

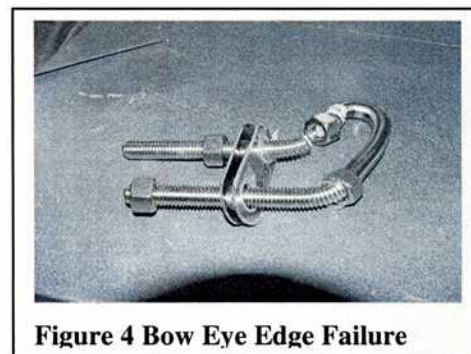
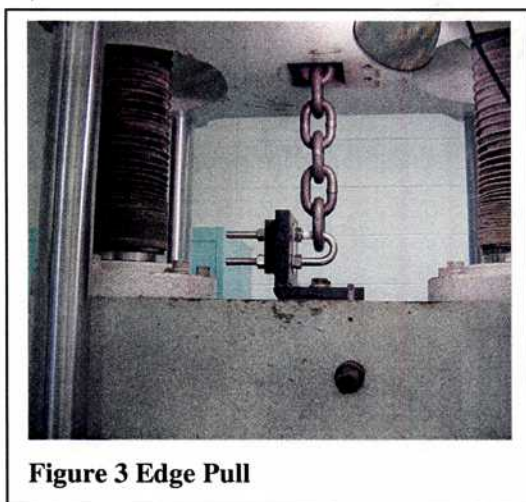
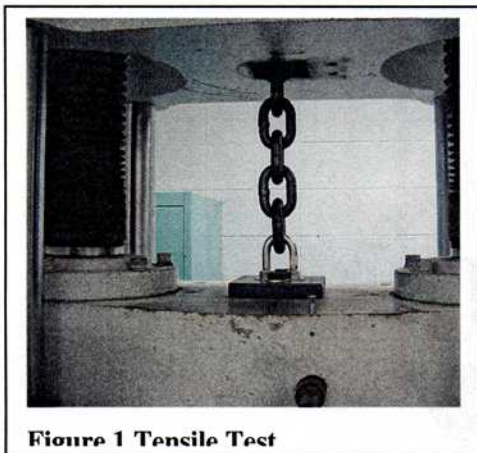


August 27, 2003

CENTER FOR THE BUILT ENVIRONMENT  
260-481-4176 • FAX: 260-481-5734

Re: Bow Eye Strength Tests

On June 10, 2003, The Center for the Built Environment (CBE) conducted a series of tests on bow eyes provided by EPCO Products, Inc. Fixtures for each series of tests were fabricated in our machine shop to accommodate tensile, side pull, and edge pull on the bow eyes. The following photographs indicate fixture arrangement and typical failure for each type of test.



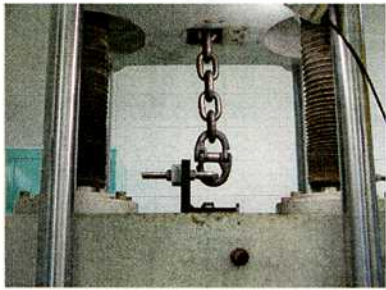


Figure 5 Side Pull



Figure 6 Side Pull Failure

Two tests were performed on each type of bow eye for each type of loading. The following table summarizes the failure loads.

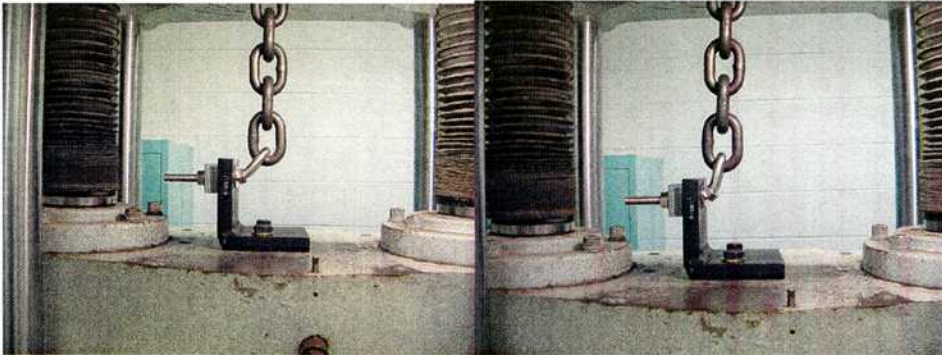
### Summary of Failure Loads on Bow Eyes

