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TR #15-0001

Rolling Bend Flex Test Report

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1. Introduction

The focus of this test report is concentrated on the destructive flex forces involved in a continuous motion application. For continuous motion flex testing, there are a various experiments available. Many are familiar with the “Tick Tock” test since it has been around for quite some time. The test is named “Tick Tock” because the test fixture’s swing arm moves back and forth through a 180 degree arc similar to the movement of a clock pendulum. Quabbin performed the original flex testing on their industrial Ethernet cables using a “Tick Tock” fixture and received positive results. However after field observations and experimentations, Quabbin concluded the “Tick Tock” method is a special case because the supported bend cable bend radius is fixed by a mandrel. This is not the typical installation of a cable on a robot arm.

Quabbin believes that a more realistic test is an unsupported rolling bend trial. In an unsupported continuous bend, the cable construction has to prevent the bend from becoming concentrated in a small area. Disruption to a small area can lead to cable failure through nicking because flexing at a kink can cause conductor and shield failure. A robotic arm has reach and exhibits variety in the flex motion that inevitably spreads force over a sizable section of the cable. Simulating these parameters requires a more comprehensive type of flex testing equipment, specifically a device that can simulate a rolling bend. Loosely making the comparison of a human arm to a robotic arm, a rolling bend test can simulate not only the bending of an elbow (like the Tick Tock) but additionally the reach of the arm which in fact turns out to be critical.

2. Testing Equipment

- 8753E Network Analyser
- DTX-1800 Portable tester
- Quabbin flex testing machine

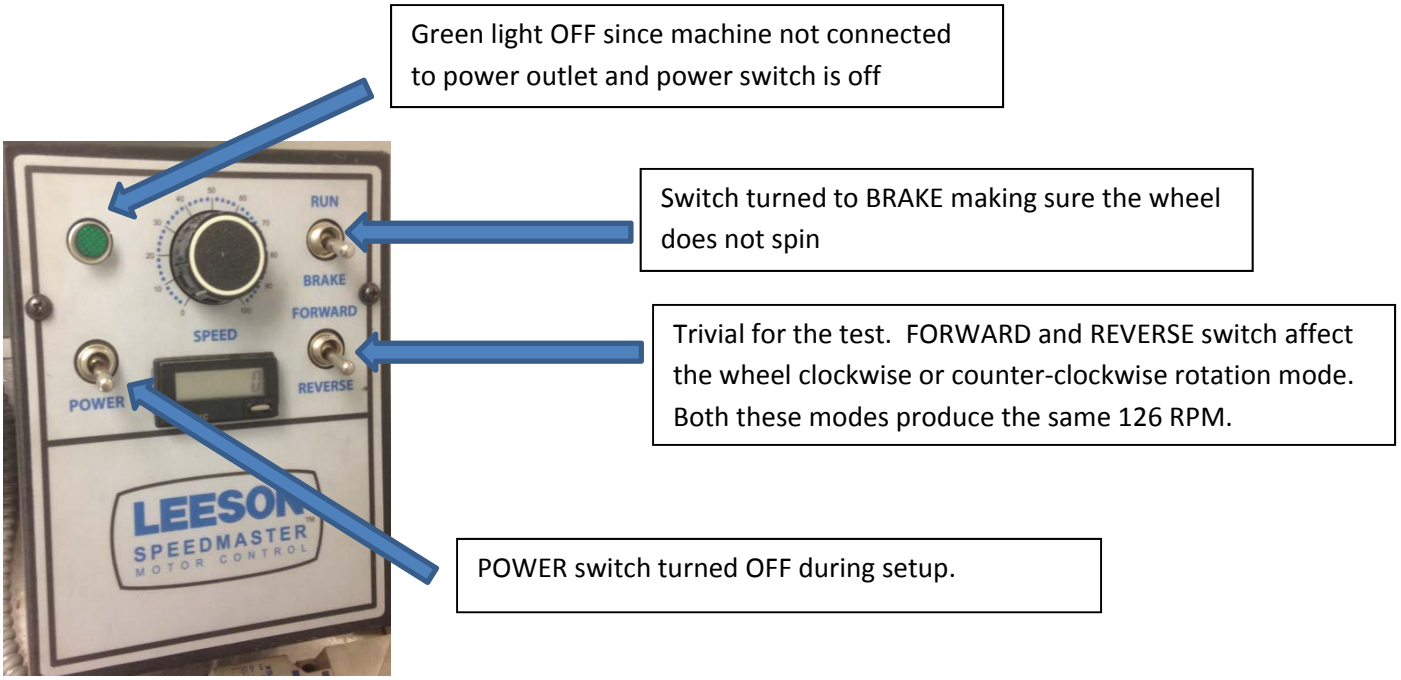
3. Resources

Flex testing was done on the following Quabbin cables: 5025, 5026, and 5083. Additional cables will be added to this report as they complete testing.

