix B, identifiable by the sample number. The following sign conventions apply to the data:

- The force is positive in tension (negative in compression);
- The cylinder position reading is zero when the rod is at mid-stroke, the reading increases positively from the mid-stroke position to compete retraction (+ 3 in), the reading increases negatively from the mid-stroke position to complete extension (- 3 in).

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PICTURES

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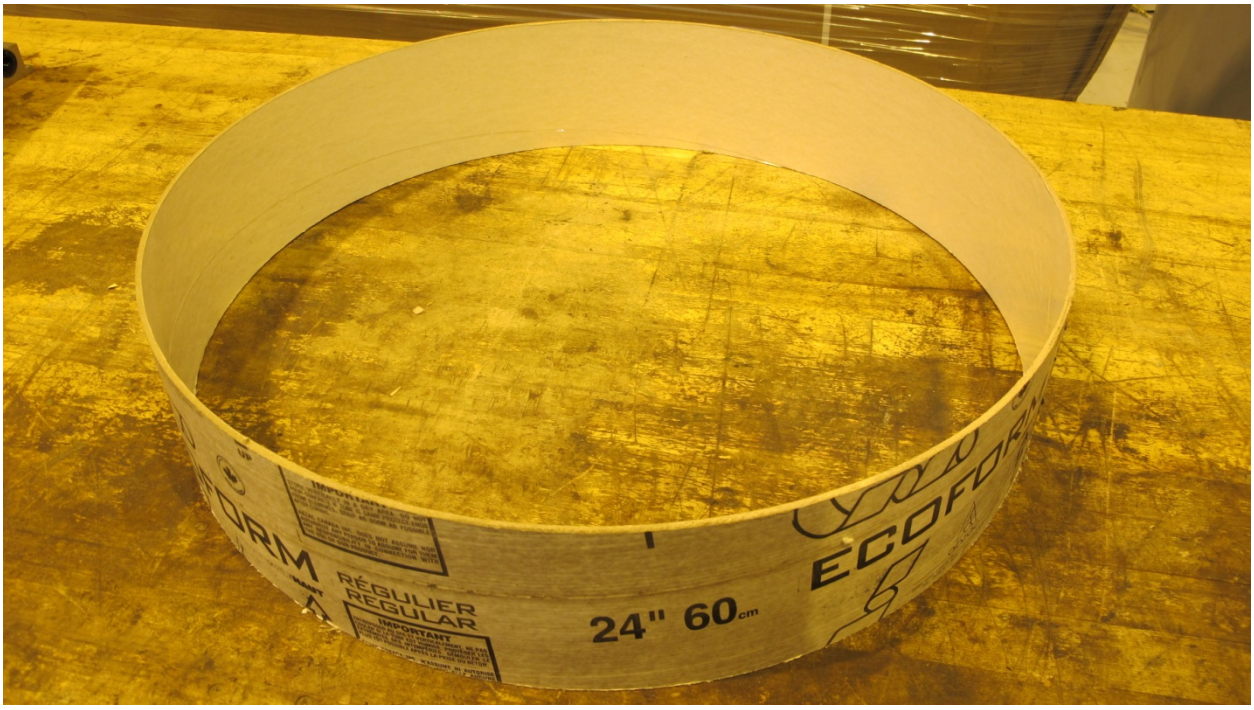
Picture A.1 – Concrete tube forms received for testing



Picture A.2 – Typical 1/8 inch thick 5 inch wide sample

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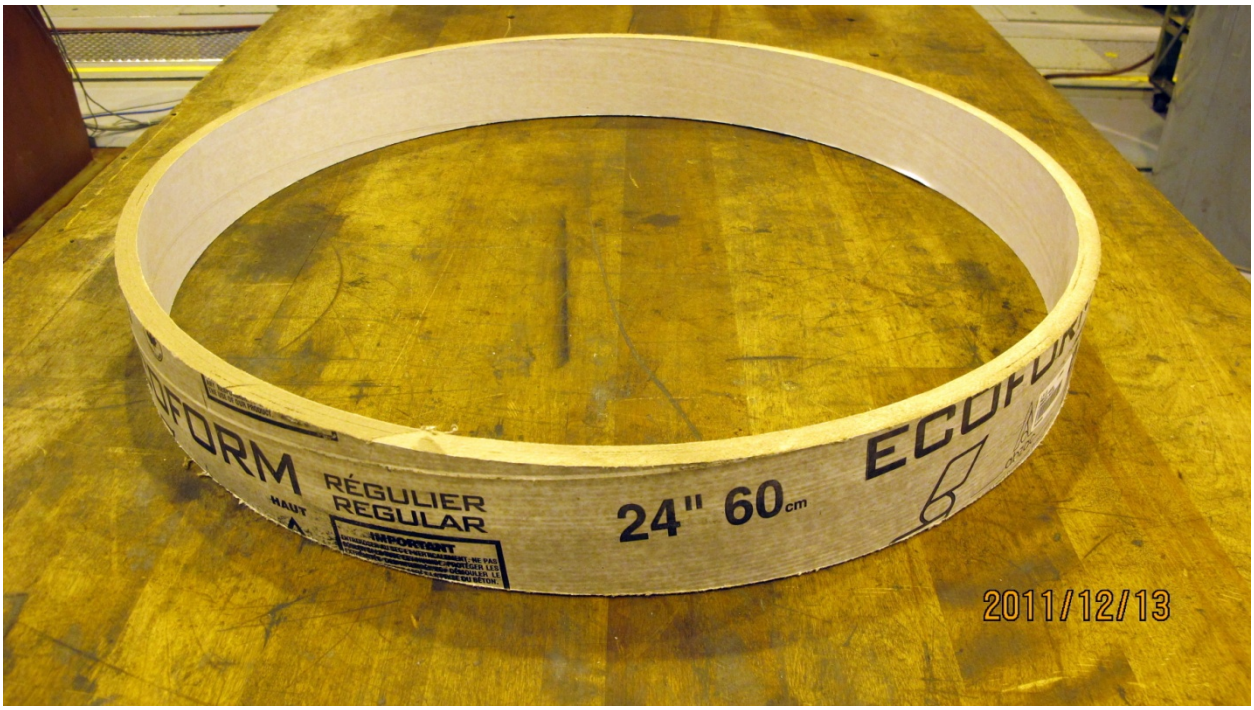
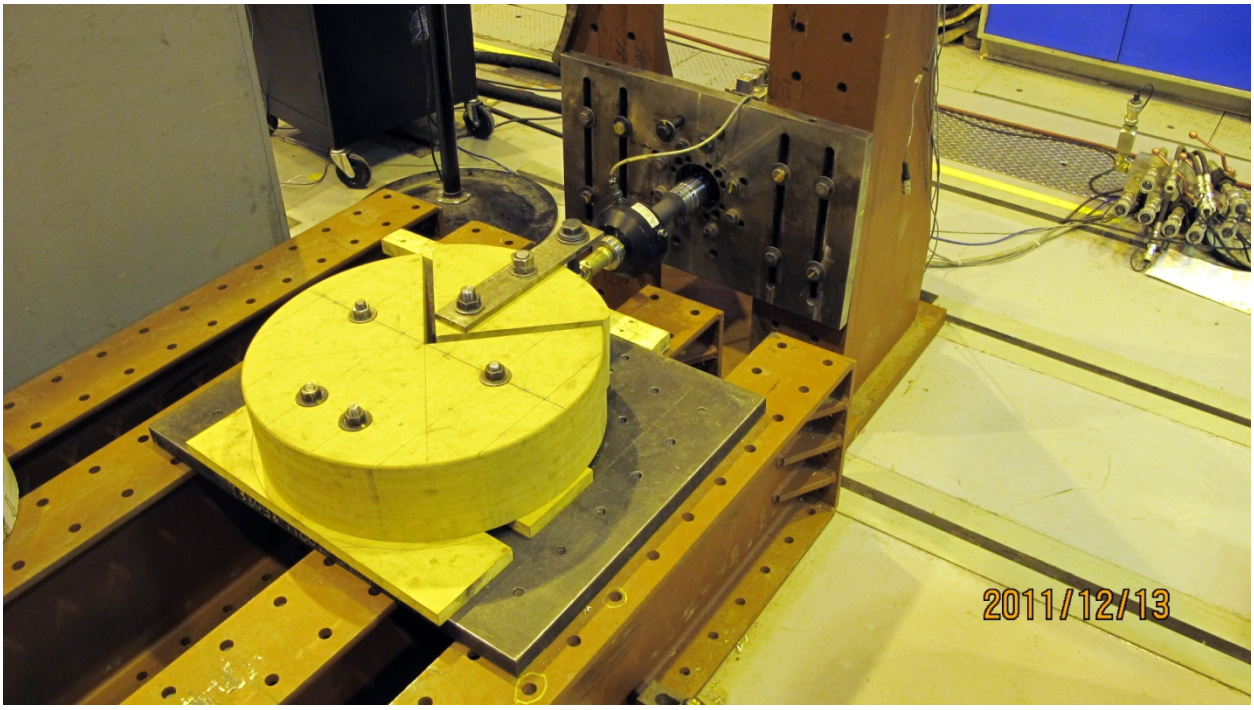
Picture A.3 – Typical 1/4 inch thick 5 inch wide sample

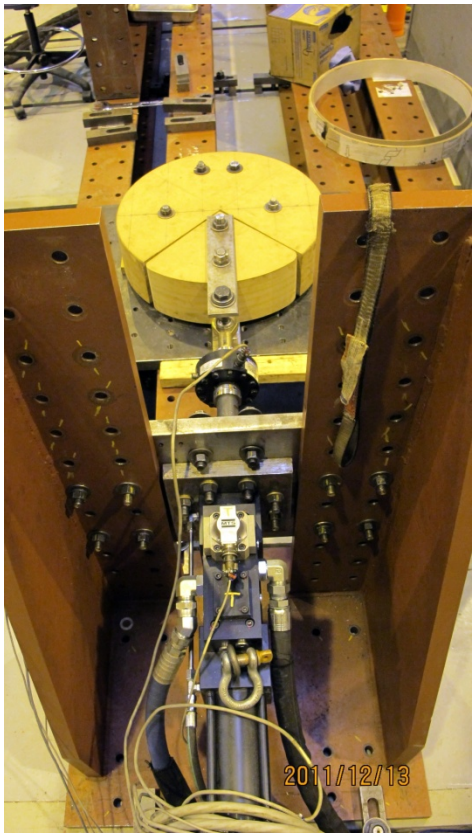
Picture A.4 – Typical 3/8 inch thick 3 inch wide sample



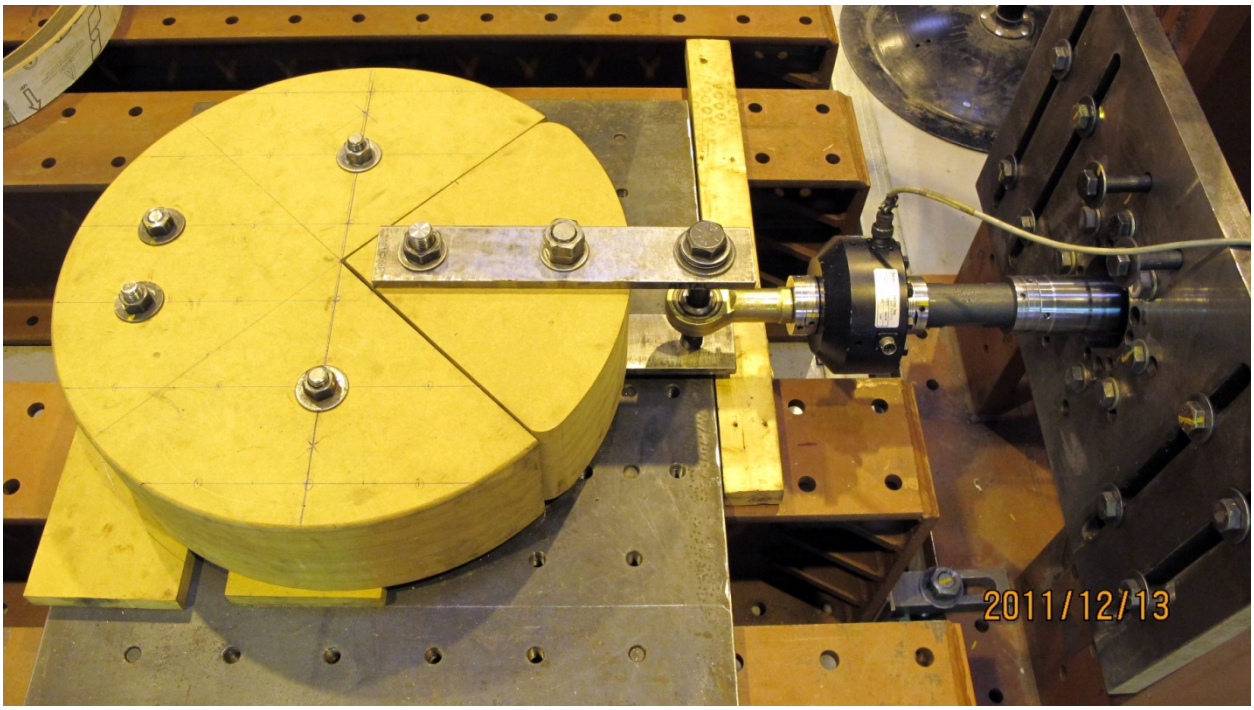
Picture A.5 – Typical 1/2 inch thick 3 inch wide sample



