

**Fisher Space Systems, LLC**  
**Progress Report #13**  
**Inflated Beam**  
**04/01/2013 – 04/05/2013**

Monday, 04/01/2013

I cut two (four pieces) 4.25" flanges and drilled six 1/4" holes for the carriage bolts and one 1 3/8" hole for the bulkhead adapter. I sanded (16 grit), cleaned (denatured alcohol), and epoxied (Hobby Hanger 30 minute cure) the flanges. I let them dry overnight.

Tuesday, 04/02/2013

I used the 4" diameter flanges to test an air barrier for the carriage bolts. I covered the carriage bolts (already installed in the bottom piece of the flange) with 2 mil drop cloth. I reassembled the Mylar tube and Kevlar sleeve and pressured check up to 40 psig before it started leaking to fast for the pump to keep up. I cycled the pressure up to 48 psig. The flanges and air barrier over the carriage bolts seem to hold. A leak occurred around one of the screws. The recess for the carriage bolt on the flange stripped and would not lock into place. I could not tighten the carriage bolt to keep the air from leaking.

Wednesday, 04/03/2013

I prepared the 4.25" flanges for the Mylar tube and Kevlar beam. I covered the carriage bolts with 2 mil drop cloth and taped them into position using Scotch double sided tape. I used the Mylar tube from Friday (length = 3' 7", diameter = 4.77" with Duct tape on the ends). I draped the Mylar over the bolts and taped it into place. I placed the top piece of the flange over the Mylar and screwed on the bulkhead adapter to hold it into place. Using the Kevlar sleeve from Friday (length = 5' 1" (3' 3" inflated) and diameter = 1.9" (4.45" - 4.85" inflated)), I draped it over the bolts and used washers and hex bolts to secure it into place. I repeated the procedure for the other flange.

I tested it up to 58 psig without any leaks. The pump held the pressure. At 58 psig, a slow leak occurred just below the flange. At first, the leak appeared to be caused by lack of Kevlar support. The Kevlar sleeve had a gap at the leak location. But, after closer inspection, there seemed to be no break in the Mylar. The leak may have occurred at the flange. Probably through the fold in the taped end of the Mylar.

Thursday, 04/04/2013

I massed the cable system used for E' measurements at 0.374 kg (wt. = 3.64 N). When the 5 lb weight is added, total load ~ 25.9 N. I cut Mylar to a length of 10' and a width to 17" (includes 2" overlap). I cut a Kevlar sleeve 15.6' (or 15' 7"). When inflated the Kevlar sleeve decreased in length to 9' 1" (a factor of 1.72). The Mylar tube split down the seam.

Friday, 04/05/2013

I cut a new Mylar tube to a length of 9'6" and a width of 18" (2" overlap) resulting in a

diameter of 5.1". The post examination of the Mylar tube from yesterday showed an average circumference of 14.75" or a diameter of 4.7". The intended diameter was 4.77" or a circumference of 15". Could 0.07" diameter really make a difference in making the seam split? I taped over the split and tried to work on the Kevlar sleeve as it is being inflated.

I tried to get some preliminary measurements of  $E'$ . I had trouble with the cable system and decided to use 50 lb test Spectra<sup>®</sup> fishing line instead. I pressurized the Kevlar/Mylar tube and worked down the length to try and even out the sleeve diameter. The measurements of the 9' 1" Kevlar sleeve gave me inconsistent results. The effective modulus,  $E'$ , was on the order of  $10^9$  N/m<sup>2</sup>. I had inconsistent deflections at 5 and 16 psig. I guess it is back to the drawing board.

### Summary

I tried covering the carriage bolts with 2 mil drop cloth to serve as an air barrier over the bottom piece of the flanges. It worked, so far. The pressure leaks occur at different places along the beam. I cut larger diameter flanges and used the Kevlar sleeve and Mylar tube from last week to further test the approach and was able to get the pressure up to 58 psig before leaks occurred. The leaks appeared to be at flange in the fold in the Mylar tube.

The 9'1" Kevlar sleeve did not work out. The beam diameter was inconsistent for all the measurements. I will have to go back to smaller beams.

### Lessons Learned

- 2 mil drop cloth works well as an air barrier over the carriage bolts.
- 50 lb test Spectra fishing line works well as a weightless cable for  $E'$  measurements.
- it is very difficult to get a consistent measurement using Kevlar beams over 9' long.