

Pull-out Force Testing

Conducted for

FreMarq Innovations



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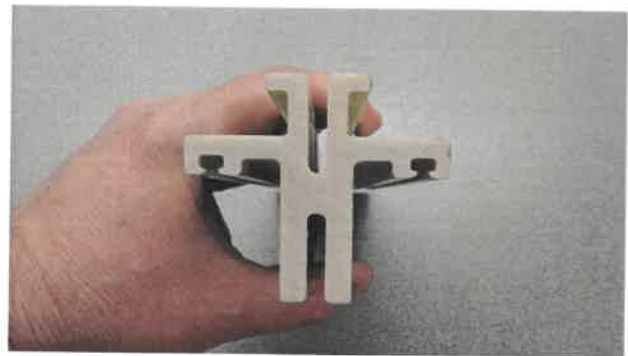
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Project Background:

FreMarq Innovations Inc. is developing a line of commercial windows utilizing new materials and construction techniques. As part of this development process, testing of various components of the windows is necessary to ensure performance of the final product. FreMarq Innovations contacted the UW-Stout Manufacturing Outreach Center (MOC) with their needs for testing. This report outlines the test procedures used and summarizes the test results.

Test Procedure:

Test method ASTM D6117—13 was used as a reference. Testing was conducted on a Tinius Olsen, model 602 hydraulic universal testing machine, with a 60,000 pound load capacity. Pull-out forces were measured for two different thread forms (coarse and fine) on 1/4" diameter steel screws, 1 1/4" in length, driven into fiberglass reinforced urethane pulltrusion samples. These samples measured 9" in length and the screws were driven at 4 1/4" from opposite ends of the sample. This was done so that the two testing areas were not directly across from one another. Testing temperature was 68 degrees Fahrenheit.



The screws were driven in most of the way with a cordless drill, and final tightening onto the 3/8" thick bottom plate of the pulling fixture (grey, in photos below) was done using a torque wrench set to 80 inch pounds.

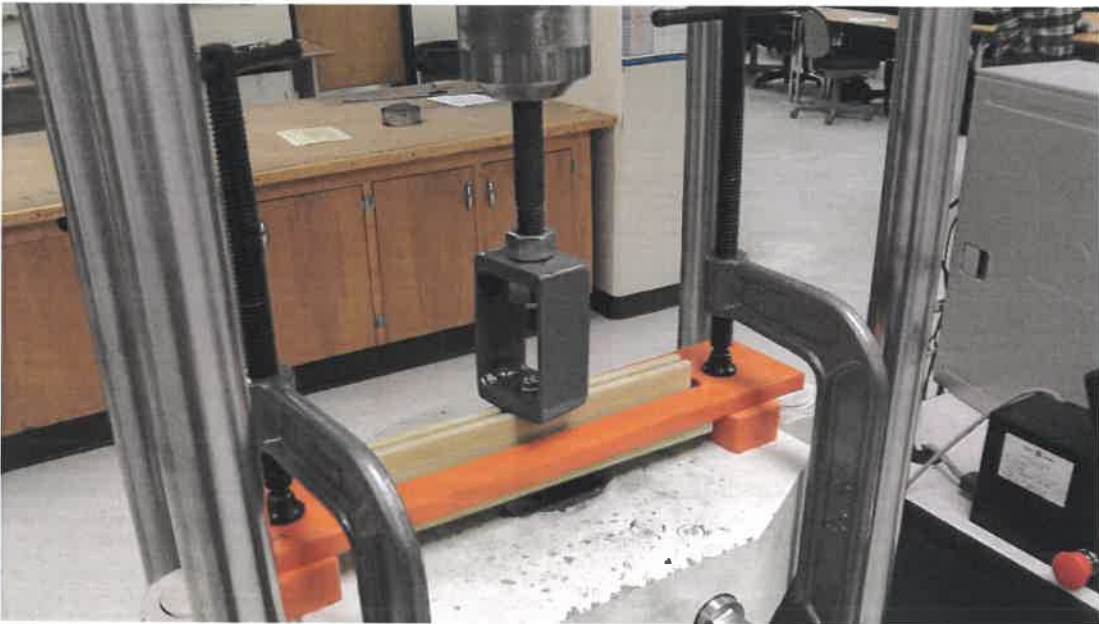
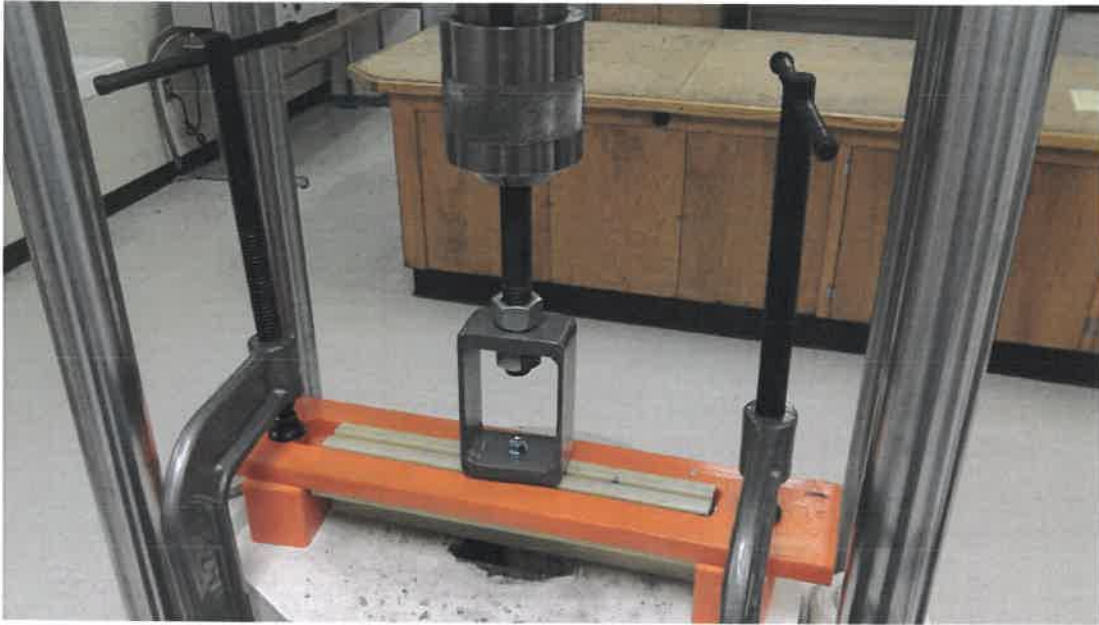