Picture A.6 – Test bench



Picture A.7 – Test bench



Picture A.8 – Test bench

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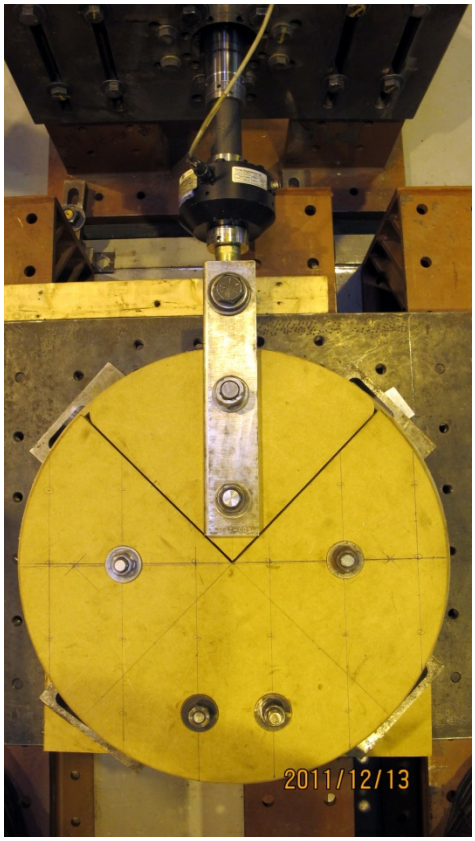
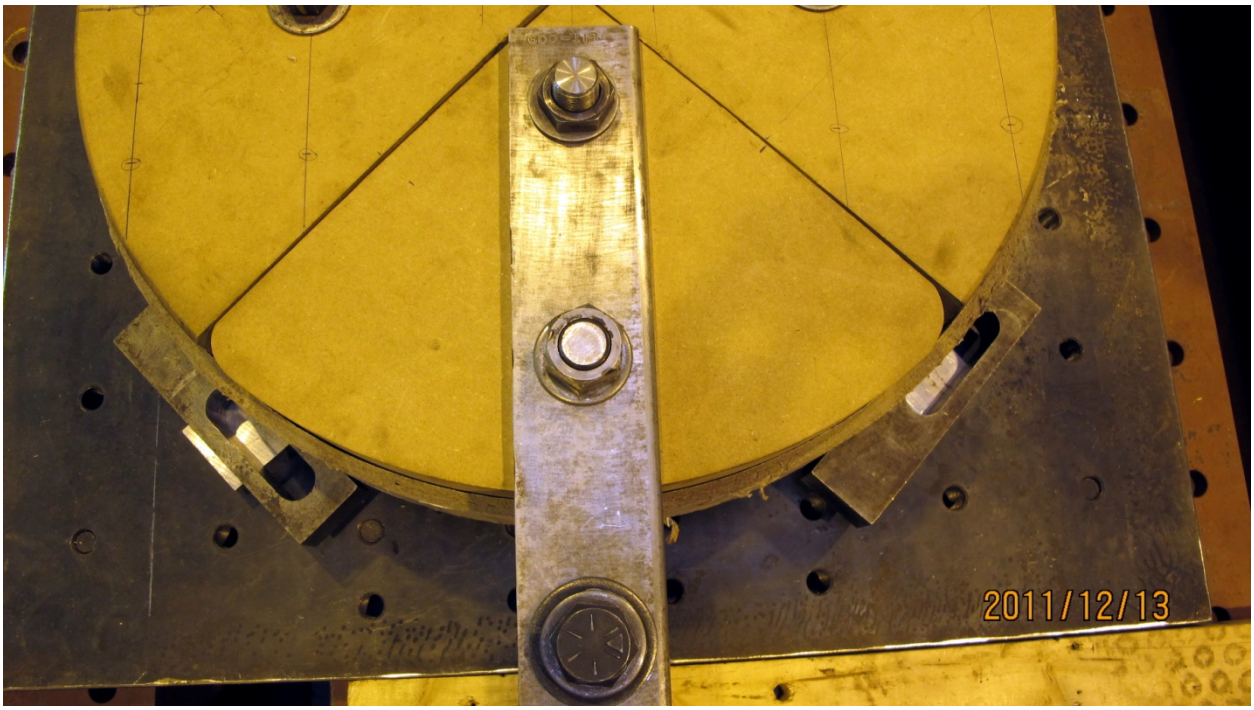


Picture A.9 – Sample installation prior to a test, typical, shown with a 1/2 inch thick sample



Picture A.10 – Sample installation prior to a test, typical, shown with a 1/2 inch thick sample

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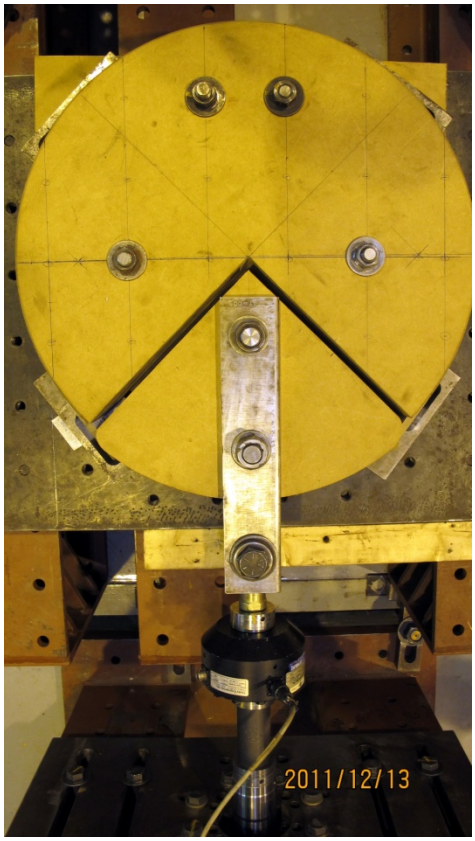
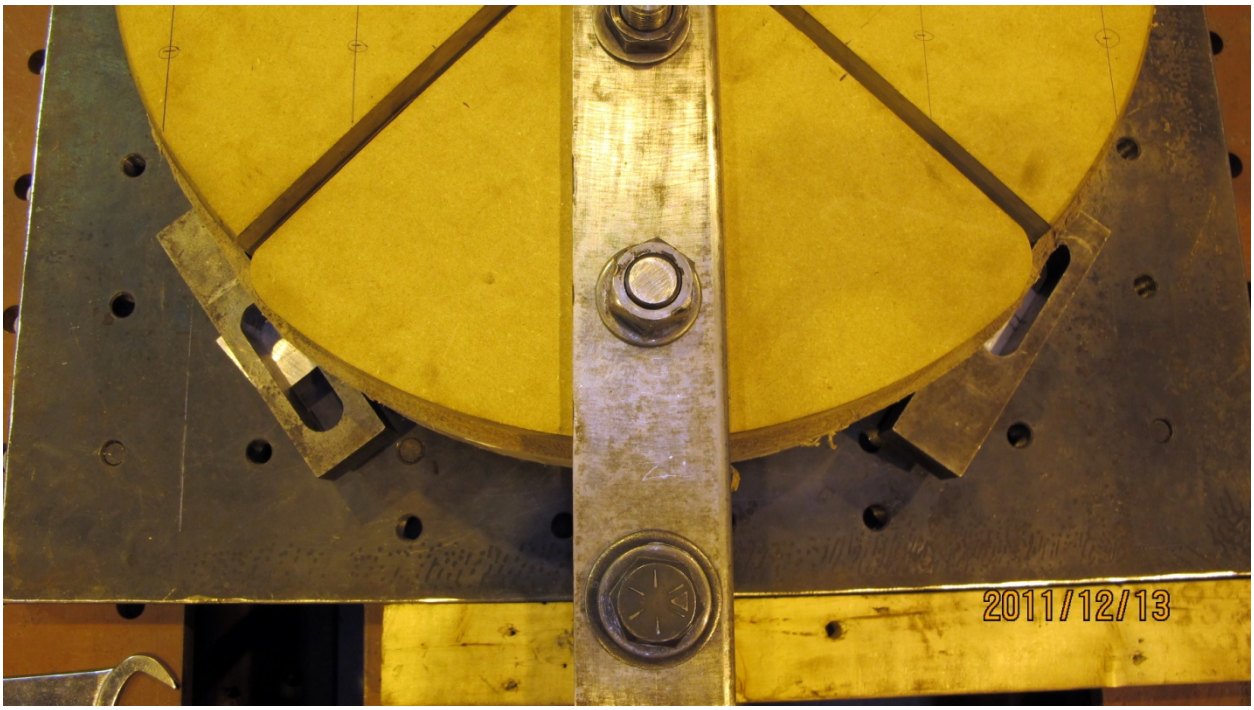
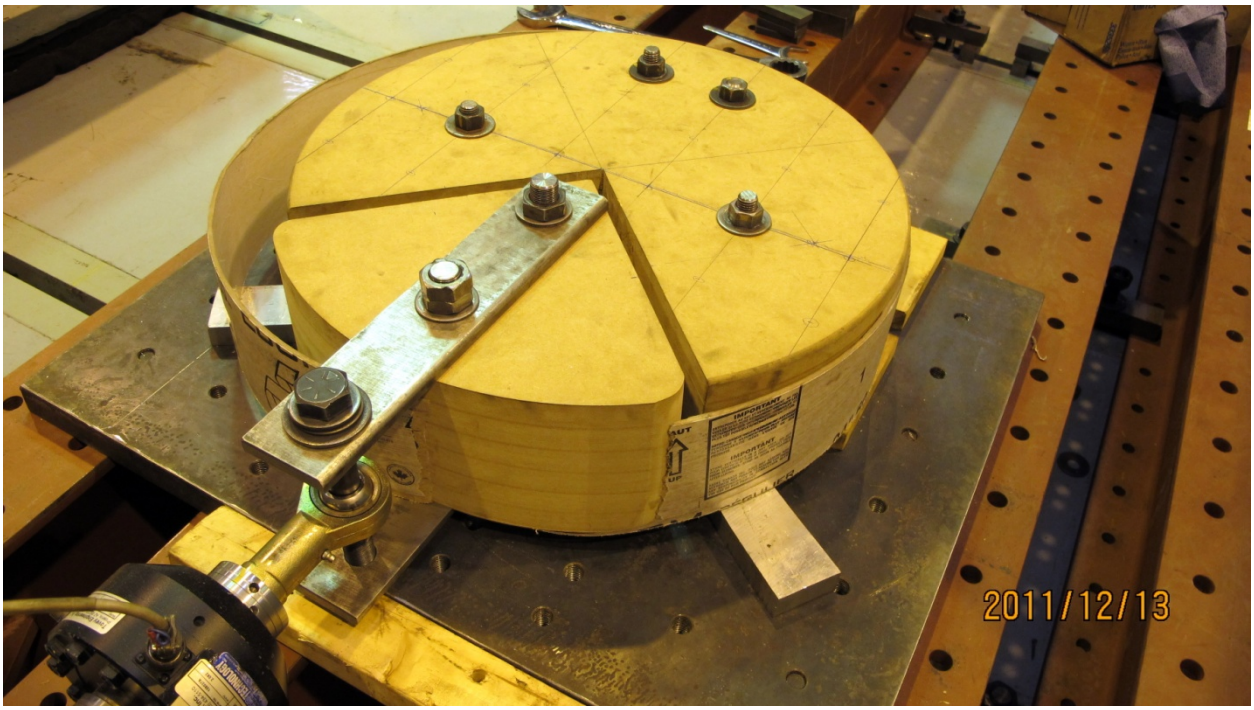