Tests performed June 10, 2003

Tensile (lbs)	Type	151	113	164	123
	304	47,000	31,400	31,900	18,000
	316	36,300	28,800	29,900	16,800
Edge (lbs)	Type	151	113	164	123
	304	18,400	18,900	11,200	7,500
	316	21,100	21,000	14,500	11,200
Side (lbs)	Type	151	113	164	123
	304	5,300	17,000	2,800	1,500
		<b>6,400</b>	<b>3,900</b>	<b>10,600</b>	<b>6,000</b>
	316	31,100	9,500	2,700	12,000
		<b>32,800</b>	<b>3,400</b>	<b>4,400</b>	<b>11,400</b>
		<b>33,000</b>			
		<b>32,100</b>			

The values designated in **red** did not exhibit failure loads consistent with results of the other tests. Additional bow eyes were requested for these items for additional testing. Retest items, performed July 21, 2003, are designated in **bold type**. These results, **bold type**, can be used for side pull failure loads. The high failure loads of the 151-316 bow eyes in the side pull test resulted from direct contact of the bow eye nuts with the plate fixture, with a resultant load transfer to the plate. The CBE requested 2 additional 151-116 bow eyes to verify the failure mechanism. These tests were performed on August 18, 2003, with results shown in **blue** in the table. The fixture could not be modified to accommodate the loading and deformation. During the side pull test, the bow eye deformed to a vertical position, resulting in contact of the nuts with the test fixture long before failure occurred. The load was transferred to the fixture at approximately 5000 lbs. This load and resultant deformation would simulate an "in-use" condition, not a true

material failure as in the other tests. Depending on the material that the bow eye is attached, failure may occur in this material before bow eye failure. The average failure load of 32,300 lbs will be reported under the preceding condition of failure. The following photographs illustrate the loading and failure condition.



Tensile tests results and edge pull test results correlate to expectations of material behavior for a single test situation. Side pull test results are not as conclusive, even with a second series of tests. However, with an appropriate factor of safety, side pull results can be used.

Please don't hesitate to contact me if you have any questions. Attached is a final table with the single failure load of each of the bow eyes, taking into consideration all of the tests.

Sincerely,

*C. Wayne Unsell*

C. Wayne Unsell, PhD, PE

Encl. Failure Load of Bow Eyes

**Failure Loads for Bow Eyes      August 27, 2003**

**EPCO Products, Inc.**

<b>Tensile (lbs)</b>	<b>Type</b>	<b>151</b>	<b>113</b>	<b>164</b>	<b>123</b>
	<b>304</b>	47,000	31,400	31,900	18,000
	<b>316</b>	36,300	28,800	29,900	16,800
<b>Edge (lbs)</b>	<b>Type</b>	<b>151</b>	<b>113</b>	<b>164</b>	<b>123</b>
	<b>304</b>	18,400	18,900	11,200	7,500
	<b>316</b>	21,100	21,000	14,500	11,200
<b>Side (lbs)</b>	<b>Type</b>	<b>151</b>	<b>113</b>	<b>164</b>	<b>123</b>
	<b>304</b>	6,400	3,900	10,600	6,000
	<b>316</b>	32,300	3,400	3,500	11,700

**Tests Conducted by the Center for the Built Environment  
Department of Civil and Architectural Engineering Technology  
Indian-Purdue University Ft. Wayne**

**By**

**C. Wayne Unsell and Larry Brown**

**From**

**July 20-Aug. 15, 2003**