4. Setup

For initial setup, it is important to consider safety. Flex machine should remain OFF before testing can begin by making sure the power cord is NOT connected to the outlet. The

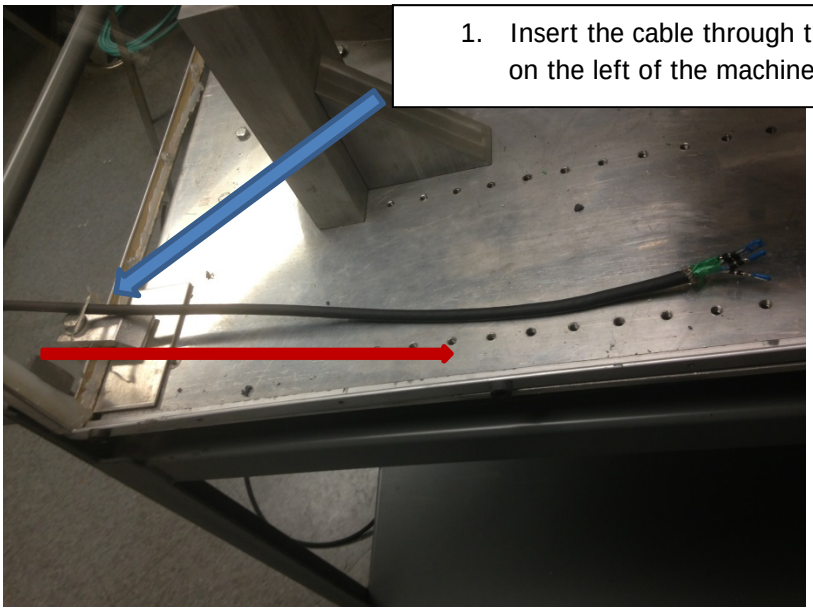
access door can be unlocked and opened. The following picture indicates how the machine should appear before testing.



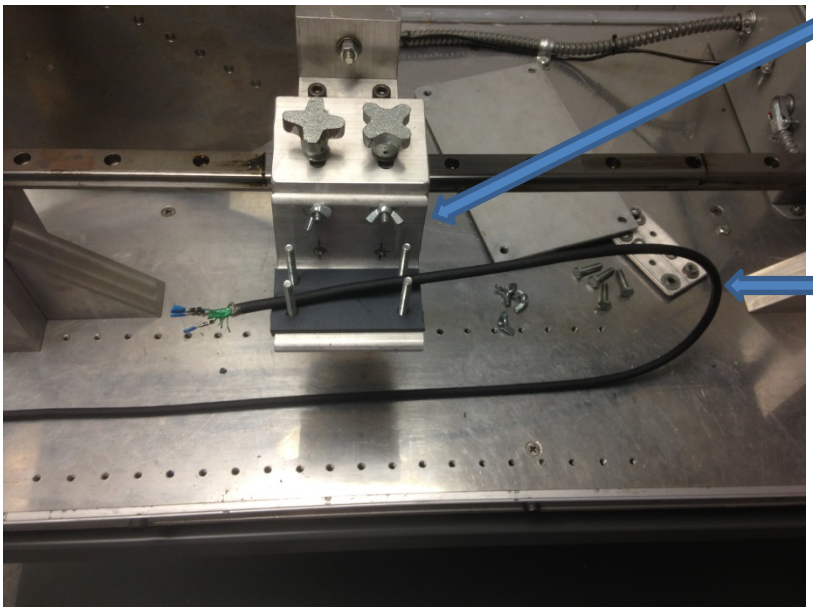
When machine is securely OFF, the cable setup can begin. The machine is capable of testing one or two cables at once. If 2 cables have a similar O.D., then it is possible to test them together. Prior to setting up the cables in the flex machine, pins and loads must be installed on both ends of the cables. The testing of the cable follows Quabbin standard procedures. Inserting the cable into the flex machine can begin once the cables are pinned or connectorized.

