

# DALLAS LABORATORIES, INC.

Consultants and Technologists  
Chemical and Petroleum Chemists

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Submitted by: Associated Fiberglass Enterprises  
2411 Weaver Street  
Fort Worth, TX 76117

Date: May 22, 2019

Attn: Kendall George

Report No.: 52191-A

## REPORT

Lab Sample No.: Four (4) Samples

52191-1 ≈1.125" Thick FRT from 4 ft. diameter manhole (Five Specimens)  
52191-2 ≈1.25" Thick FRT from 5 ft. diameter manhole (Four Specimens)  
52191-3 ≈0.5" Thick FRT from 4 ft. diameter manhole (Five Specimens)  
52191-4 ≈0.5" Thick FRT from 5 ft. diameter manhole (Five Specimens)

## PROCEDURE

Samples were tested for flexural strength (axial direction) per ASTM D790 with the following results:

## RESULTS

### 52191-1:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	11,222	1.278
2	11,430	1.306
3	10,197	1.396
4	10,551	1.341
5	<u>10,034</u>	<u>1.372</u>
Average	10,687	1.339
Standard Deviation	617	0.048

### 52191-2:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	9,770	1.722
2	8,781	1.710
3	9,014	1.700
4	<u>9,268</u>	<u>1.676</u>
Average	9,208	1.702
Standard Deviation	424	0.020

52191-3:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	17,139	1.058
2	17,394	1.120
3	18,556	1.007
4	18,879	0.967
5	<u>17,535</u>	<u>0.987</u>
Average	17,900	1.028
Standard Deviation	768	0.062

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52191-4:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	20,577	1.191
2	22,368	1.353
3	23,339	1.344
4	22,421	1.281
5	<u>22,028</u>	<u>1.367</u>
Average	22,146	1.307
Standard Deviation	1,001	0.073

DALLAS LABORATORIES, INC.

  
Kevan W. Jones, Vice President

Analyst: KJ  
KWJ: js

Report Date: May 21, 2019

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Sample ID: 52191-1A  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 20, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

4' Manhole FRT  
Axial

	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.000	1.080	1007.1	11221.9	0.88	*****	1278066.5
2	2.000	1.080	1025.7	11429.7	0.90	*****	1306004.7
3	2.000	1.080	915.1	10196.7	0.71	*****	1395862.9
4	2.000	1.081	948.6	10551.2	0.81	*****	1341127.9
5	2.000	1.085	908.8	10034.3	0.65	*****	1371511.0
Mean	2.000	1.081	961.1	10686.8	0.79	0.00	1338514.6
Stdv	0.000	0.002	53.1	617.0	0.11	0.00	47684.6

Specimen Comments:

- 1 : fracture
- 2 : offset fracture 1"
- 3 : fracture
- 4 : fracture
- 5 : offset fracture

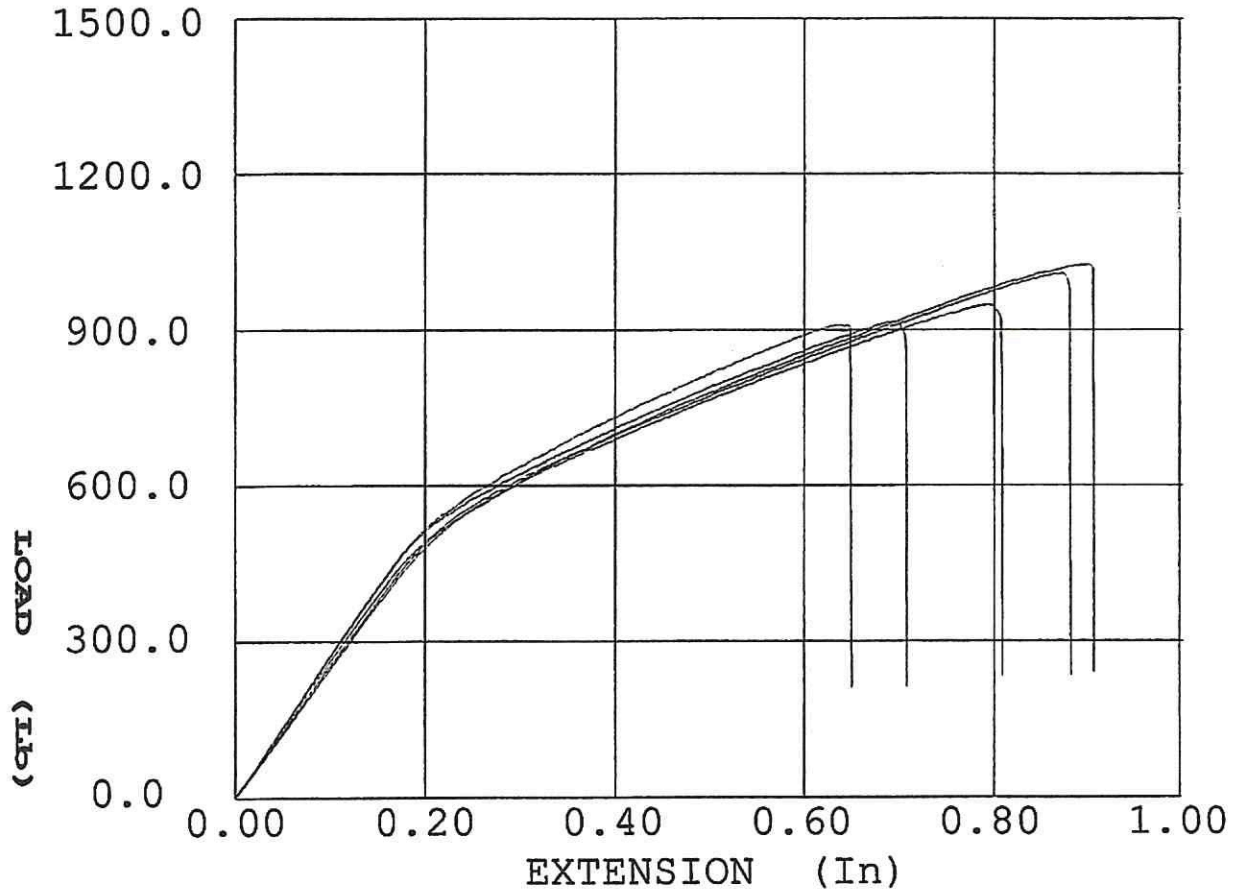
Calculation Inputs:

Span 17.33 In

Test Inputs:

Crosshead Speed 0.460 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 2.40 In

52191-1A



Shown: All Curve(s)

Report Date: May 21, 2019

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Sample ID: 52191-2A  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 20, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

5' Manhole FRT  
Axial

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	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.000	1.240	1006.6	9770.4	0.72	*****	1722466.9
2	2.000	1.240	904.6	8780.8	0.59	0.47	1710359.6
3	2.000	1.250	943.7	9013.8	0.69	*****	1699544.6
4	2.000	1.240	954.8	9268.4	0.68	*****	1676223.7
Mean	2.000	1.243	952.4	9208.3	0.67	0.47	1702148.7
Stdv	0.000	0.005	42.0	424.3	0.05	0.00	19656.5

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Specimen Comments:

- 1 : Fracture/crack
- 2 : Fracture/crack
- 3 : fracture
- 4 : fracture exterior

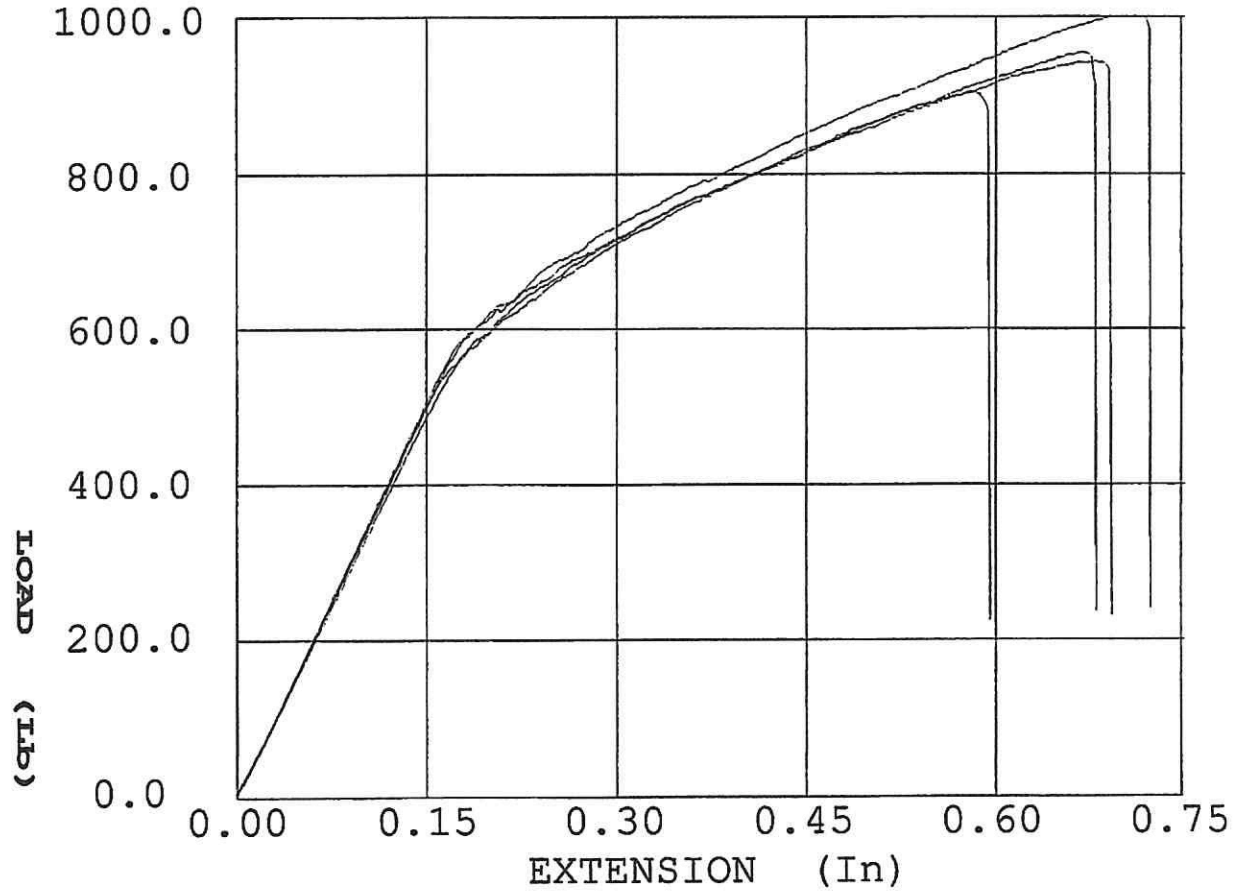
Calculation Inputs:

Span 19.90 In

Test Inputs:

Crosshead Speed 0.530 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 2.65 In

52191-2A



Shown: All Curve(s)

Report Date: May 21, 2019

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Sample ID: 52191-3A  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 21, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

4' Manhole FRT  
Axial

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	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.105	0.506	728.8	17138.7	0.55	0.55	1058216.3
2	2.058	0.535	808.4	17393.8	0.51	0.50	1120057.5
3	2.062	0.532	854.4	18555.8	0.62	0.61	1007237.2
4	2.095	0.550	943.9	18878.5	0.59	0.59	966781.0
5	2.084	0.510	749.9	17535.3	0.54	0.53	986842.3
Mean	2.081	0.527	817.1	17900.4	0.56	0.56	1027826.9
Stdv	0.020	0.018	86.4	767.5	0.04	0.04	61766.2

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Specimen Comments:

- 1 : fracture
- 2 : delam/fracture
- 3 : delam/crack
- 4 : delam/crack
- 5 : delam/crack

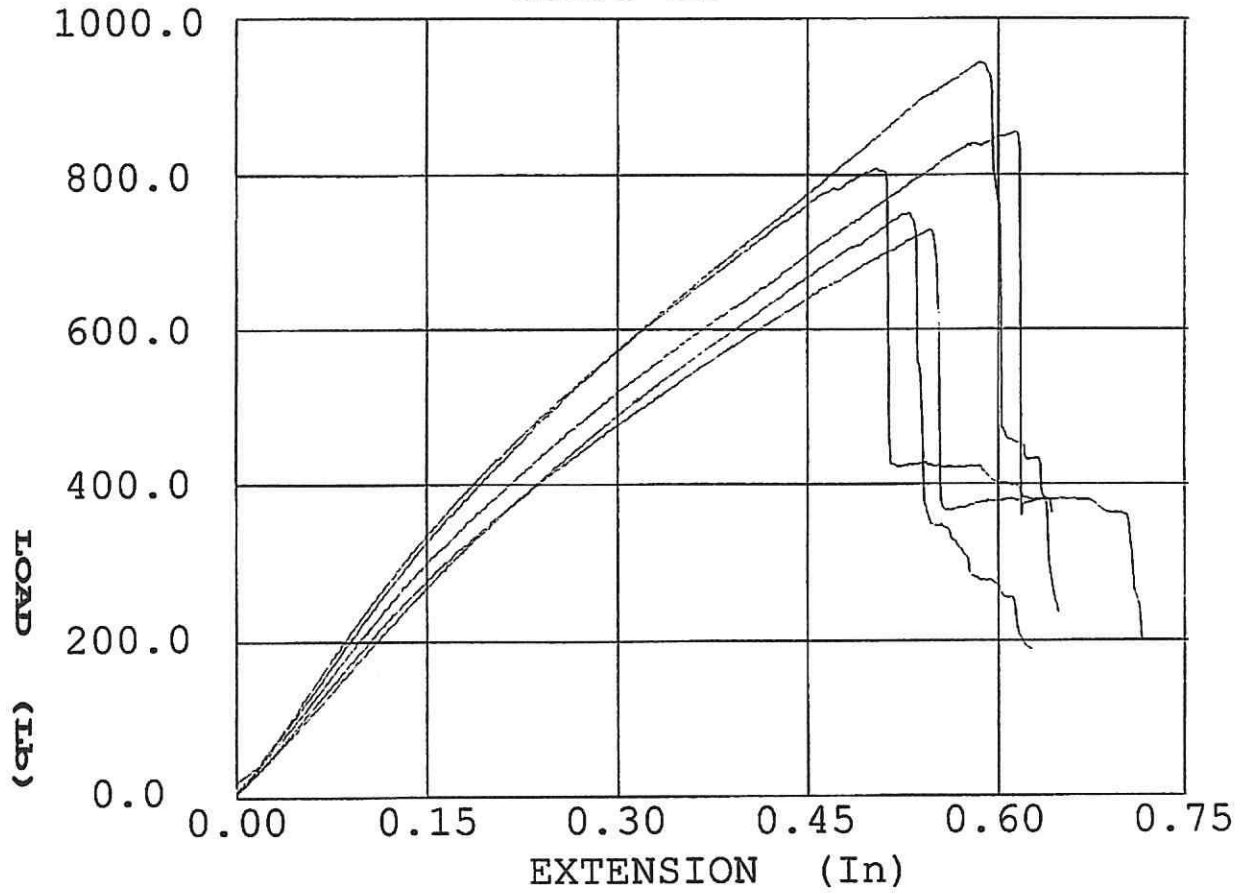
Calculation Inputs:

Span 8.45 In

Test Inputs:

Crosshead Speed 0.225 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 1.12 In

52191-3A



Shown: All Curve(s)



Report Date: May 21, 2019

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Sample ID: 52191-4A  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 21, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

5' Manhole FRT  
Axial

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	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.000	0.635	1142.9	20577.4	0.57	0.56	1191306.7
2	2.007	0.607	1139.2	22367.8	0.58	0.56	1352642.2
3	2.010	0.613	1213.8	23333.8	0.60	0.60	1343739.1
4	2.070	0.620	1228.7	22421.1	0.58	0.58	1281215.2
5	2.040	0.610	1151.6	22027.9	0.57	0.56	1367316.8
Mean	2.025	0.617	1175.2	22145.6	0.58	0.57	1307244.0
Stdv	0.029	0.011	42.6	1001.3	0.01	0.02	72664.6

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Specimen Comments:

- 1 : delam
- 2 : delam
- 3 : delam/crack
- 4 : delam/crack
- 5 : delam

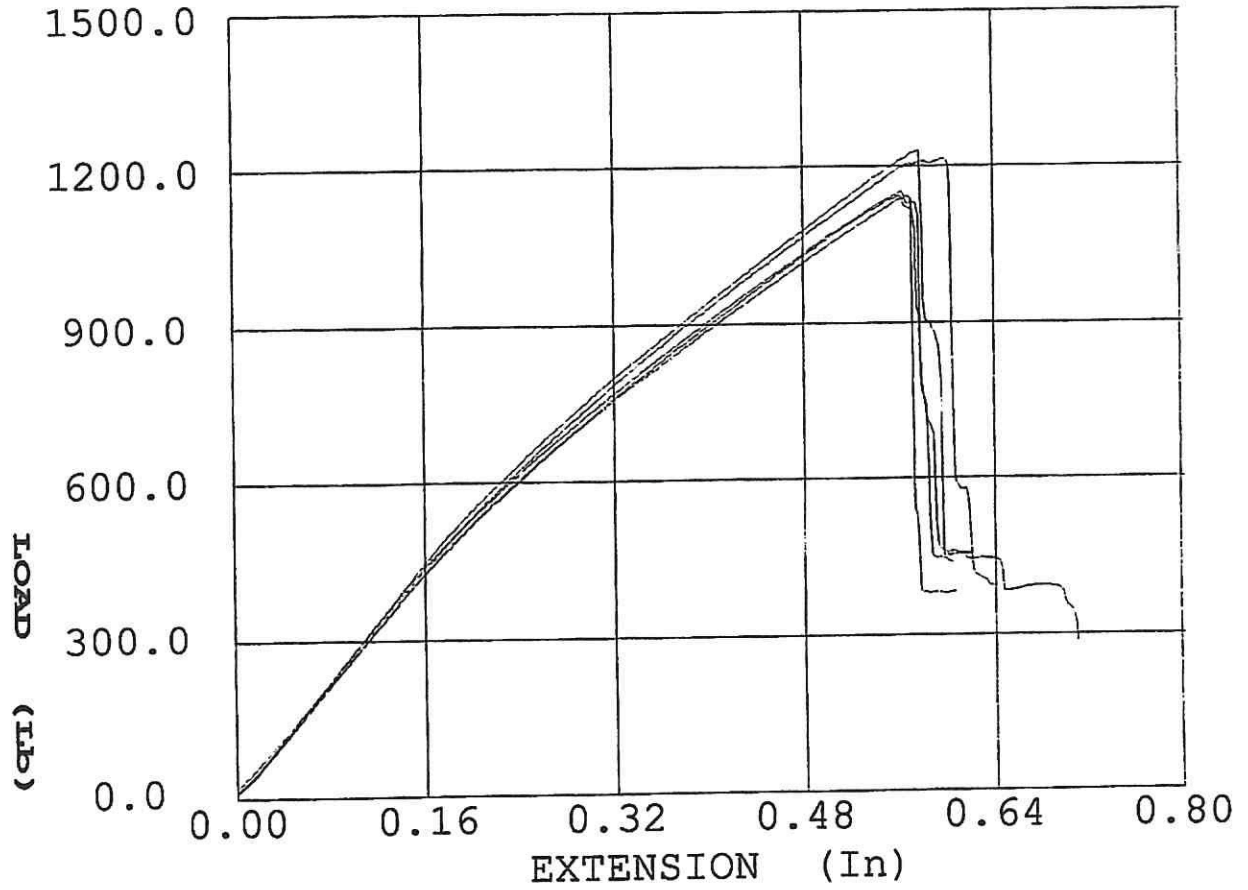
Calculation Inputs:

Span 9.68 In

Test Inputs:

Crosshead Speed 0.258 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 1.29 In

52191-4A



Shown: All Curve(s)

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FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

Submitted by: Associated Fiberglass Enterprises  
2411 Weaver Street  
Fort Worth, TX 76117

Date: May 22, 2019

Attn: Kendall George

Report No.: 52191-T

## REPORT

Lab Sample No.: Four (4) Samples

52191-1 ≈1.125" Thick FRT from 4 ft. diameter manhole (Five Specimens)  
52191-2 ≈1.25" Thick FRT from 5 ft. diameter manhole (Five Specimens)  
52191-3 ≈0.5" Thick FRT from 4 ft. diameter manhole (Five Specimens)  
52191-4 ≈0.5" Thick FRT from 5 ft. diameter manhole (Five Specimens)