Test Procedure continued:

Here, we see:

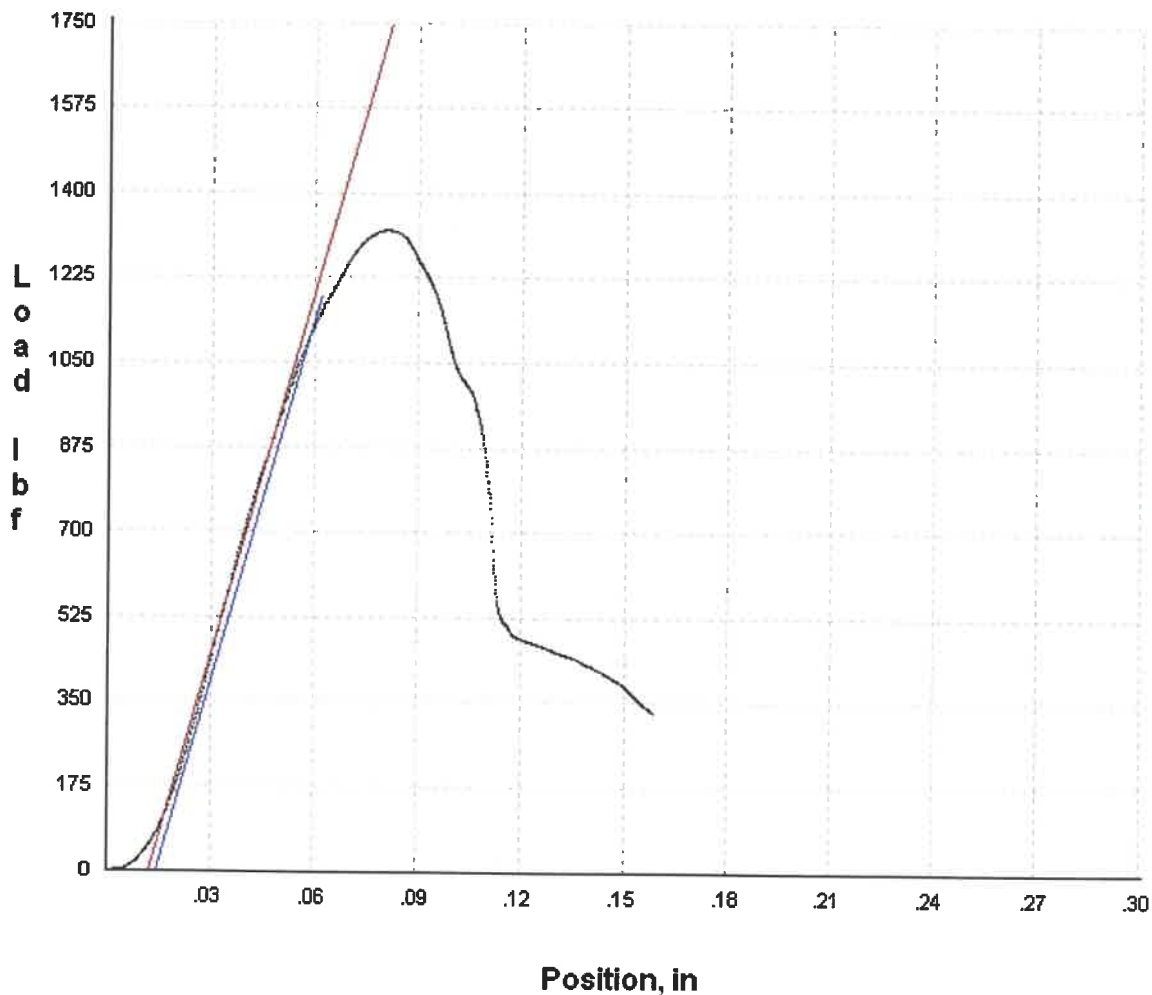
A fine thread screw ready to be pulled from the side of the pulltrusion with flanges (top photo).