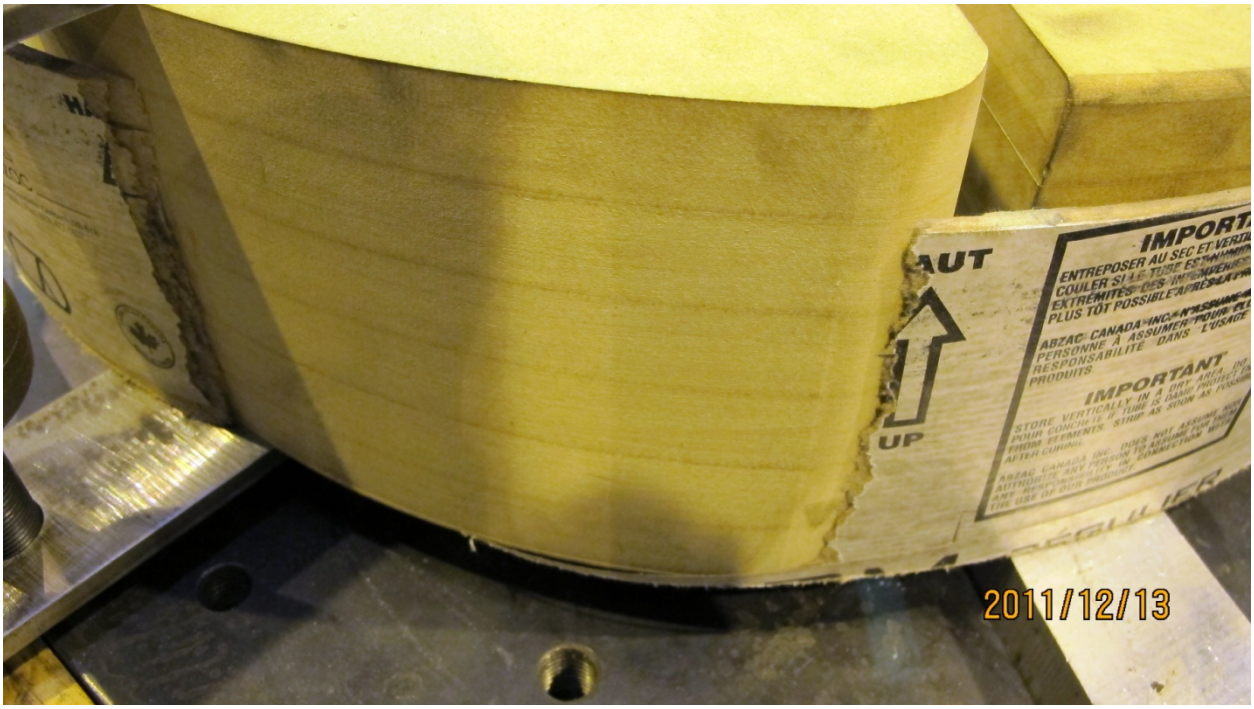
Picture A.11 – Typical sample deformation under loading, 1/2 inch thick sample shown



Picture A.12 – Typical sample deformation under loading, 1/2 inch thick sample shown



Picture A.13 – Typical breakage, 1/8 inch thick sample shown



Picture A.14 – Typical breakage, 1/8 inch thick sample shown

LOADING CURVES

- **Force versus Time**
- **Cylinder position versus Time**
- **Force versus Cylinder position**