## PROCEDURE

Samples were tested for flexural strength (transverse/hoop direction) per ASTM D790 with the following results:

## RESULTS

### 52191-1:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	20,791	1.206
2	17,608	1.209
3	19,742	1.157
4	18,347	1.080
5	<u>20,133</u>	<u>1.110</u>
Average	19,324	1.115
Standard Deviation	1,311	0.057

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### 52191-2:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	21,288	1.585
2	21,904	1.597
3	21,782	1.591
4	24,671	1.608
5	<u>19,158</u>	<u>1.413</u>
Average	21,761	1.559
Standard Deviation	1,968	0.082

52191-3:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	74,485	2.704
2	73,293	2.570
3	70,438	2.511
4	73,686	2.693
5	<u>67,632</u>	<u>2.391</u>
Average	71,907	2.574
Standard Deviation	2,836	0.131

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52191-4:

<u>Specimen</u>	<u>Peak Stress, psi</u>	<u>Modulus, 10<sup>6</sup> psi</u>
1	74,735	3,115
2	69,029	3,003
3	72,459	3,107
4	75,590	3,309
5	<u>70,545</u>	<u>3.050</u>
Average	72,472	3,117
Standard Deviation	2,757	0.117

DALLAS LABORATORIES, INC.

  
Kevan W. Jones, Vice President

Analyst: KJ  
KWJ: js

Report Date: May 21, 2019

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Sample ID: 52191-1T  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 20, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

4' Manhole FRT  
Transverse

	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	1.990	1.083	1855.0	20790.6	1.08	*****	1206240.6
2	1.990	1.090	1591.4	17608.1	1.03	0.83	1208786.9
3	1.990	1.093	1794.1	19741.5	1.07	*****	1156945.8
4	1.990	1.095	1673.5	18347.3	0.99	0.98	1079796.2
5	1.990	1.095	1836.3	20132.9	1.08	*****	1110437.8
Mean	1.990	1.091	1750.0	19324.1	1.05	0.91	1152441.5
Stdv	0.000	0.005	113.4	1311.3	0.04	0.11	57295.5

Specimen Comments:

- 1 : crack delam
- 2 : delam fracture
- 3 : delam break
- 4 : fracture crack
- 5 : break fracture

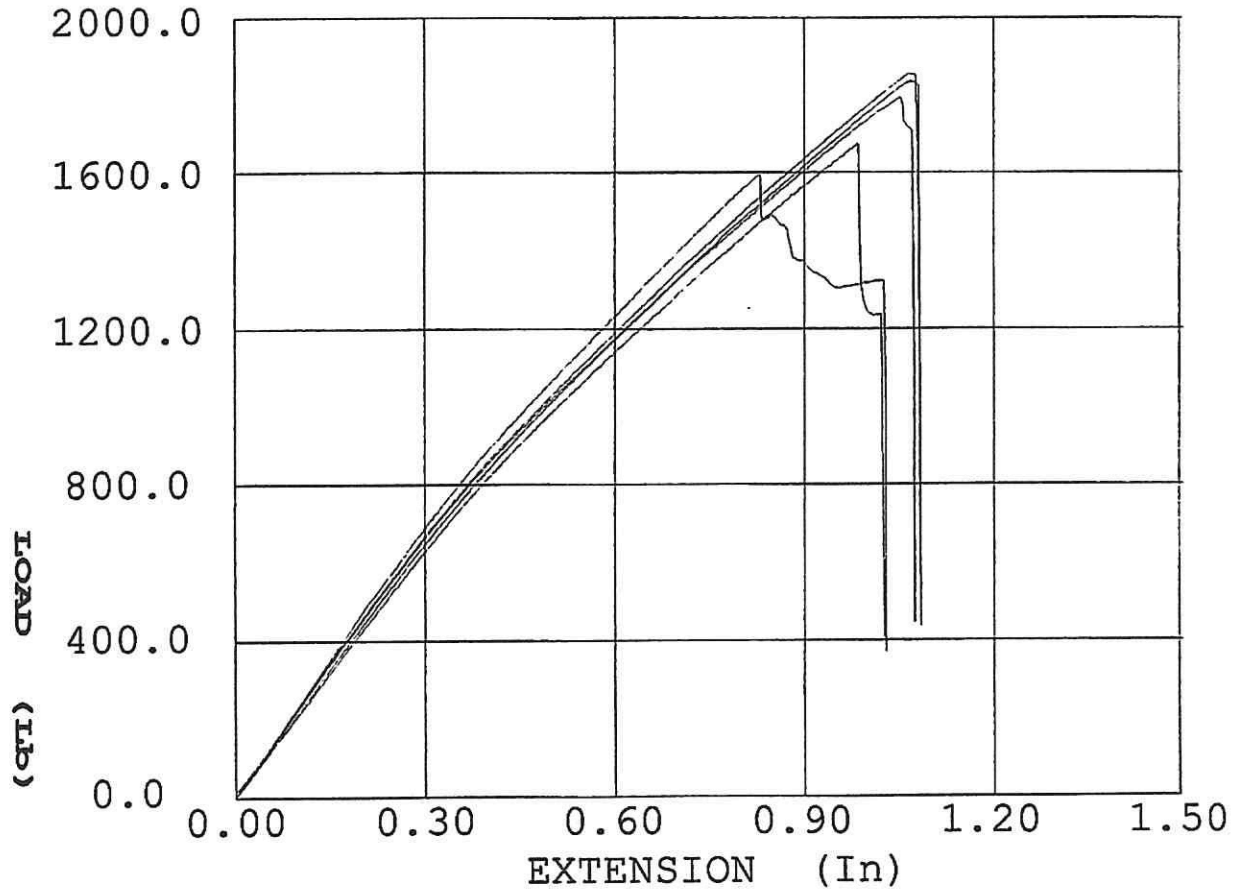
Calculation Inputs:

Span 17.44 In

Test Inputs:

Crosshead Speed 0.460 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 2.40 In

52191-1T



Shown: All Curve(s)

Report Date: May 21, 2019

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Sample ID: 52191-2T  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 20, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

5' Manhole FRT  
Transverse

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	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Flex Modulus PSI
1	2.000	1.240	2193.2	21288.2	1.11	1584918.6
2	2.000	1.240	2256.6	21903.7	1.13	1596786.7
3	2.000	1.241	2247.6	21781.7	1.13	1590907.8
4	2.000	1.245	2562.2	24670.7	1.27	1608145.9
5	2.000	1.245	1989.6	19157.9	1.04	1412967.2
Mean	2.000	1.242	2249.8	21760.5	1.14	1558745.2
Stdv	0.000	0.003	205.3	1967.7	0.08	81942.5

---

Specimen Comments:

- 1 : Delamination/fracture
- 2 : delam/fracture
- 3 : Delam/fracture
- 4 : Delam/fracture
- 5 : Delam/fracture

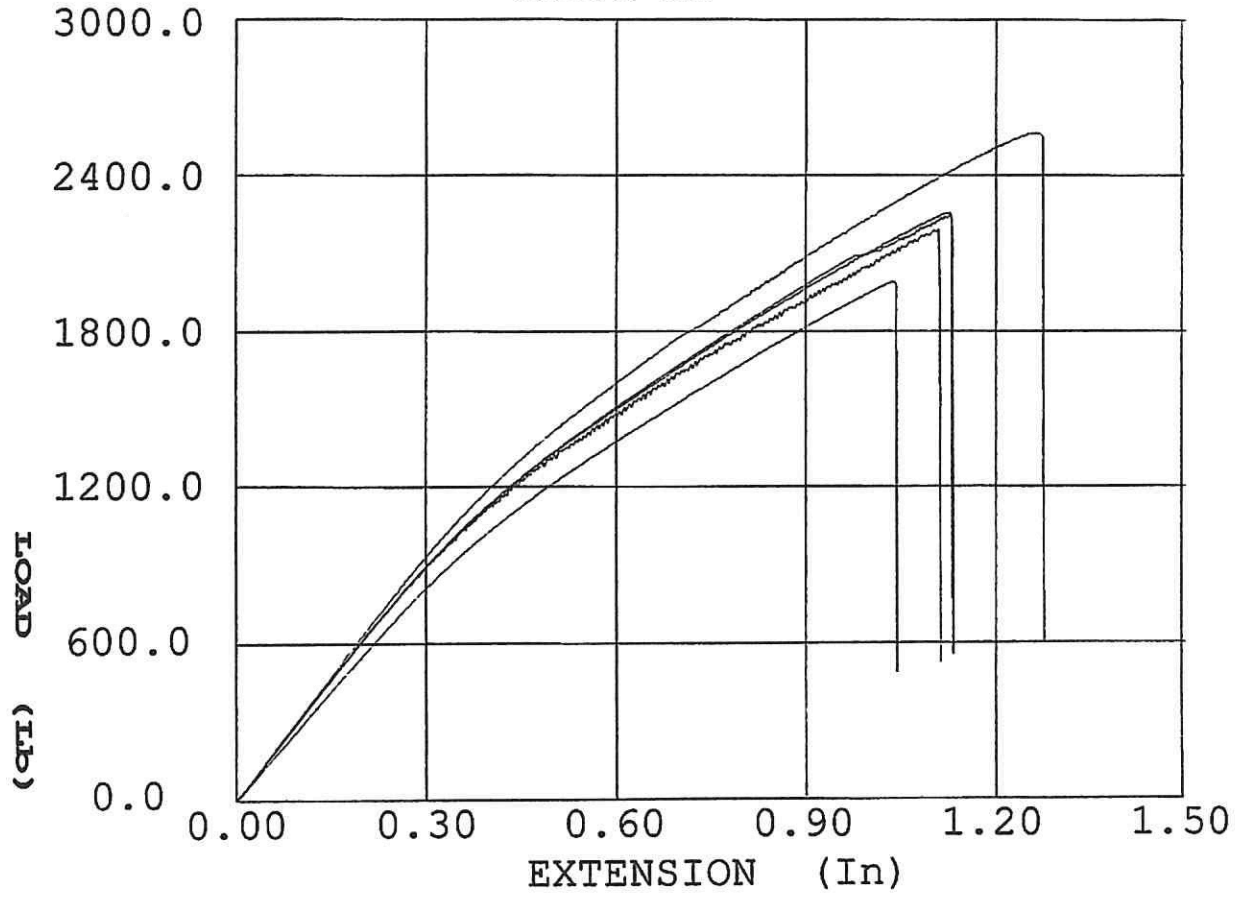
Calculation Inputs:

Span 19.90 In

Test Inputs:

Crosshead Speed 0.530 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 2.65 In

52191-2T



Shown: All Curve(s)



Report Date: May 21, 2019

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Sample ID: 52191-3T  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 21, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

4' Manhole FRT  
Transverse

	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.057	0.515	3206.0	74484.9	0.70	0.65	2703788.7
2	2.072	0.533	3403.8	73293.4	*****	0.65	2569965.6
3	2.100	0.522	3179.9	70437.6	*****	0.66	2511484.1
4	1.968	0.515	3034.4	73685.9	*****	0.66	2693176.6
5	2.155	0.550	3478.4	67632.3	*****	0.65	2390539.2
Mean	2.070	0.527	3260.5	71906.8	0.70	0.66	2573790.8
Stdv	0.068	0.015	179.3	2835.7	0.00	0.00	130986.9

Specimen Comments:

- 1 : delam
- 2 : delam
- 3 : delam
- 4 : delam
- 5 : delam

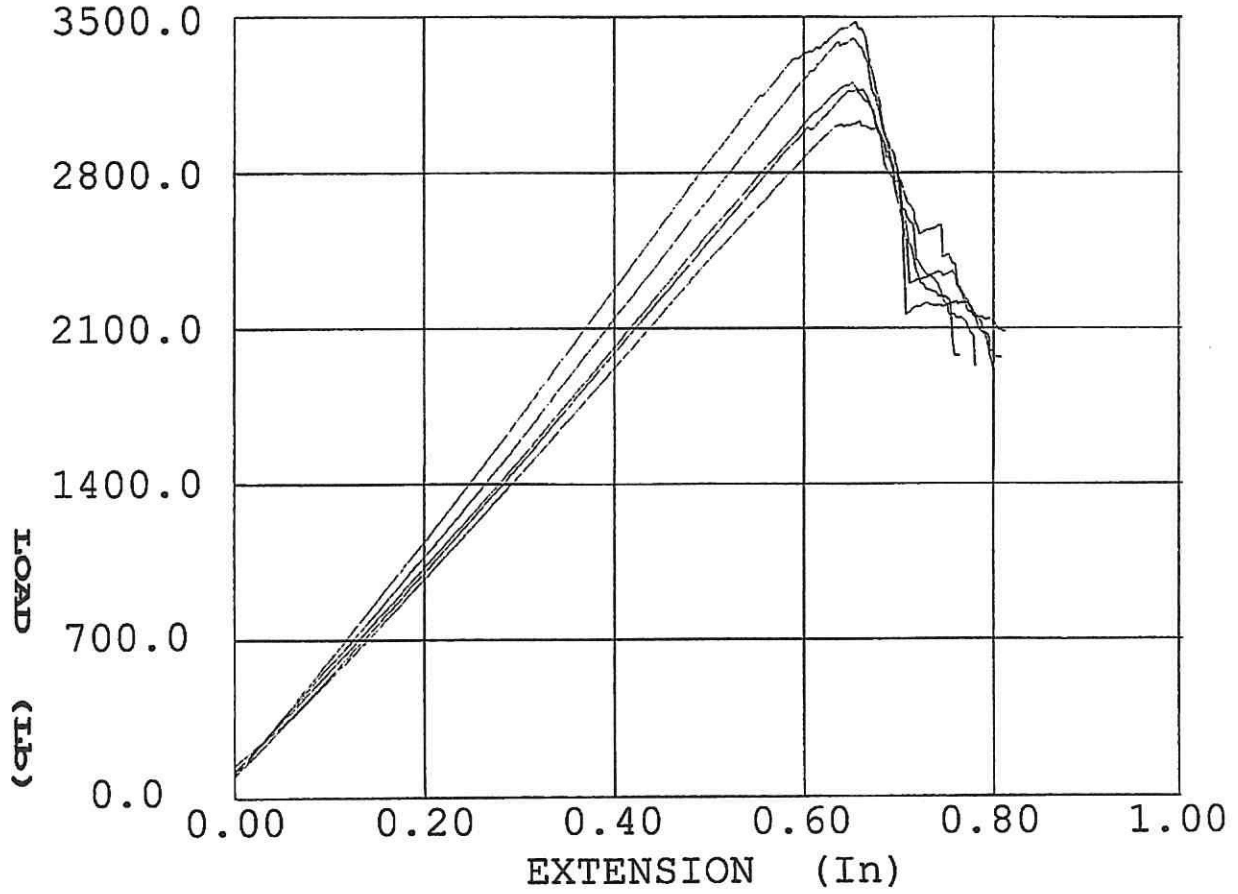
Calculation Inputs:

Span 8.45 In

Test Inputs:

Crosshead Speed 0.225 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 1.12 In