A. 1 cable setup:

When only a single cable is being tested on the machine, the following steps should be taken.

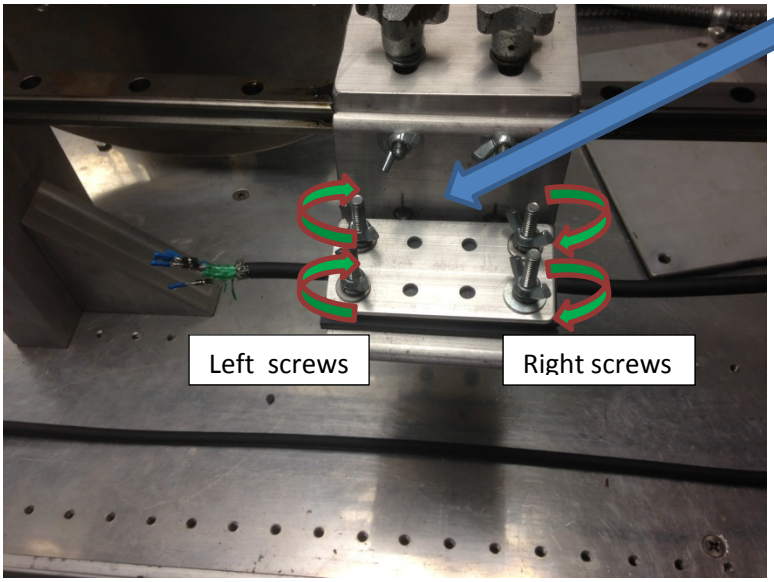


1. Insert the cable through the clamp hole on the left of the machine.

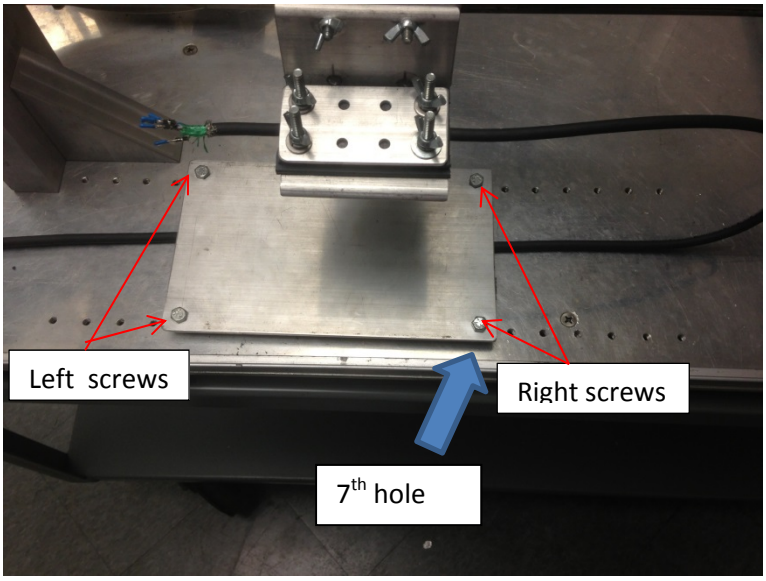


2. Place the cable on the top clamp leaving about 2 inches of cable.

3. The inserted cable should ‘flow’ freely when inserted in the machine. When placed in the machine, the cable should relax without any tension. The natural twist of the cable lay should agree with its placement.