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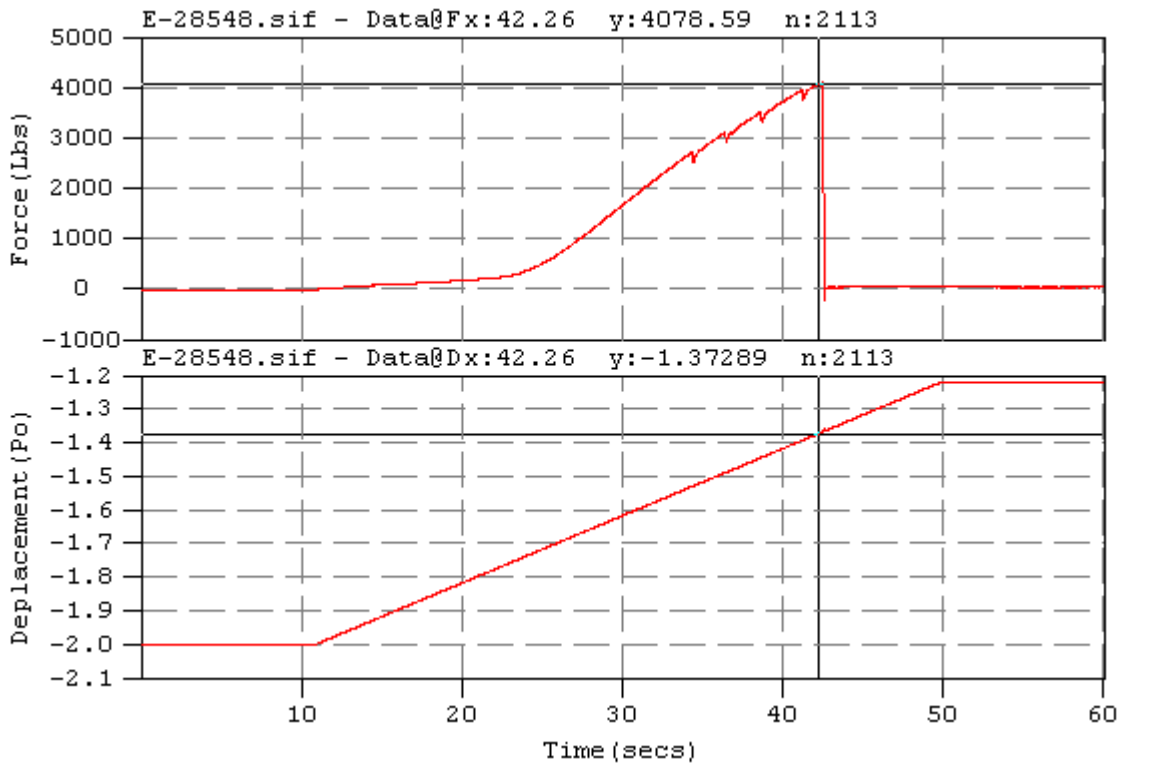
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Force (Lbs)
5000
4000
3000
2000
1000
0
-1000
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Deplacement (Po)
-1.2
-1.3
-1.4
-1.5
-1.6
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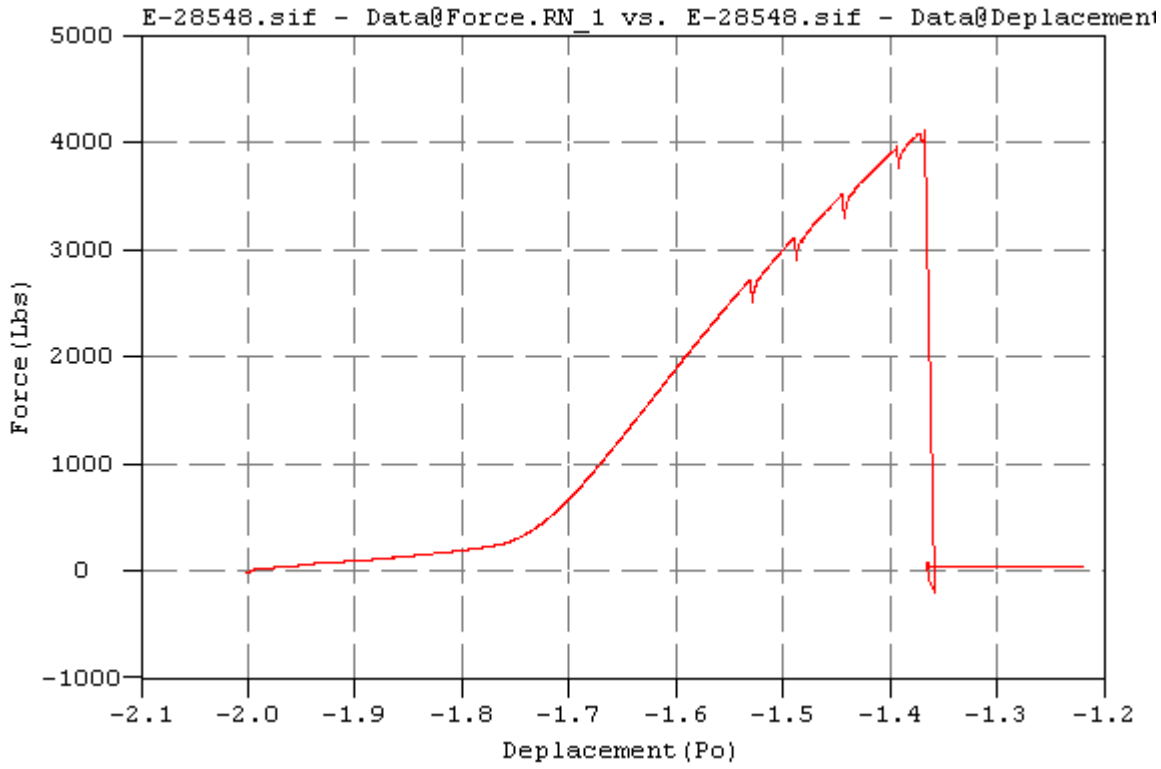
10
20
30
40
50
60
Time (secs)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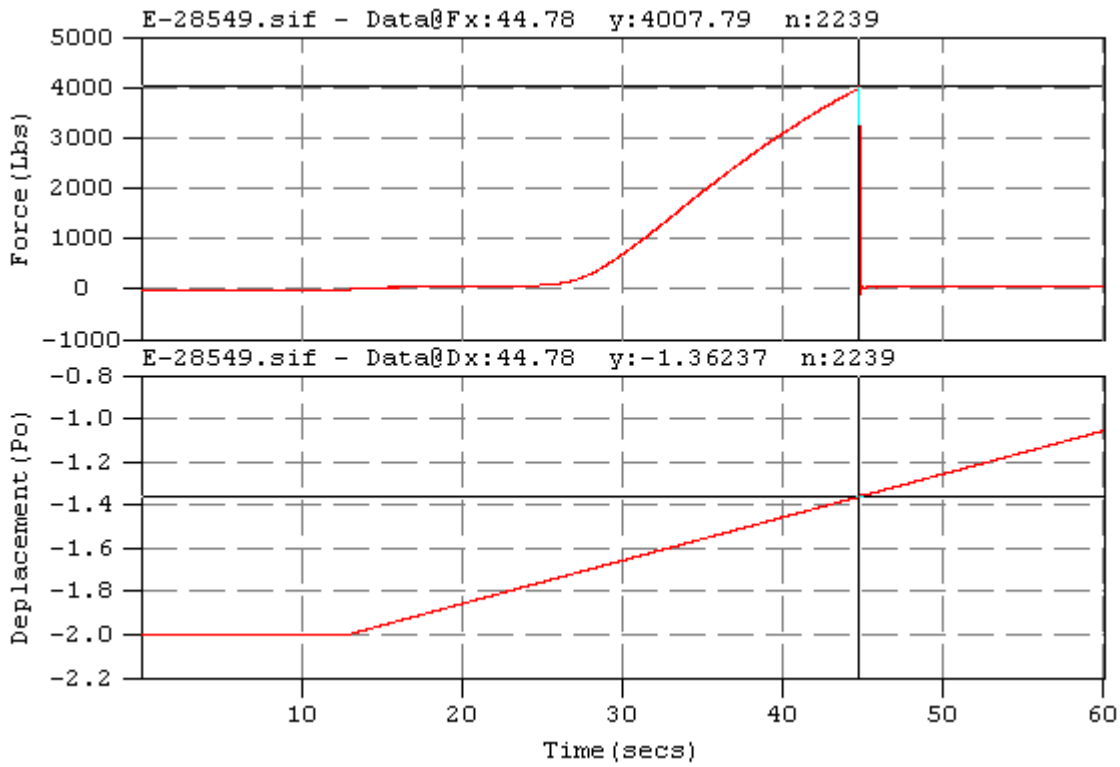
Force (Lbs)
5000
4000
3000
2000
1000
0
-1000
-2.1
-2.0
-1.9
-1.8
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
Deplacement (Po)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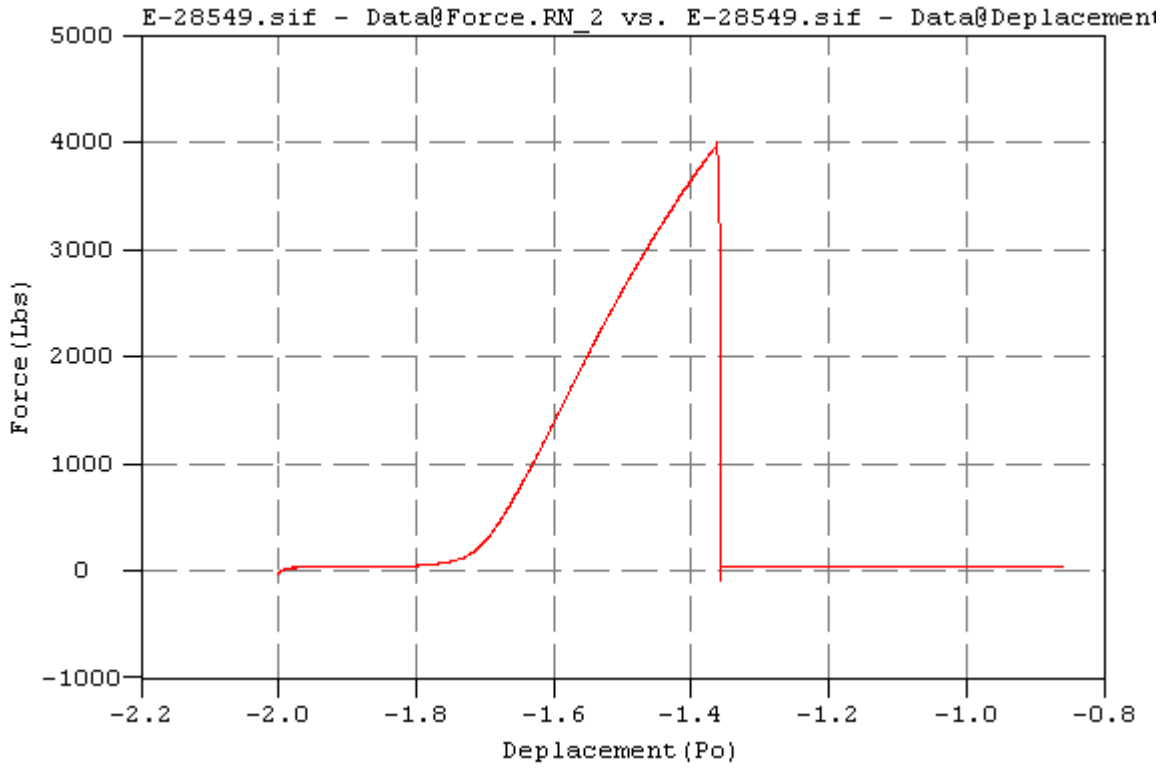
Force (Lbs)
5000
4000
3000
2000
1000
0
-1000
E-28549.sif - Data@Dx:44.78 y:-1.36237 n:2239
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
10
20
30
40
50
60
Time (secs)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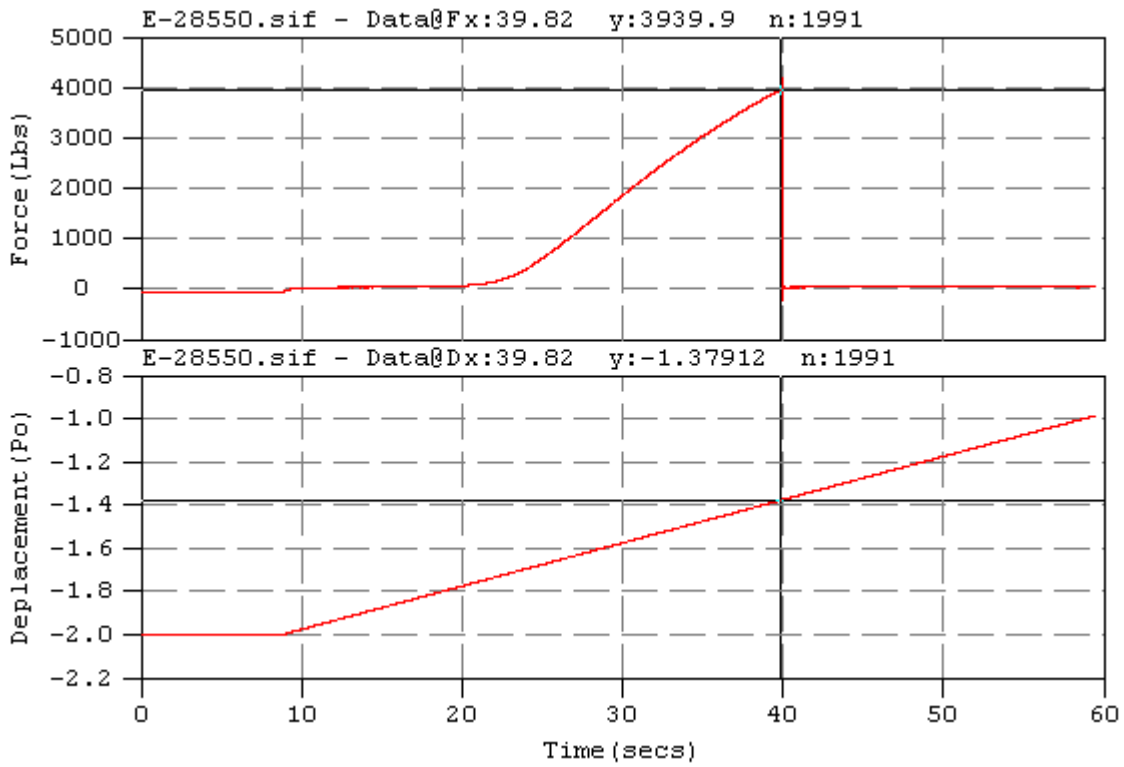
Force (Lbs)
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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Force (Lbs)
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4000