52191-3T



Shown: All Curve(s)

Report Date: May 21, 2019

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Sample ID: 52191-4T  
Method: FLEX ASTM D790 (FRT)  
Data path: C:\QTESTW

Test Date: May 21, 2019  
Operator ID: KJ

Sample Inputs:

Material  
Comments

5' Manhole FRT  
Transverse

	Width (b) In	Depth (d) In	Peak Load Lb	Peak Stress PSI	Elong @ Break In	Elong @ Yield In	Flex Modulus PSI
1	2.000	0.628	3834.1	74735.3	*****	0.71	3115429.4
2	2.000	0.638	3655.0	69028.7	*****	0.69	3002809.8
3	2.015	0.632	3793.0	72459.0	*****	0.69	3107013.5
4	2.012	0.626	3876.4	75589.5	0.78	0.70	3309023.8
5	2.054	0.637	3824.1	70545.2	*****	0.67	3050464.9
Mean	2.016	0.632	3796.5	72471.5	0.78	0.69	3116948.3
Stdv	0.022	0.005	84.5	2757.3	0.00	0.02	116663.7

Specimen Comments:

- 1 : delam
- 2 : delam
- 3 : delam
- 4 : delam
- 5 : delam

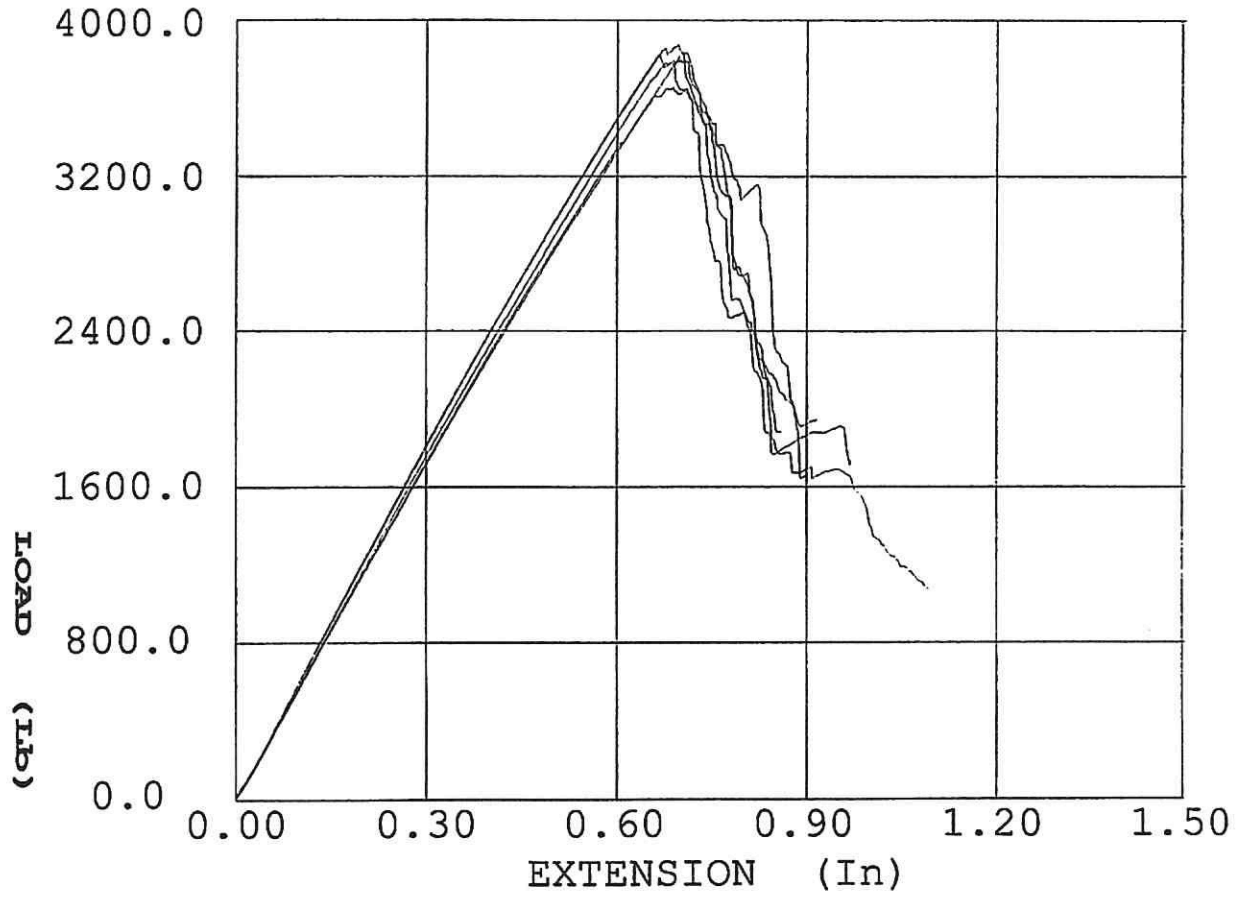
Calculation Inputs:

Span 10.25 In

Test Inputs:

Crosshead Speed 0.273 In/Min  
% Strain Limit 5.0 %  
Ext Limit HI 1.37 In

52191-4T



Shown: All Curve(s)