A coarse thread screw ready to be pulled from the side of the pulltrusion without flanges (bottom photo).



Test Procedure continued:

Samples were then loaded into the universal test frame, where the screws were pulled out at a rate of 0.5" per minute. A plot of force vs displacement was generated, and peak force for each sample was recorded.



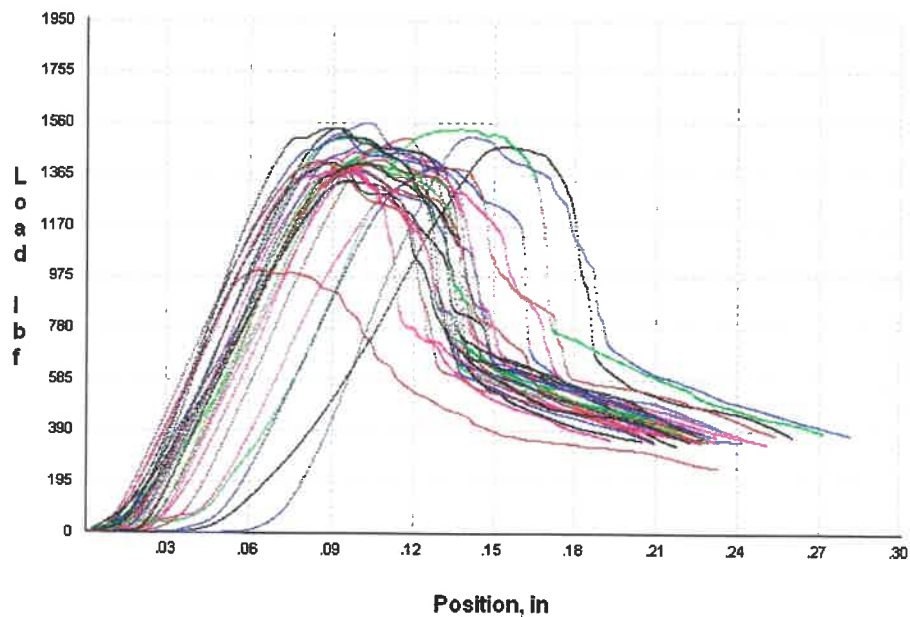
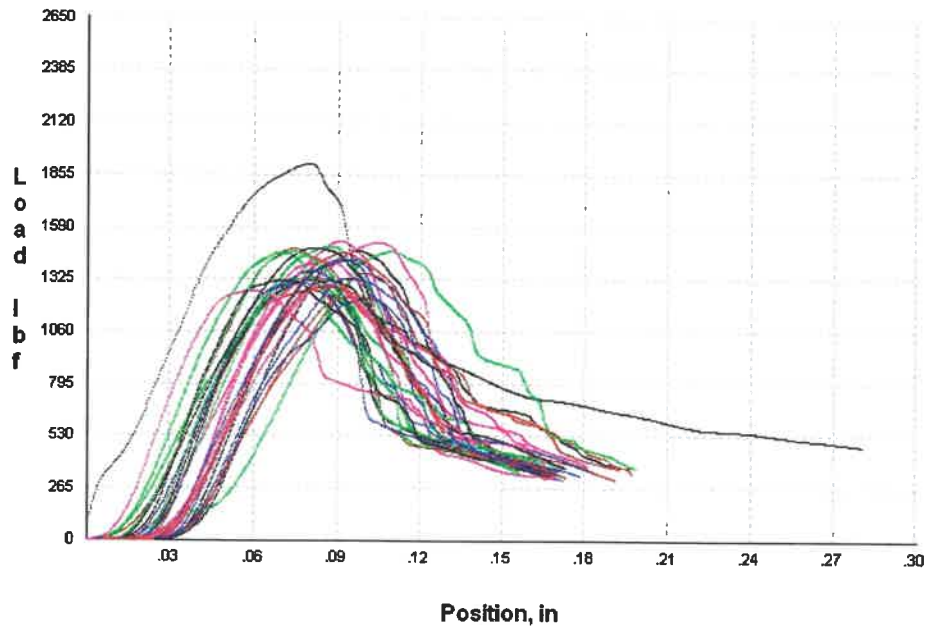
Test Results:

Test results are shown below for 30 samples for the fine threaded fastener and 30 samples for the coarse thread fastener. All 60 samples were tested on 3-3-16 based on availability of testing resources.

Sample Number	Peak Load, lbs force		Gap Width on Pulltrusion, inches	
	Fine Thread Screws	Coarse Thread Screws	Flange side (Fine Thread)	NO Flange side (Coarse Thread)
1	1910	1489	0.178	0.174
1 repeat *	X	1071	X	X
2	1322	1380	0.186	0.181
3	1365	1361	0.184	0.181
4	1519	999	0.178	0.175
5	1269	1412	0.188	0.179
6	1320	1422	0.186	0.177
7	1332	1396	0.186	0.178
8	1233	1427	0.188	0.178
9	1333	1415	0.186	0.18
10	1236	1338	0.19	0.179
11	1470	1508	0.179	0.175
12	1490	1508	0.18	0.172
13	1426	1440	0.182	0.175
14	1411	1423	0.186	0.18
15	1357	1472	0.184	0.178
16	1317	1411	0.186	0.178
17	1465	1563	0.18	0.172
18	1308	1468	0.186	0.178
19	1264	1403	0.187	0.177
20	1481	1541	0.181	0.175
21	1320	1453	0.186	0.18
22	1462	1510	0.182	0.175
23	1419	1397	0.186	0.181
24	1512	1504	0.18	0.175
25	1461	1542	0.18	0.175
26	1485	1537	0.18	0.173
27	1465	1483	0.178	0.175
28	1325	1379	0.187	0.179
29	1297	1392	0.188	0.181
30	1287	1407	0.188	0.18
Average	1395	1433	0.184	0.177
St. Dev.	129	100	0.004	0.003

Test Results Continued:

For each of the 60 tests conducted, a force vs displacement curve was generated. The graphs below are overlaid plots for the 30 fine thread (top graph) and 30 coarse thread (bottom graph) fasteners respectively.



Tester's Notes:

The testers noted also that the major diameter of the coarse thread screws was slightly larger at 0.250" than that of the fine thread screws at 0.242". While the fine thread screws had more threads engaged, the coarse thread screws had deeper engagement into the pulltrusion.

As the screws were pulled out, there was an audible sound associated with the glass fibers breaking, and a corresponding drop in load as the pulltrusion gave way. To the naked eye, there did not appear to be any deformation of the steel screws themselves.

On test 1 of the coarse screw, the load did not return to zero. A repeat test was run approximately 1" away from the first test. The repeat test value was lower due to it's proximity to the first test site. The repeat test data was discarded and is not included in the calculations herein. The original test 1 value for the coarse fastener was determined to be valid and is included the calculations herein.

A short video clip of the testing conducted was saved in the project file for future reference if needed.

Deformation and material pull-out was minimal. Here we see samples 30 (top) and 25 (bottom), showing post-test appearance.