3000
2000
1000
0
-1000
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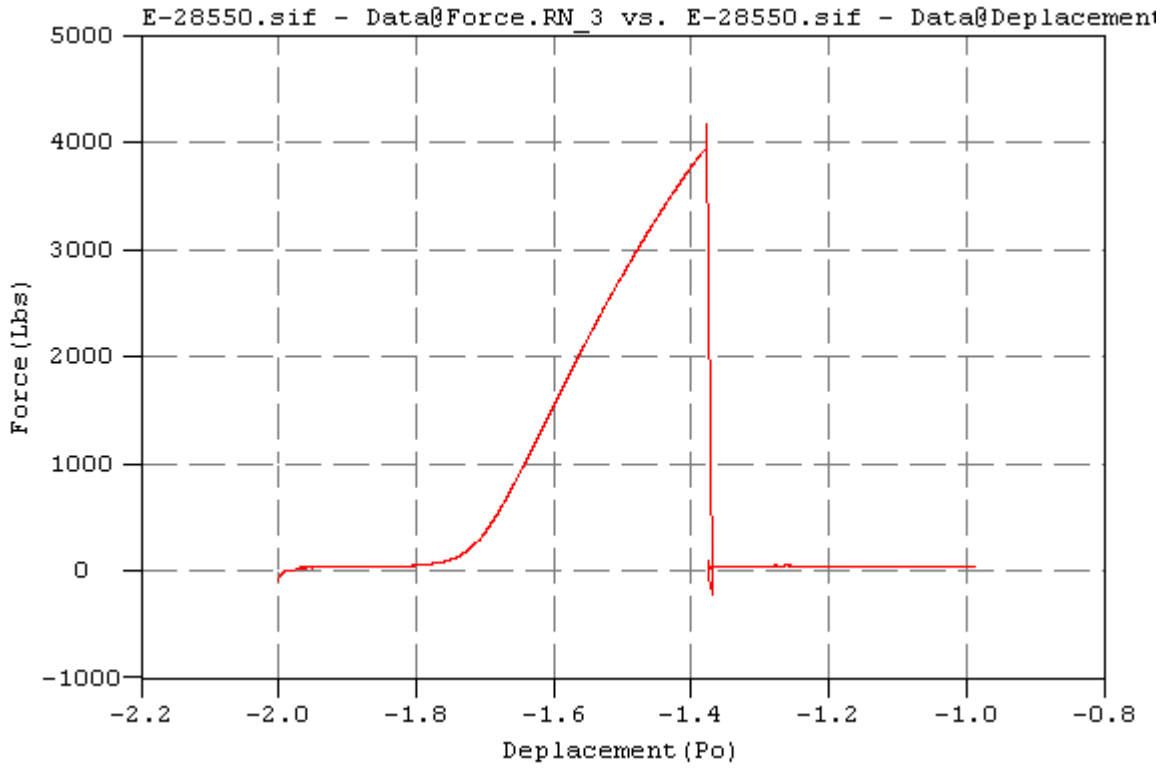
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
0
10
20
30
40
50
60
Time (secs)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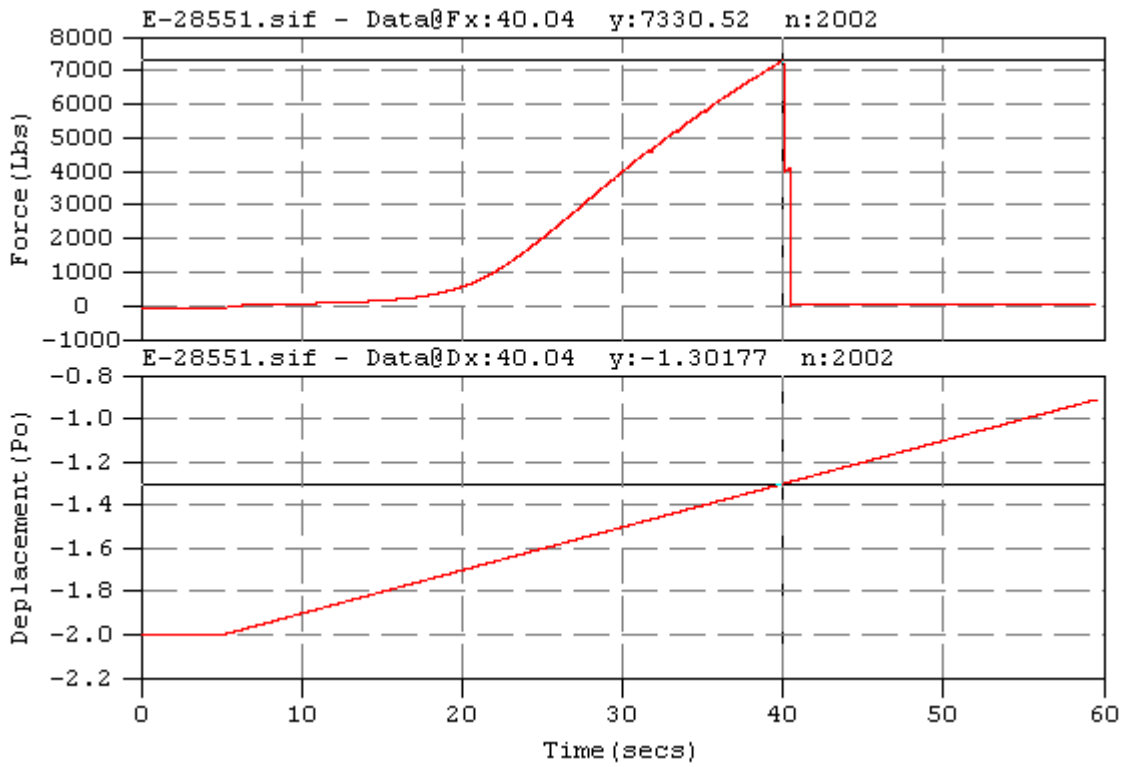
Force (Lbs)
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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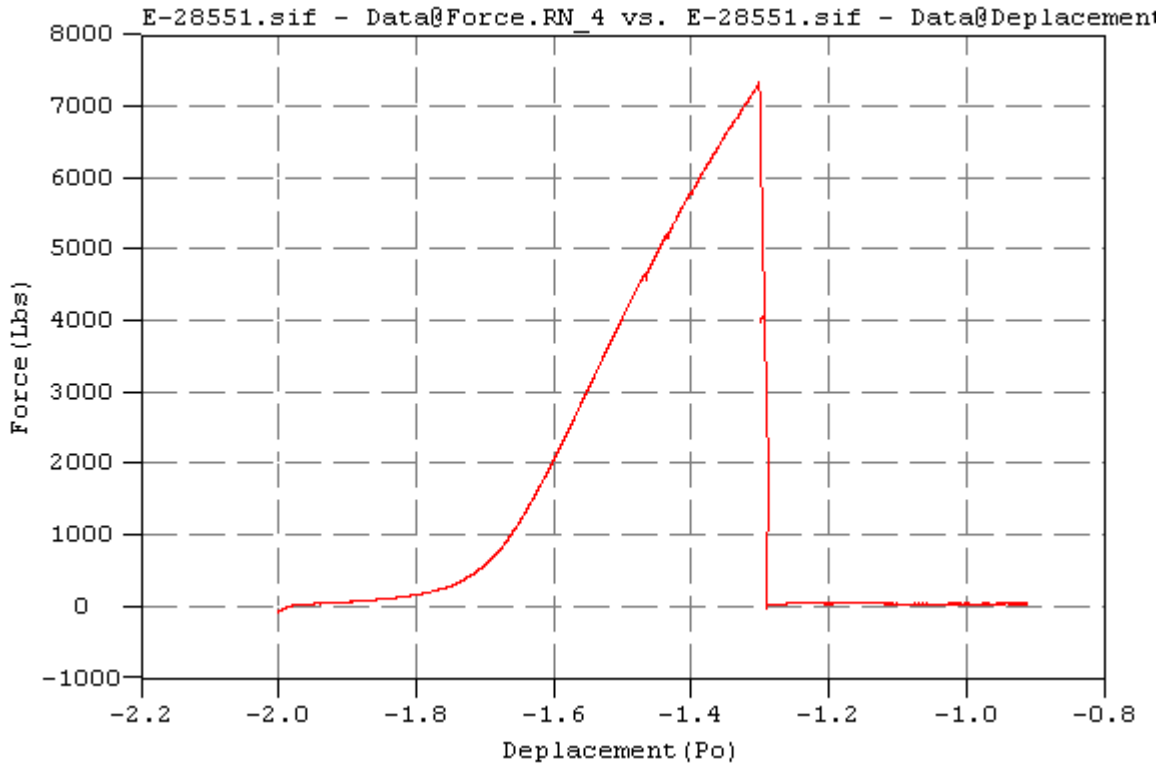
Force (Lbs)
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
E-28551.sif - Data@Dx:40.04 y:-1.30177 n:2002
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
0
10
20
30
40
50
60
Time (secs)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Force (Lbs)
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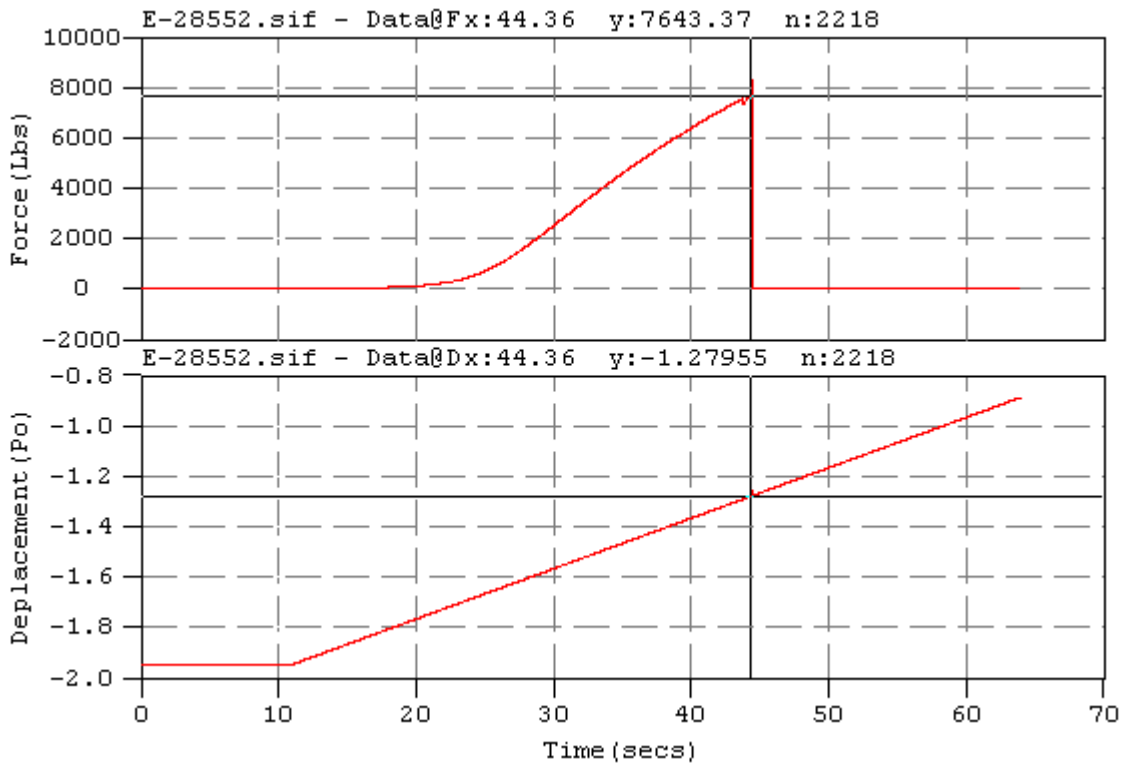
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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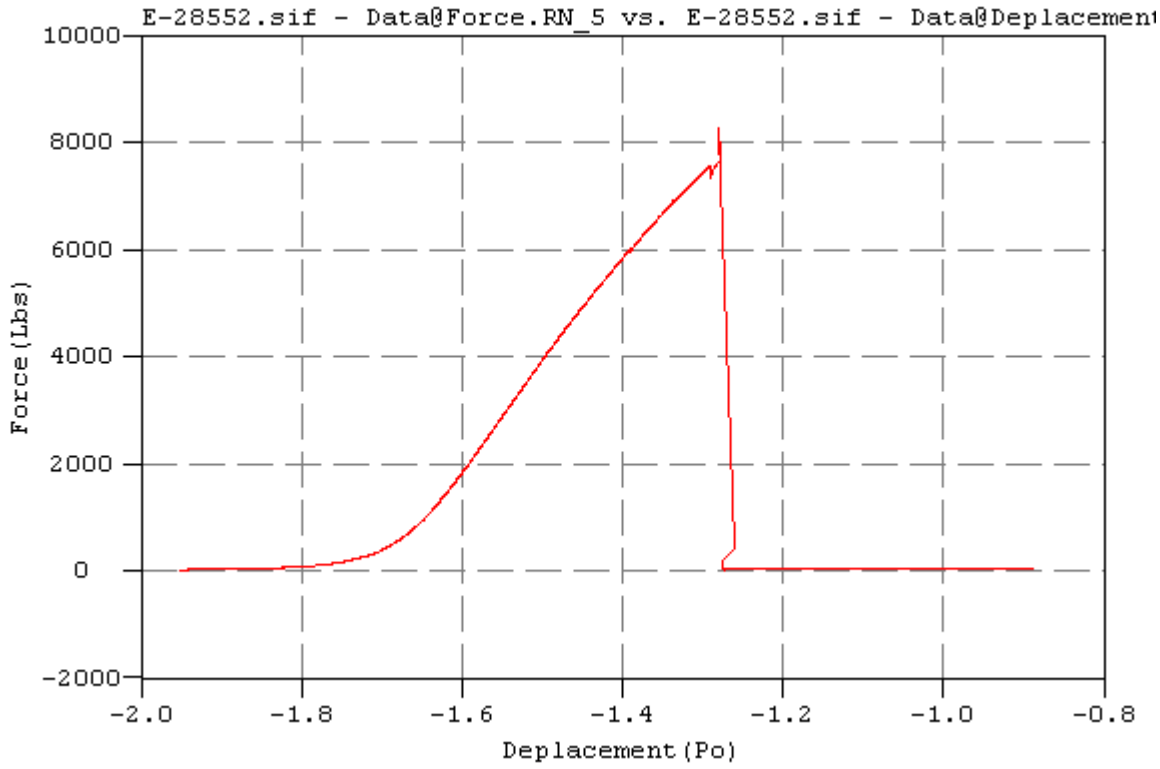
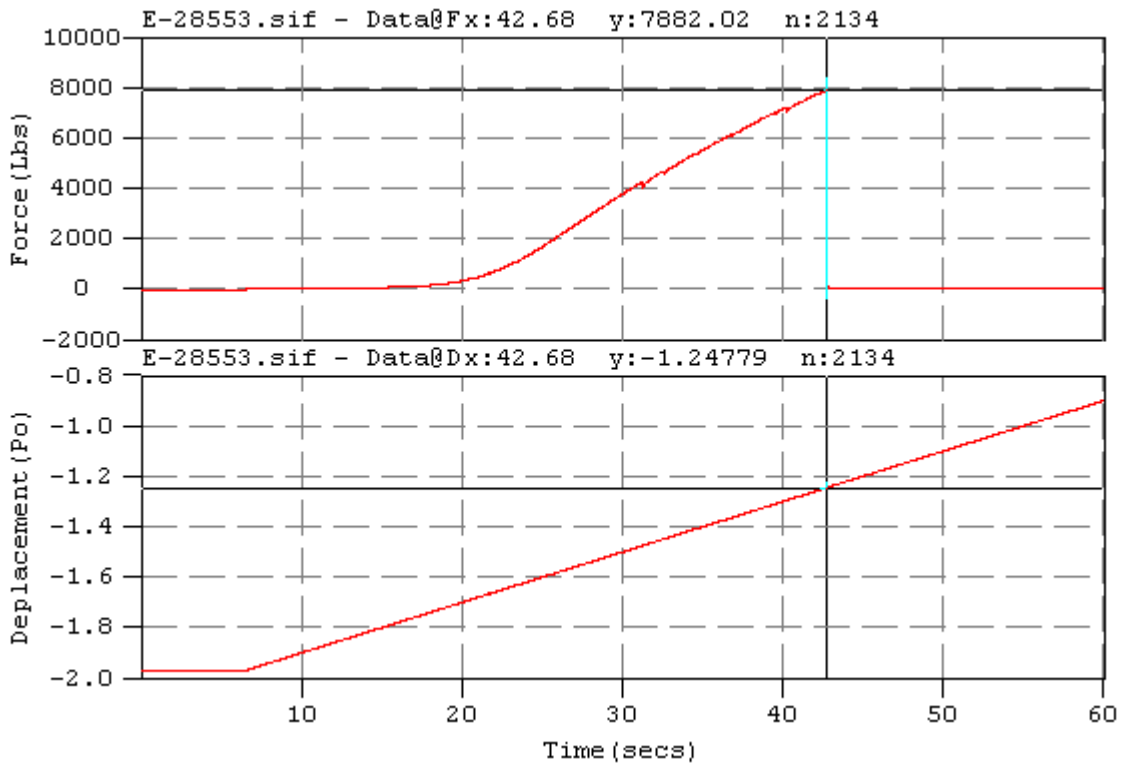
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
E-28552.sif - Data@Dx:44.36 y:-1.27955 n:2218
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
0
10
20
30
40
50
60
70
Time (secs)