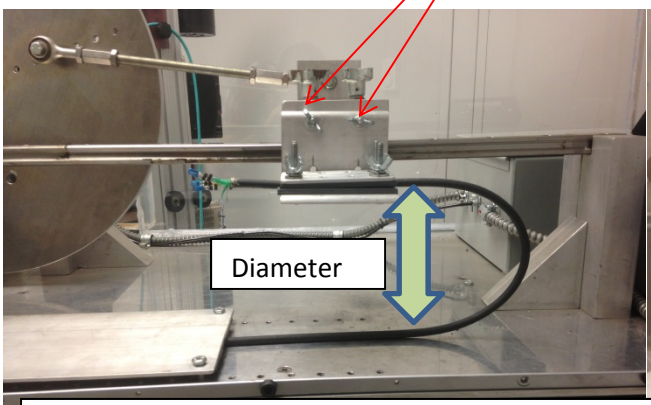


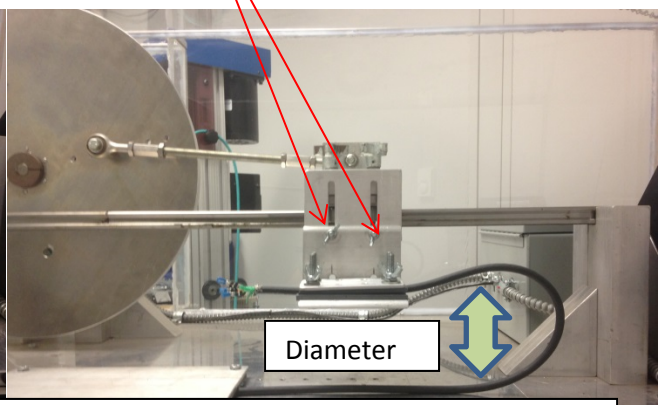
4. The top plate can then be secured and screwed on. The 2 left screws should be screwed on simultaneously insuring that the plate is clamped on evenly. The same goes for the right screws. It is recommended to go back and forth between the left screws and right screws making sure the clamp is secure. When a small resistance is being given by the screws it is important to STOP. It is essential not to crush the cable when screwing on the top clamp. Foam is added between the top 2 plates to prevent damage to the cable.



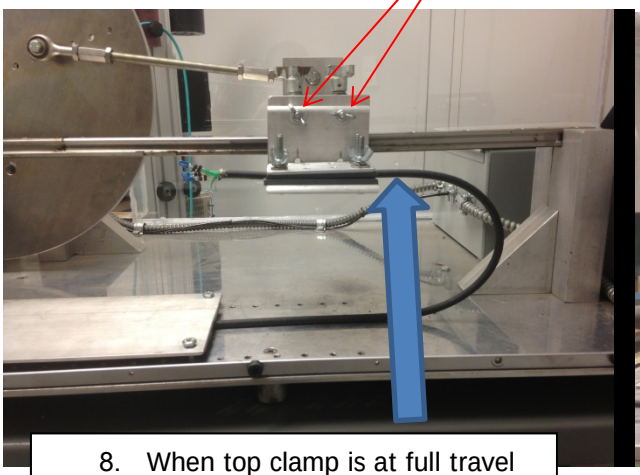
5. Bottom clamp should begin on the 7th hole from the right. Tighten the 2 left screws simultaneously as well at the 2 right screws. STOP when a small resistance is given on the screws insuring no crush on the cable.

6. The height of the top clamp can be adjusted up and down by loosening these screws

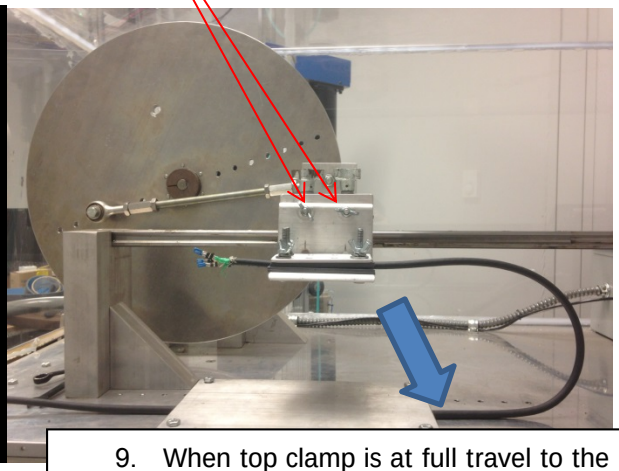




7. It is important to adjust the top clamp to the correct diameter. The diameter of the setup can be calculated by taking the O.D. of the cable and multiplying it by 20 for 10X flex testing. The diameter for 20X flex testing can be calculated by taking the O.D. of the cable and multiplying it by 40. The top clamp can be adjusted to the required diameter for the 10X and 20X cable.

