NEW METHOD FOR BREAKING HIGH STRENGTH PRESTRESS CABLE

Final Report
For
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8. ABSTRACT

A new method was developed for breaking high strength prestressed cable. The old method used an aluminum oxide grit packed into a special gripping jaw. The new method uses aluminum shims wrapped around the cable and then is gripped with a V-grip. The new method gives nearly 100 percent "good breaks" on the cable compared to approximately 10 percent good breaks with the old method. In addition, the new cable breaking method gives higher ultimate tensile strengths, is more reproducible, is quicker, cleaner and easier on equipment.

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TABLE OF CONTENTS

INTRODUCTION

High strength prestress cable must meet certain strength properties which are tested by breaking the cable in a hydraulic tension testing machine. The cable is gripped by the tension testing machine and then pulled to failure to measure the ultimate tensile strength. During this process, the cable is slightly damaged by the gripping jaws of the machine. As a result, the cable breaks prematurely in the grip, instead of breaking between the grips.

For many years, a tinning process was used to protect the cable from grip damage. The process used an acid cleaner, an acid flux and a tin solder. This process was eliminated about 5 years ago to avoid the use of hazardous chemicals. The method used to replace the tinning method was the aluminum oxide grit method.

GRIT METHOD

A specially designed gripping jaw is packed with the grit. In theory, the grit is supposed to provide even gripping pressure on the cable to eliminate stress points that would cause premature breaking. In actual practice, the grit method still causes stress points, and approximately 90 percent of the cable samples break in the grips.

This method is only marginally acceptable. The cable obtains the minimum ultimate strength using this method, but technically, according to the ASTM test method, if the cable breaks in the grip, the result is supposed to be discarded and another sample tested. Due to the large number of "bad breaks" or breaks in the grip, it is not practical to keep retesting. Instead, if the ultimate tensile strength is more than the minimum required, this is considered good enough.

However, there is always a question as to how much higher the ultimate strength might go if the sample is gripped in such a way that it breaks between grips. For purpose of definition, this will be referred to as a "good break".

In addition to producing bad breaks, the grit method has other disadvantages:

- The grit is very messy to work with. Grit gets all over the machine and the floor. It is likely that the life of the testing machine is reduced as the grit causes accelerated wear in the moving parts of the gripping jaws.

- Samples frequently have to be retested because the ultimate tensile strength does not meet the minimum before experiencing a bad break.

- The hard prestress cable wears down the grips each time a sample is broken. The grips have to be replaced once every two or three years.

ALUMINUM SHIM METHOD

The Metals Testing Section (Gary Begg, Steve Twohey, and Bob Mattingly) and Mike Lauzon of the Machine Shop came up with an alternate method of gripping the prestress cable. This method uses a V-grip. The cable is sandwiched between two strips or shims of soft aluminum to protect the cable from grip damage. The aluminum is soft enough that it deforms to the shape of the cable and does not slip during the pulling process. It is also thick enough so that it does not allow the teeth of the grips to penetrate through the aluminum and damage the cable causing a bad break.

The aluminum is an 1100-O alloy, and 0.125 inches thick. The strips are approximately 0.7 inches wide and 9 inches long. The shims are given a slight crease down their length so they conform better to the radius of the cable. Two shims are used on each end of the cable for a total of four shims for each piece of cable tested.

The shims are initially held in place with masking tape. Then the cable and shims are placed into the jaws of the tensile testing machine. The shims are initially pressed into place by the hydraulic clamping force of the jaws. Then as the tensile test begins, the jaws are self tightening and the aluminum shims get crushed and deformed around the strands of the cable so there is no slippage between the cable and the aluminum shims. The data for the comparison of these two methods is shown below.

Grit Method Samples

Lab No.	Area (in^2)	Break St. (lbs)	Break St. (lbs/in^2)
3	0.154	43,300	281,169
4	0.154	43,700	283,766
6	0.155	43,000	277,419
7	0.156	43,200	276,923
9	0.155	44,100	284,516
11	0.155	43,050	277,742
13	0.156	46,200	296,154
14	0.156	43,600	279,487
16	0.155	43,600	281,290
17	0.154	42,500	275,974
18	0.153	41,800	273,203
20	0.152	44,200	290,789
21	0.153	43,200	282,353
22	0.154	42,300	274,675
23	0.151	43,800	290,066
24	0.153	42,100	275,163
27	0.153	42,200	275,817
28	0.153	42,300	276,471
29	0.153	42,400	277,124
30	0.155	43,500	280,645
31	0.154	43,400	281,818
32	0.154	42,900	278,571
33	0.154	43,400	281,818
34	0.153	42,100	275,163
36	0.154	43,050	279,545
37	0.155	42,000	270,968
38	0.153	42,000	274,510
39	0.153	41,900	273,856
40	0.154	43,400	281,818
41	0.154	42,400	275,325
42	0.153	43,400	283,660
43	0.153	43,300	283,007
44	0.153	43,500	284,314
		Average	279,852
		Standard Dev.	5,429

Aluminum Shim Method Samples

Lab No.	Area (in^2)	Break St. (lbs)	Break St. (lbs/in^2)	
45	0.153	42,400	277,124	good break
46	0.154	43,300	281,169	good break
47	0.154	43,800	284,416	bad break
48	0.153	43,800	286,275	good break
49	0.153	43,800	286,275	good break
50	0.154	43,600	283,117	good break
51	0.154	44,400	288,312	good break
52	0.153	44,250	289,216	good break
53	0.154	44,400	288,312	good break
54	0.154	43,100	279,870	good break
55	0.155	44,400	286,452	good break
56	0.154	43,000	279,221	good break
		Average	284,146	
		Standard Dev.	4,007	

DISCUSSION

Only cable samples with a nominal cross sectional area of 0.154 inches are shown, that is the reason for the gaps shown in the lab numbers.

Accurate statistics on the number of bad breaks using the grit method are not available. However, technicians running this test estimate that approximately 90 percent of the samples using the grit method experienced bad breaks.

The one bad break on the aluminum shim method occurred when the aluminum shim was used for a second time. During the first use, the aluminum was deformed from the grip teeth. During the second use, the teeth penetrated the thin areas of the aluminum and contacted the cable sample causing a stress riser.

Since the grips only come into contact with the soft aluminum, there is practically no wear on the grip face. This will greatly increase the life of the grips.

RESULTS

Using the new method, 11 of 12 (92 percent) of the samples tested have been good breaks. This is a very large increase compared to the approximate 10 percent of good breaks using the grit method.

The aluminum shim method is showing slightly higher ultimate tensile strengths compared to the grit method, 284,146 verse 279,852 lbs/in^2. This represents an increase of 4294 lbs/in^2 or a 1.53 percent increase.

The standard deviation values for the break strength also show the aluminum shim method gives more reproducible results. The aluminum shim method has a standard deviation of 4007 verses 5429 lbs/in^2 for the grit method.

The aluminum shim method is a faster method since there is little clean up and greatly reduced retesting.

The aluminum shim method produces less wear on the grips, and most likely less wear on the testing machine.

CONCLUSIONS

The aluminum shim method is a superior method for breaking prestress cable than the aluminum oxide grit method. The aluminum shim method gives a very high percent of good breaks, higher ultimate tensile strength, more consistent strength numbers, is cleaner, faster, and less damaging to the equipment.