E-28552.sif - Data@Force.RN_5 vs. E-28552.sif - Data@Deplacement
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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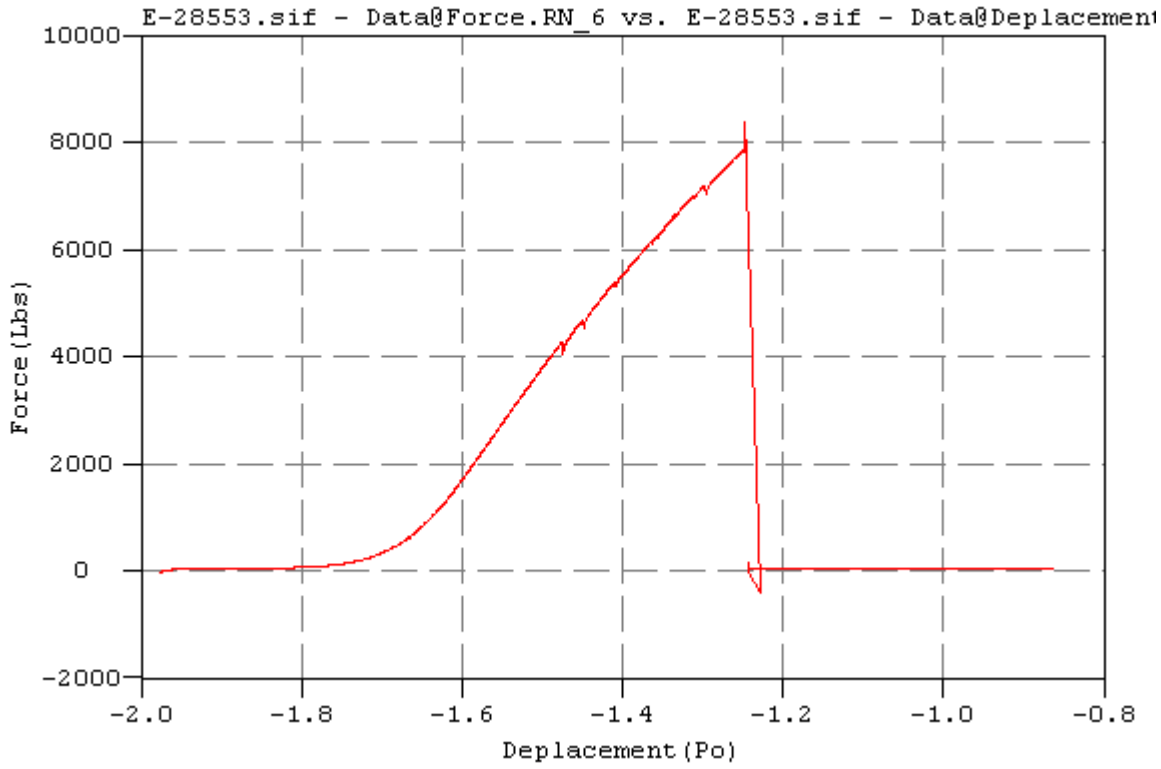
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
E-28553.sif - Data@Dx:42.68 y:-1.24779 n:2134
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
10
20
30
40
50
60
Time (secs)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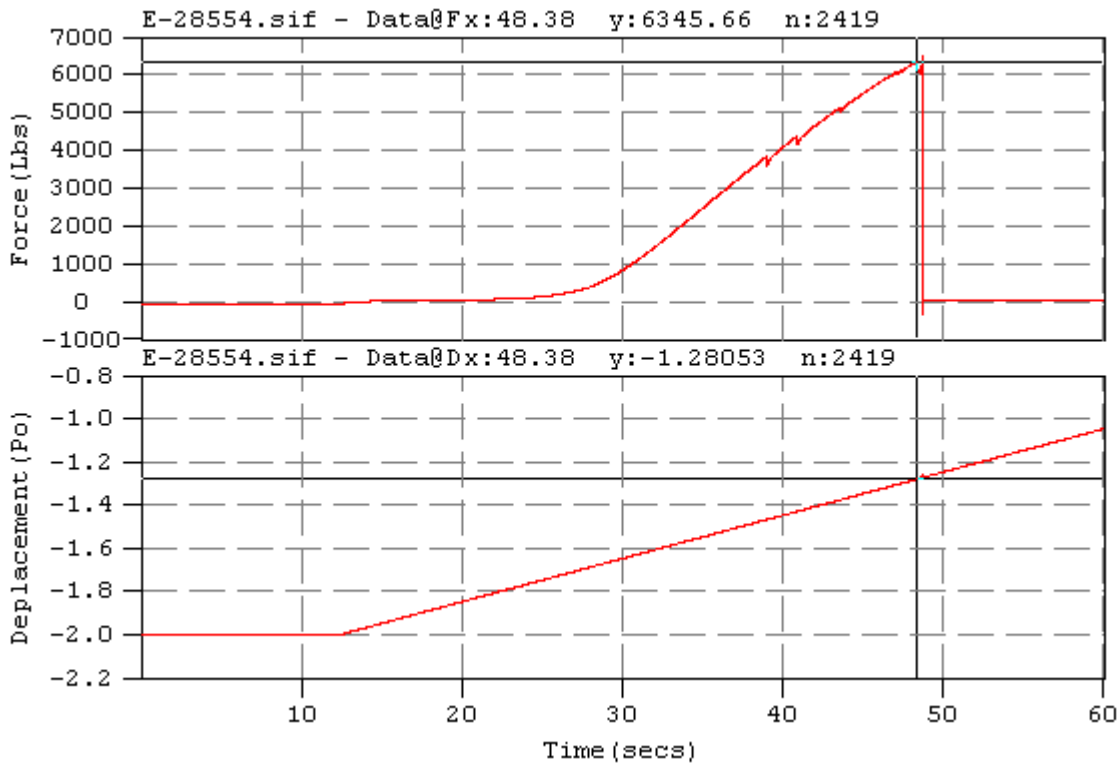
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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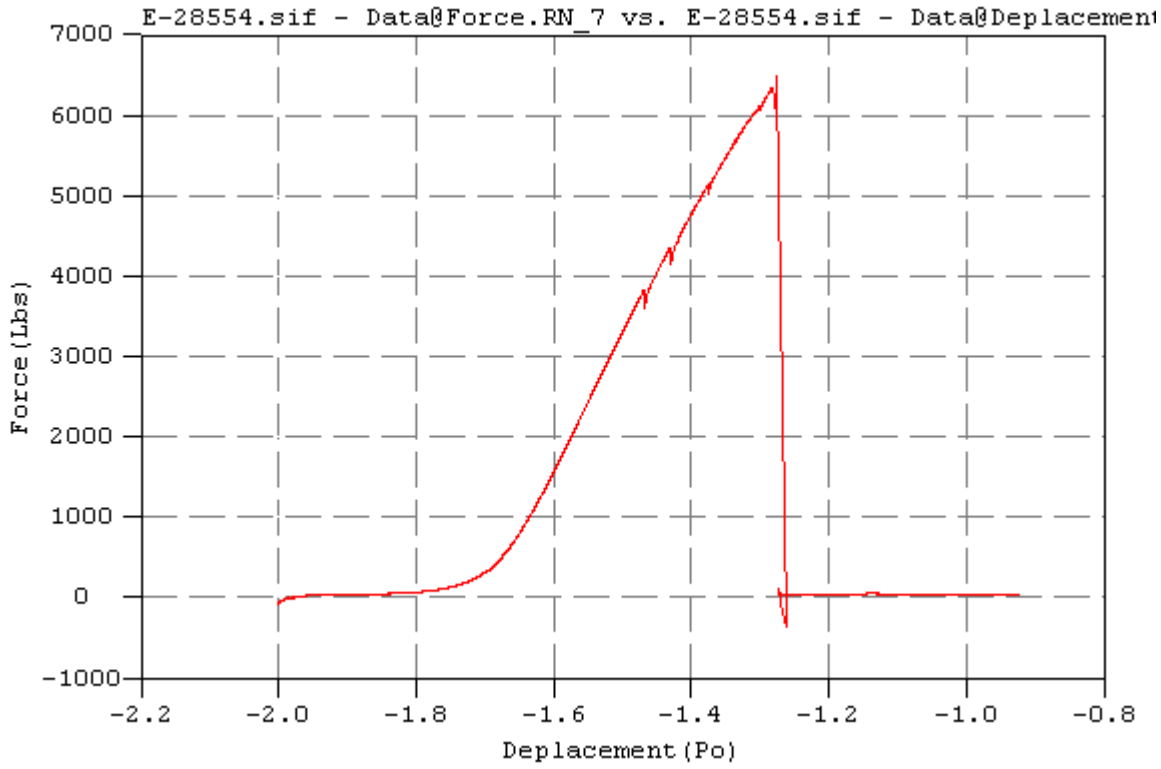
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