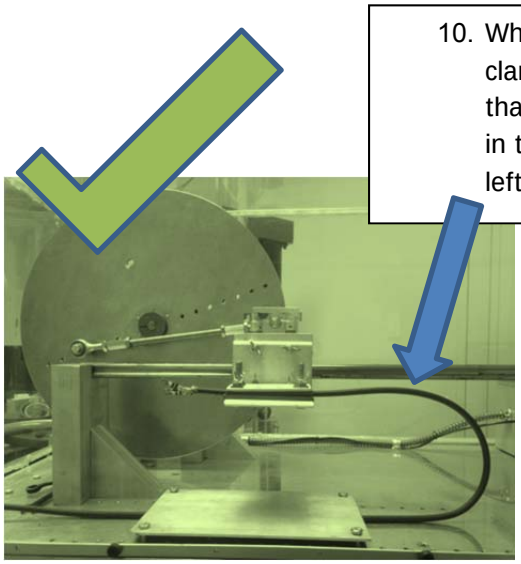


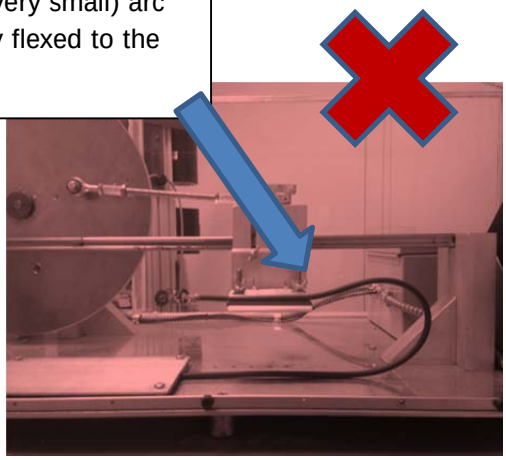
8. When top clamp is at full travel to the right, it is important to notice that there is no stress on the top cable where it meets the clamp.



9. When top clamp is at full travel to the left, it is important to notice that there is no stress on the bottom part of the cable where it meets the clamp.

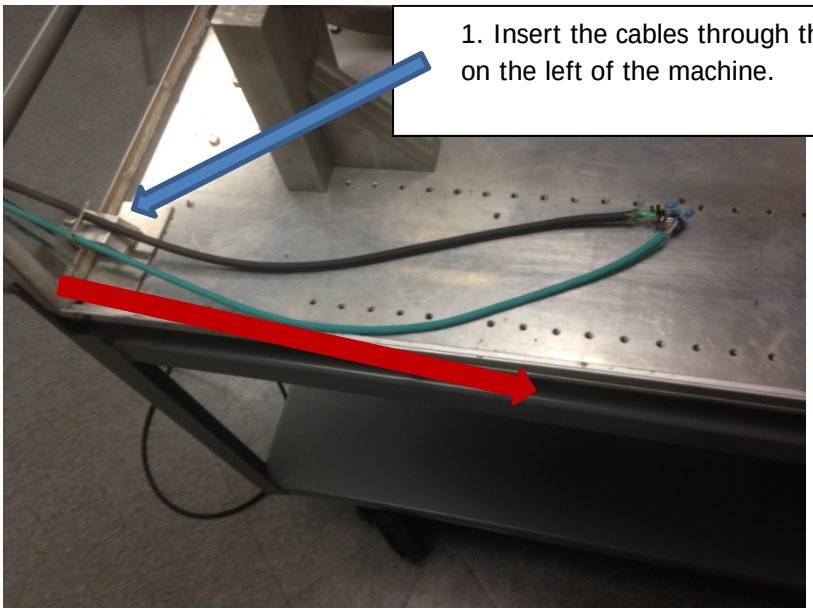
10. While adjusting the cable and the clamps, it is also important to notice that there is no (or a very small) arc in the cable when fully flexed to the left.



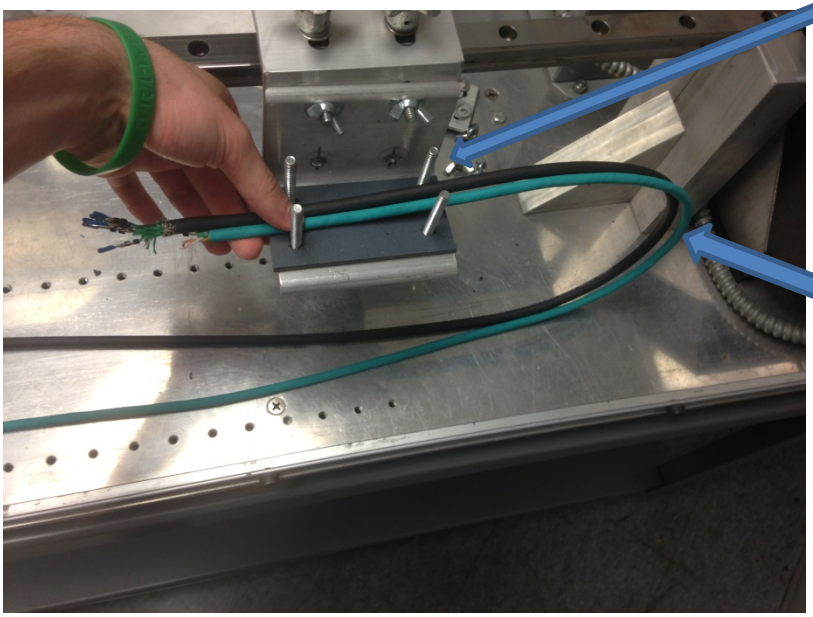


B. 2 cable setup:

If there are 2 cables being tested in the machine, the following steps should be taken.