E-28554.sif - Data@Dx:48.38 y:-1.28053 n:2419
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
10
20
30
40
50
60
Time (secs)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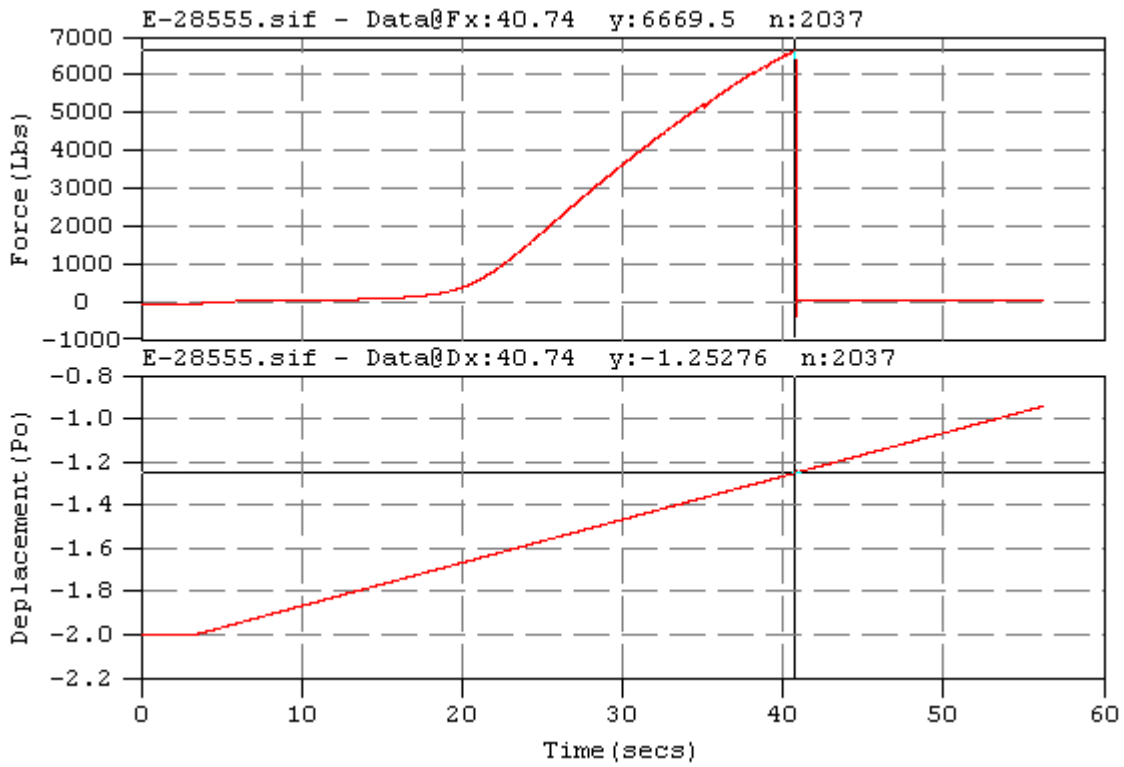
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)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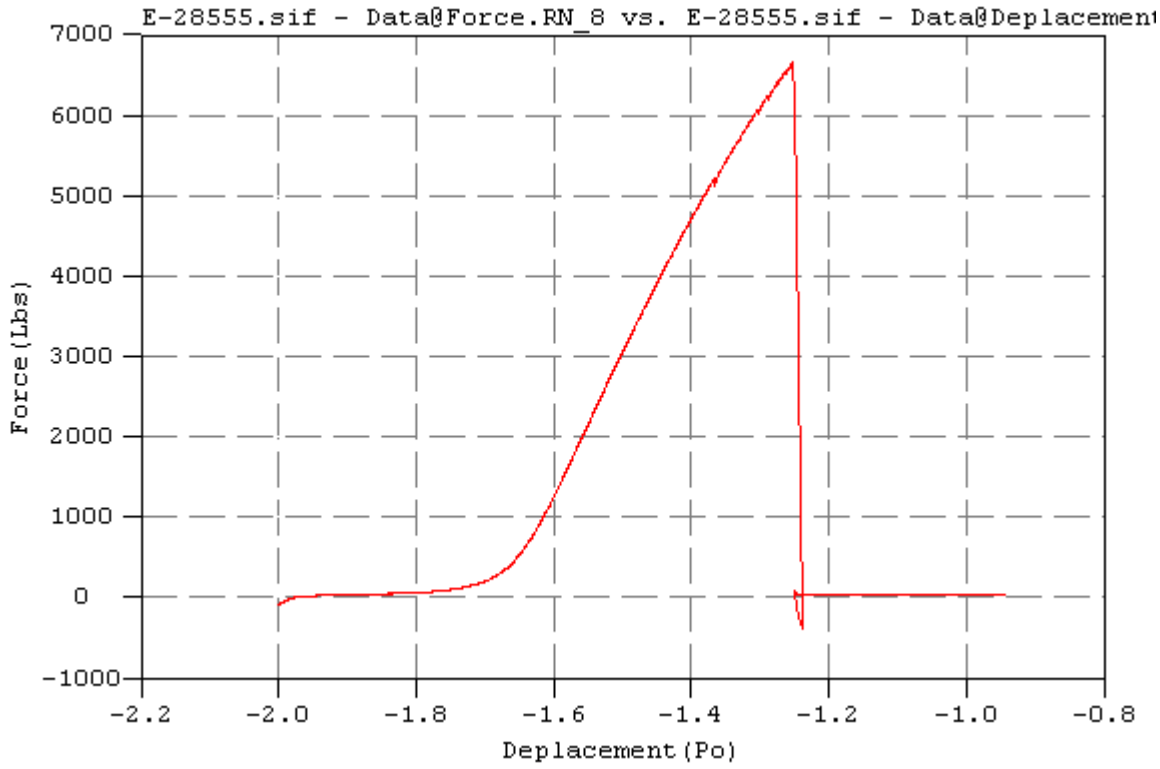
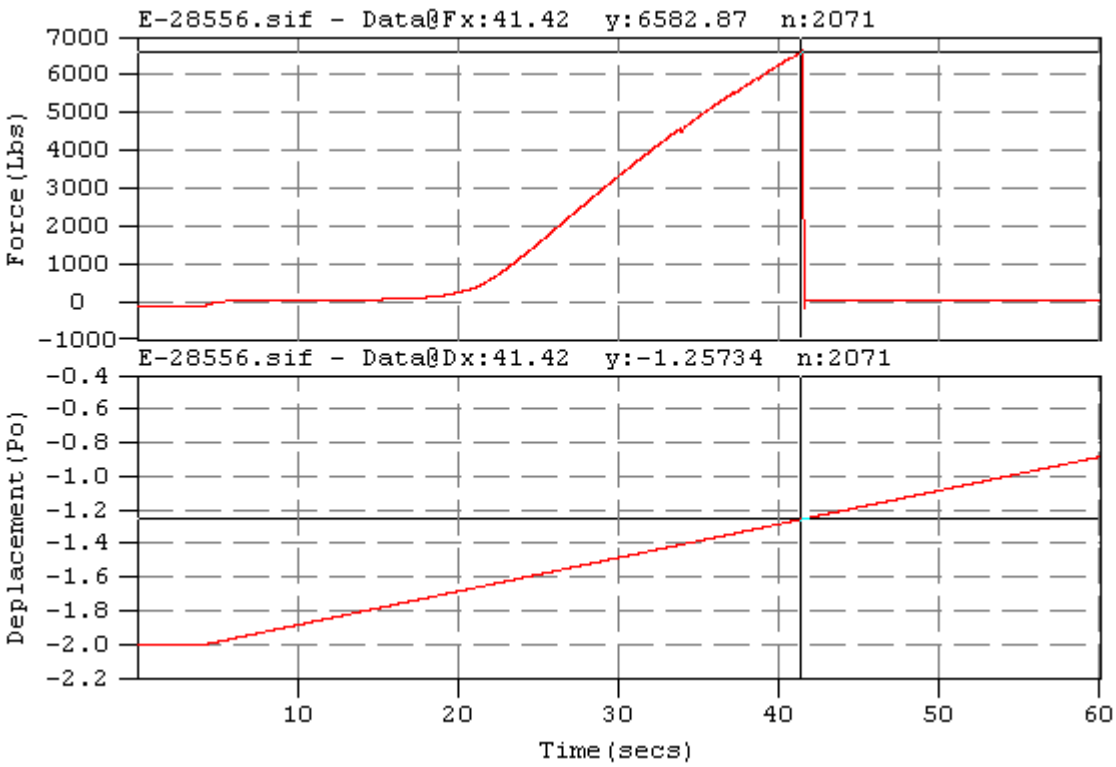
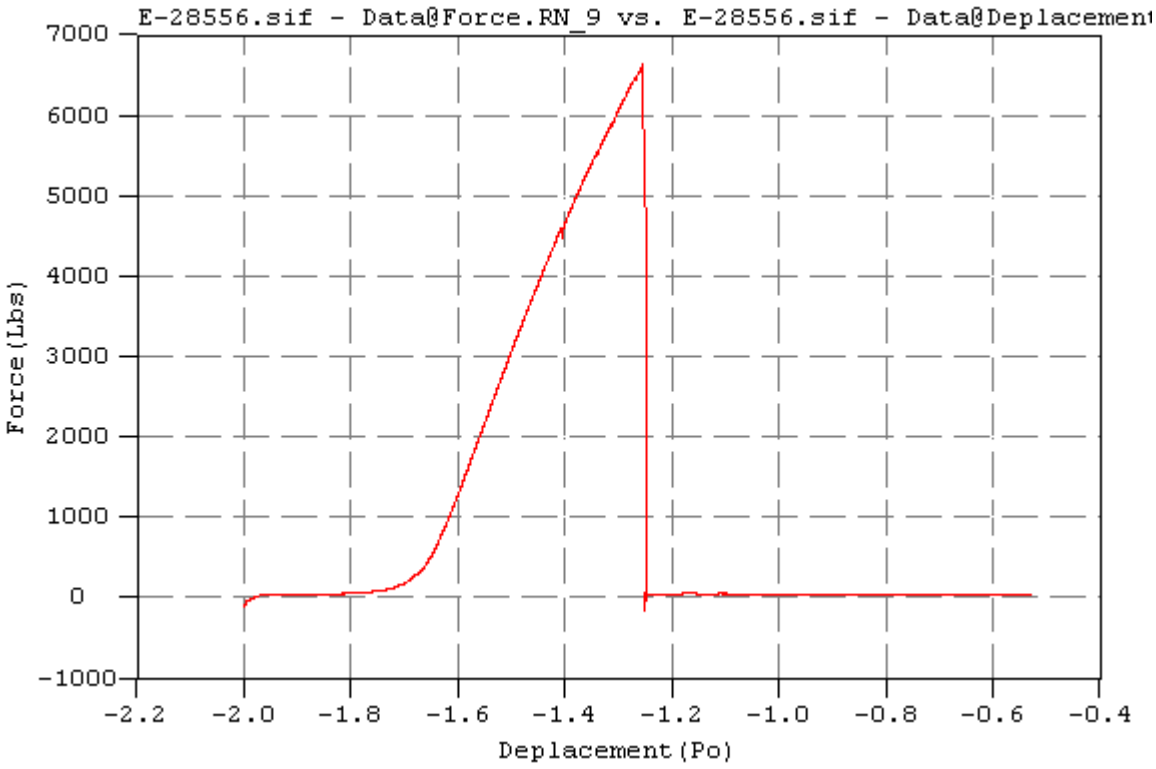
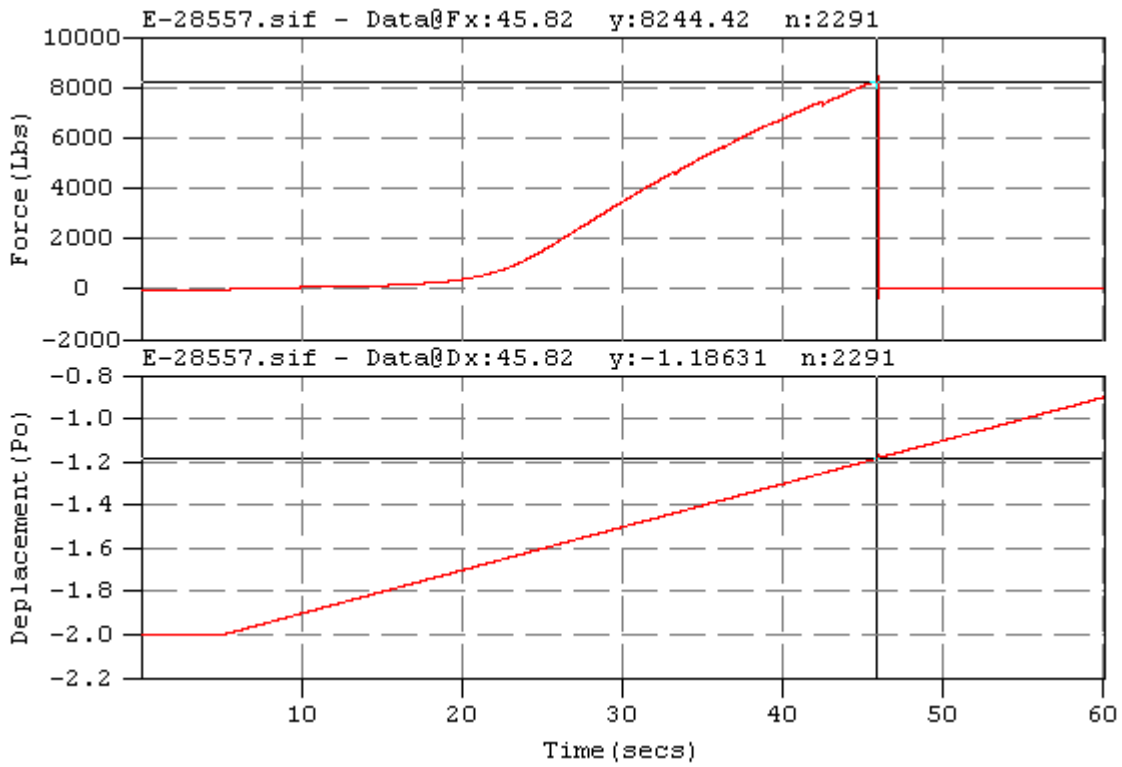
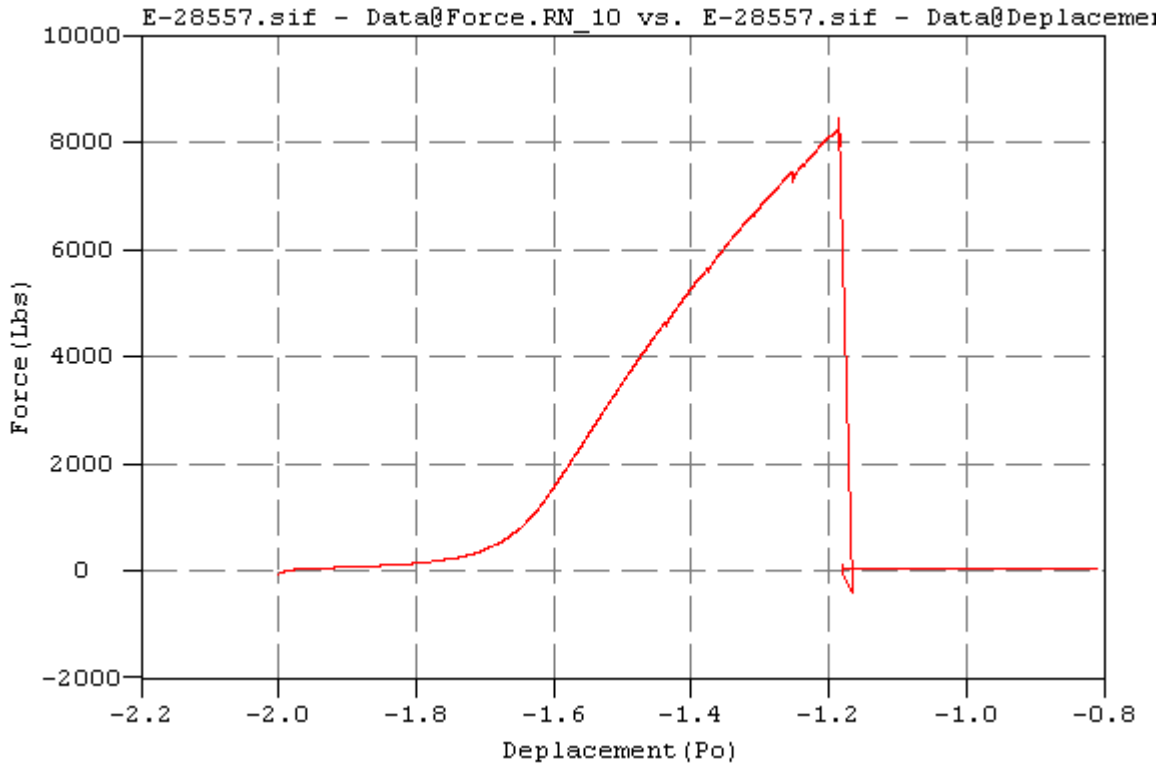
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
E-28555.sif - Data@Dx:40.74 y:-1.25276 n:2037
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
0
10
20
30
40
50
60
Time (secs)