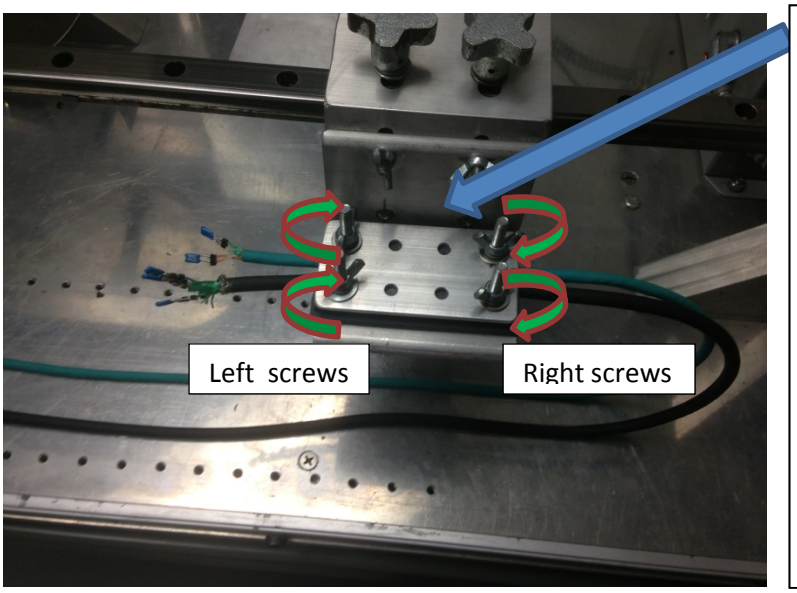


1. Insert the cables through the clamp hole on the left of the machine.

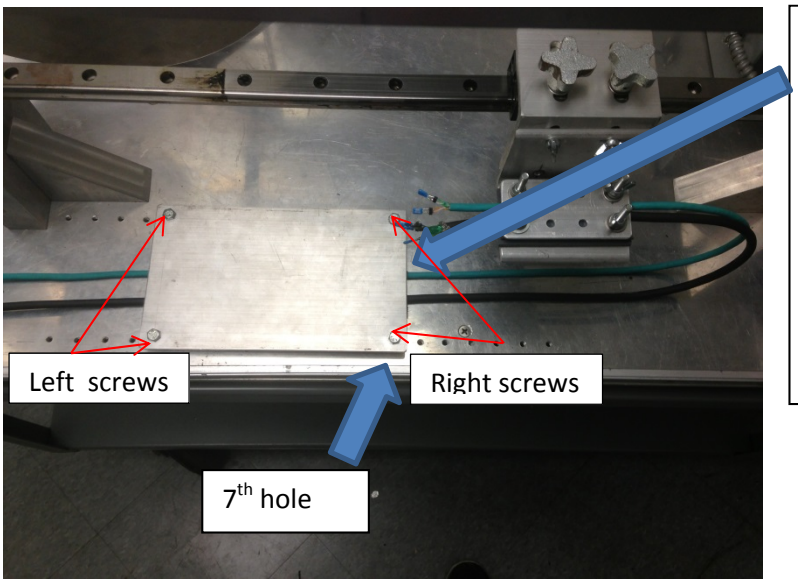


2.Place the cables on the top clamp leaving about 2 inches of cable.

3.The inserted cables should ‘flow’ freely when inserted in the machine. The natural twist of each cable lay should agree with its placement.



4.The top plate can then be secured and screwed on. The 2 left screws should be screwed on simultaneously insuring that the plate is clamped on evenly. The same goes for the right screws. It is recommended to go back and forth between the left screws and right screws making sure the clamp is secure. When a small resistance is being given by the screws it is important to STOP. It is essential not to crush the cables when screwing on the top clamp. A third of an inch should be left between the two cables insuring that there is no contact between the two while placed in the top clamp. Foam is applied between the top clamps to avoid damaging the cables.



5. Bottom clamp should begin on the 7th hole from the right. Tight the 2 left screws simultaneously as well at the 2 right screws. STOP when a small resistance is given on the screws. A small space of about a third of an inch should be left between the two cables insuring that there is no contact. It is also important not to crush the cables with the plate by screwing it too tight.

6. The height of the top clamp can be adjusted up and down by loosening these screws.

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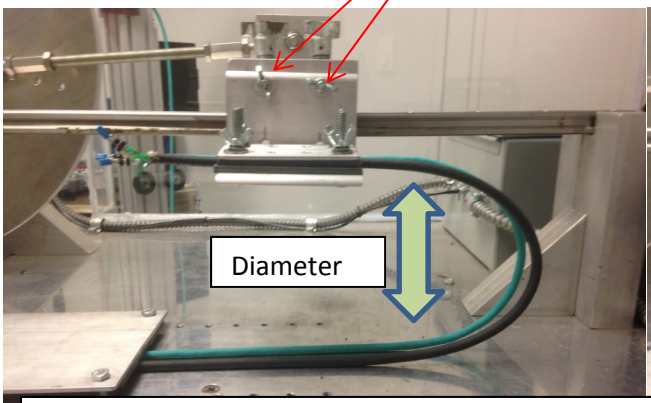
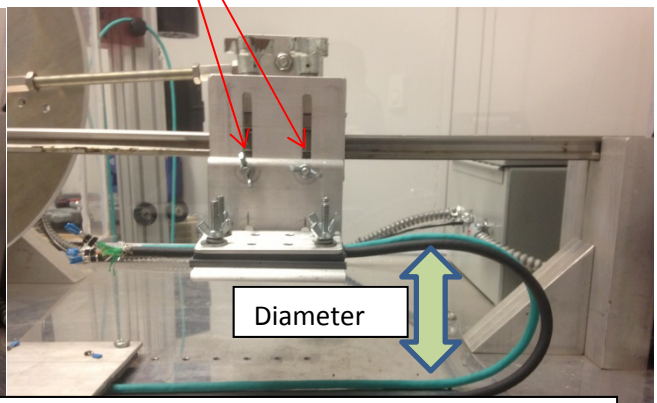
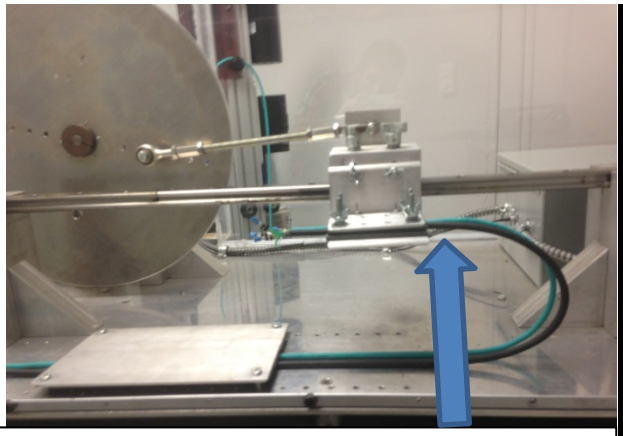
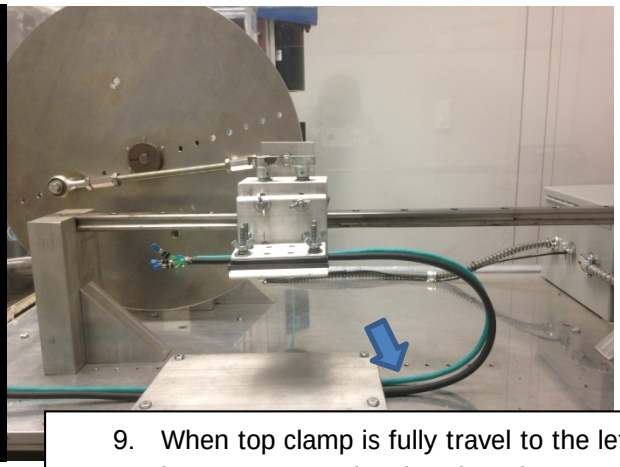




7. It is important to adjust the top clamp to the right diameter. The diameter of the setup can be calculated by taking the O.D. of the smaller cable and multiplying it by 20 for 10X flex testing. The diameter for 20X flex testing can be calculated by taking the O.D. of the smaller cable and multiplying it by 40. The top clamp can be adjusted to the required diameter for the 10X and 20X cables.