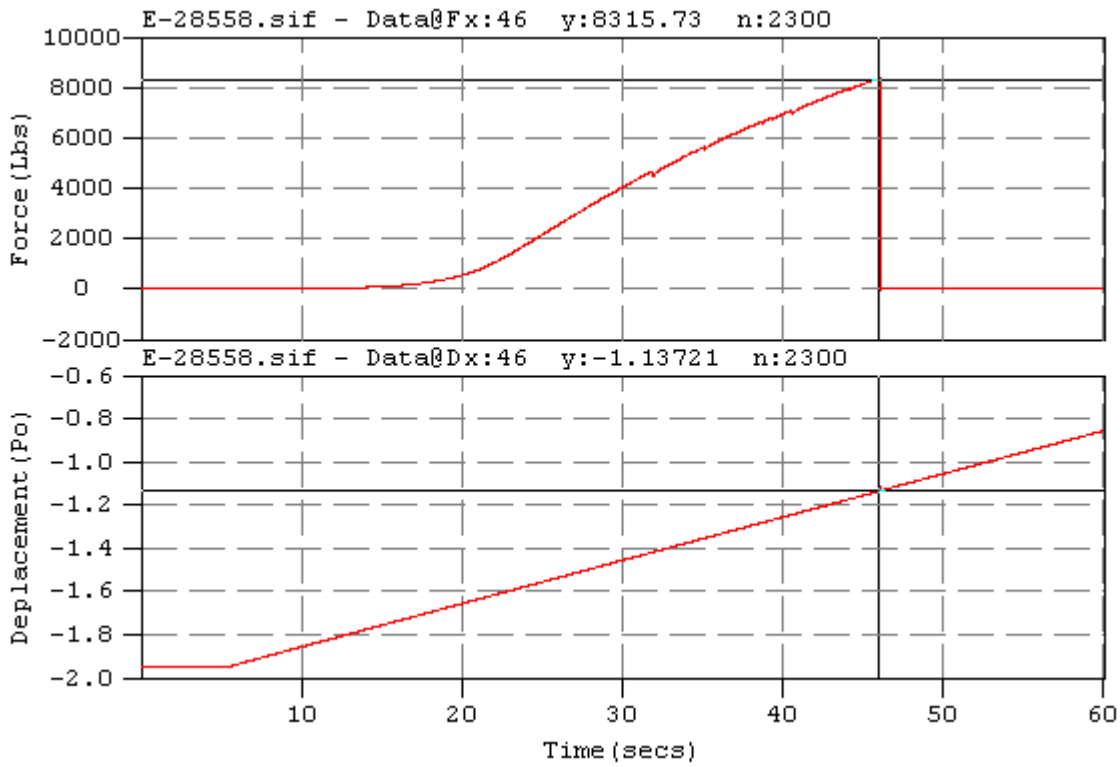

E-28555.sif - Data@Force.RN_8 vs. E-28555.sif - Data@Deplacement
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)

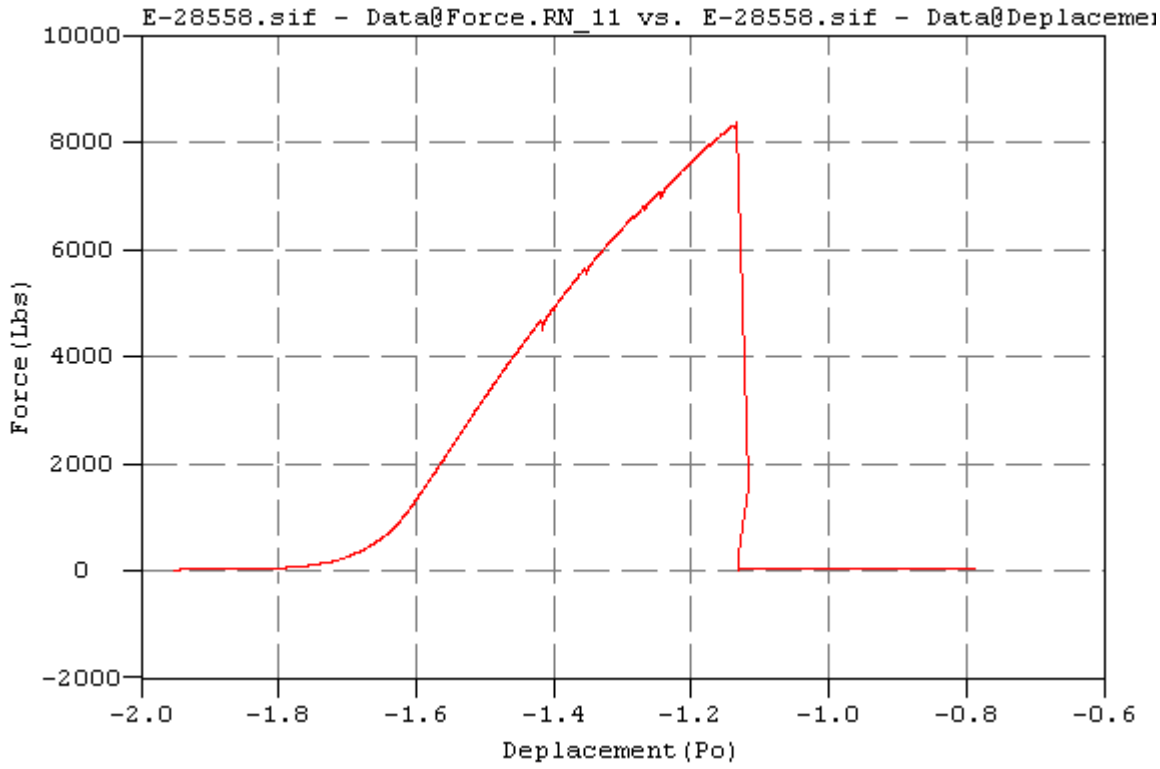

E-28556.sif - Data@Fx:41.42 y:6582.87 n:2071
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
E-28556.sif - Data@Dx:41.42 y:-1.25734 n:2071
Deplacement (Po)
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
10
20
30
40
50
60
Time (secs)

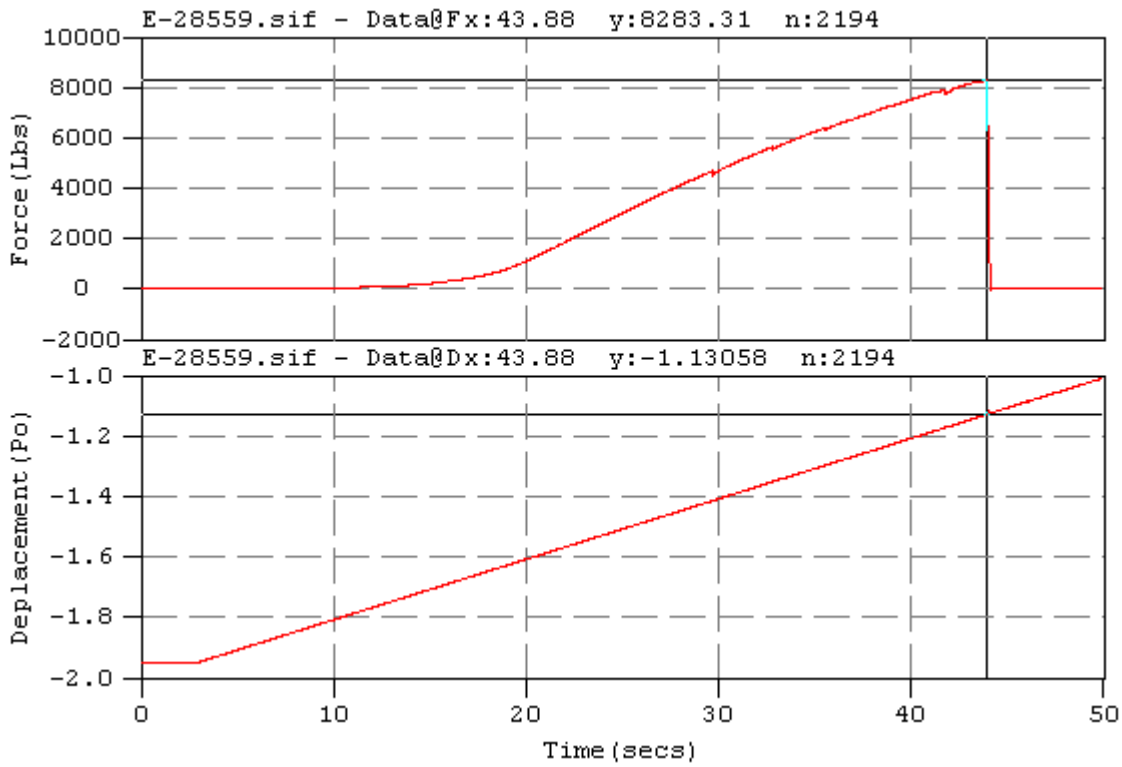

E-28556.sif - Data@Force.RN_9 vs. E-28556.sif - Data@Deplacement
Force (Lbs)
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
-0.6
-0.4
Deplacement (Po)

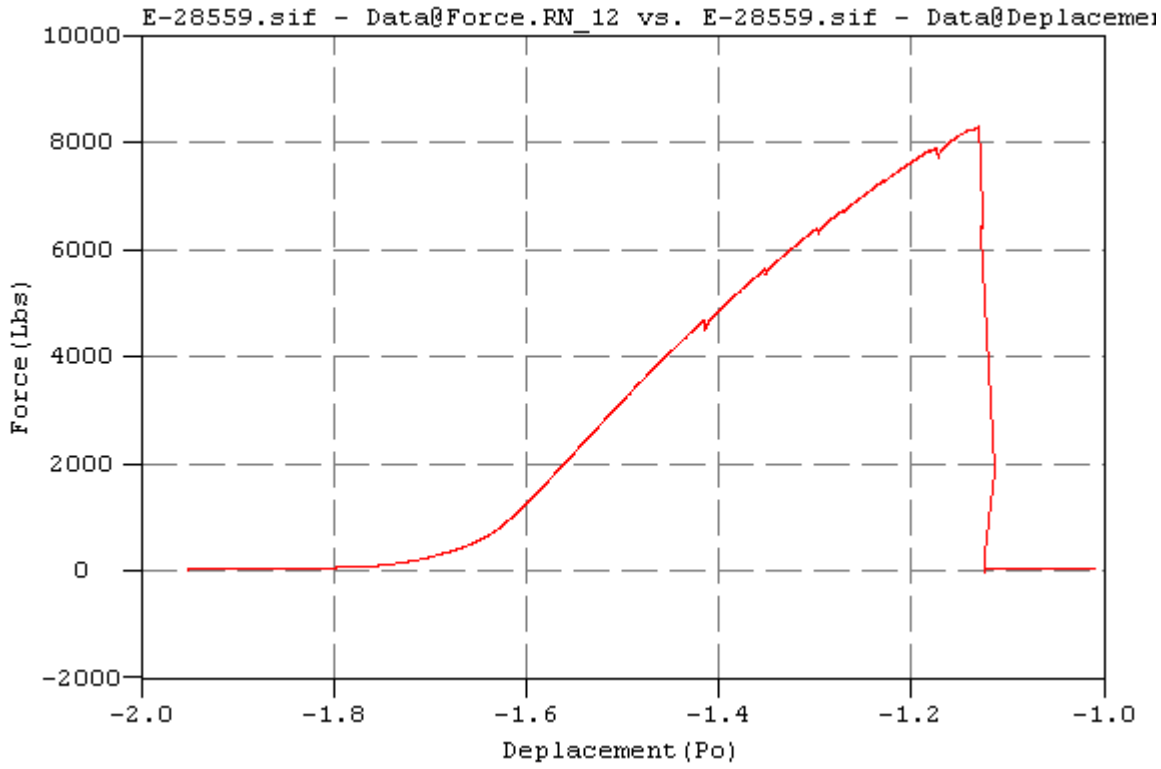

E-28557.sif - Data@Fx:45.82 y:8244.42 n:2291
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
E-28557.sif - Data@Dx:45.82 y:-1.18631 n:2291
Deplacement (Po)
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
10
20
30
40
50
60
Time (secs)


E-28557.sif - Data@Force.RN_10 vs. E-28557.sif - Data@Deplaceme
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
-2.2
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
Deplacement (Po)


E-28558.sif - Data@Fx:46 y:8315.73 n:2300
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
E-28558.sif - Data@Dx:46 y:-1.13721 n:2300
Deplacement (Po)
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
10
20
30
40
50
60
Time (secs)


E-28558.sif - Data@Force.RN_11 vs. E-28558.sif - Data@Deplaceme
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
-0.8
-0.6
Deplacement (Po)


E-28559.sif - Data@Fx:43.88 y:8283.31 n:2194
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
E-28559.sif - Data@Dx:43.88 y:-1.13058 n:2194
Deplacement (Po)
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
0
10
20
30
40
50
Time (secs)


E-28559.sif - Data@Force.RN_12 vs. E-28559.sif - Data@Deplaceme
Force (Lbs)
10000
8000
6000
4000
2000
0
-2000
-2.0
-1.8
-1.6
-1.4
-1.2
-1.0
Deplacement (Po)