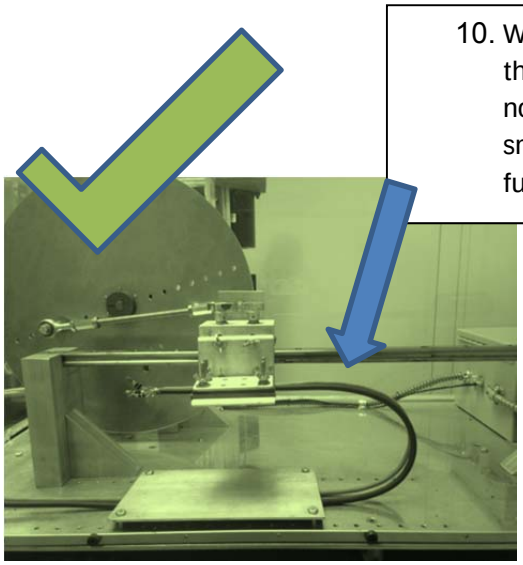


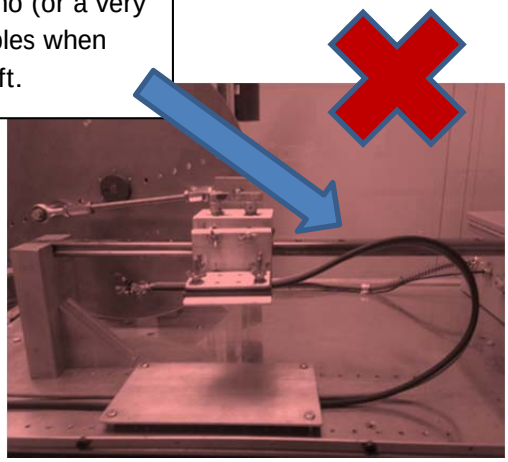
8. When top clamp is at full travel to the right, it is important to notice that there is no stress on the top cables where they meet the clamp.



9. When top clamp is fully travel to the left, it is important to notice that there is no stress on the bottom part of the cables in where they meet the clamp.

10. While adjusting the cable and the clamps it is also important to notice that there is no (or a very small) arc in the cables when fully flexed to the left.





After the cable or cables are fully secure in the machine, electrical testing can begin. The two tests that are to be performed on each cable are “Return loss” (RL) and “Cross Talk” (NEXT). It is important to first electrically test the cable or cables before flex testing is done. When turning ON the machine the power cord can be plugged in.

The OFF switch can be flipped up and the Green light should appear. This indicates that the power is ON.

The Run switch can be flipped up

The SPEED knob can be slowly turned all the way clockwise insuring the full 126 RPM

Counter indicates the amount of revolutions.

When the machine begins to turn and flex the cable, the access door is to be shut and locked for safety. Finally RL and NEXT testing can begin.

5. Test Description

In order to insure that the cables are able to withstand continuous flexing, data is recorded before, during, and after the test. For 10x flex testing, the halfway point is 750k cycles and the final is 1.25 Million cycles. For 20x flex testing, the halfway point is 5 Million cycles and the final is 10.25 Million cycles. All testing is done while the machine is running insuring that the cable can perform while being flexed in real time. The testing of the cable follows Quabbin standard procedures. The cables are tested with a radius of 10X and 20X with a rate of 126 cycles per minute.

6. Test Results:

5026 10X flex test:

	750k cycles	1.25 million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	None	None
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5902 10X flex test:

	750k cycles	1.25 million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	None	None
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5025 10X flex test:

	750k cycles	1.25 million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	None	None
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5088 10X flex test:

	750k cycles	1.25 million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	None	None
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5085 10X flex test:

	750k cycles	1.25 million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	None	None
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5026 20X flex test:

	5 Million cycles	10 Million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	Pass	Pass
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5025 20X flex test:

	5 Million cycles	10 Million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	Pass	Pass
Return Loss	Pass	Pass
Cross Talk	Pass	Pass

5088 20X flex test:

	5 Million cycles	10 Million cycles
Jacket cracks	None	None
Tape cracks	None	None
Braid strands broken	None	None
Abrasion of insulation	None	None
Conductor Failure	Pass	Pass
Return Loss	Pass	Pass
Cross Talk	Pass	Pass