Shear Pins

Last updated 08/19/2004

The test fixture is made of a carbon fiber coupler and a length of 38mm body tube. 3/4" plywood bulkheads were epoxied into each section and a welded eyebolts were secured with nuts washers. Several holes were drilled in the assembly to test various shear pin sizes and quantities. The picture on the left shows the test fixture. The picture on the right shows it in action, testing four #4 nylon screws. Click on them to see a larger image.

The first thing you'll notice is the high number of tests. I was not comfortable with the variation in data. I was using my small 500 lb load cell that was calibrated from 0 to 500 lbs with a 0.00005 lbs resolution. The accuracy is +/- 0.0001 lbs. The column below "Peak Load Each Pin" should all be the same for the same size pin. The rate of loading for this test was 20 IPM.

Warning: Including set-up pieces, well over 150 shear pins were mutilated and killed in these tests!

#2 Nylon Screws				#4 Nylon Screws		
# of Pins	**Peak Load (lbs)**	**Peak Load (Each Pin)**		**# of Pins**	**Peak Load (lbs)**	**Peak Load (Each Pin)**
2	53.123	26.56		2	81.304	40.65
2	45.952	22.98		2	85.148	42.57
2	50.848	25.42		2	75.944	37.57
2	51.799	25.90		2	80.391	40.20
2	47.924	23.96		2	80.908	40.45
Avgs	***49.93***	***24.64***			***80.75***	***40.30***
3	62.637	20.88		3	119.273	39.76
3	60.569	20.19		3	110.999	37.00

3	64.395	21.47		3	99.969	33.32
3	62.413	20.80		3	113.554	37.85
3	68.760	22.92		3	116.208	38.73
3	66.643	22.21		3	121.121	40.37
				3	123.689	41.23
Avgs	***64.24***	***21.41***			***114.97***	***38.32***
4	86.699	21.67		4	143.405	35.85
4	86.855	21.71		4	152.368	38.09
4	78.771	19.69		4	142.026	35.51
4	84.269	21.07		4	160.489	40.12
4	85.617	21.40		4	153.302	38.33
4	90.402	22.60		4	154.766	38.69
				4	160.368	40.09
Avgs	***84.44***	***21.36***			***152.38***	***38.21***

Discussion

It can be seen that when using only two shear pins: 1) the average peak load is higher for each pin and, 2) the spread within the average is greater. (The spread within an average is known as sigma.) This was true for both the #2 screws and the #4 screws. It was determined that only using two pins allowed the assembly to cock to one side causing a binding effect, thereby increasing the load variance (sigma) and average.

Using three or more pins eliminated this binding effect, producing a much lower sigma and much more consistent results.

How to use this data

Using shear pins is a tried and true method of keeping a recovery compartment secure prior to deployment. Friction fitting a coupler works, but is not consistent. We can see that using nylon screws create a consistent and predictable way of securing your coupler assembly. Knowing the load to overcome during ejection is a helpful way to determine how much ejection powder you need to both shear the pins and eject your recovery system. Remember that you still need to ground test your recovery system but using nylon screws creates a predictable and consistent recovery system.

Below is the same test as described above. The fixture was made the same way, but is made from 2.25" USR white glassine cardboard tubing. The holes were drilled and stiffened with liberal amounts of Cyanoacrylate. The #4 screws began to tear up the tubing rather quickly. The tubing held up rather nicely to the #2 screws.

There is not enough data to draw any conclusions.

#2 Nylon Screws			#4 Nylon Screws		
# of Pins	Peak Load (lbs)	Peak Load (Each Pin)	# of Pins	Peak Load (lbs)	Peak Load (Each Pin)
3	34.163		3	60.727	

#6 Nylon Screws		
# of Pins	Peak Load (lbs)	Peak Load (Each Pin)
3	181.380	60.46

Below are tests using polystyrene fork tines. These were tested in the carbon fiber fixture. The notes column on the right describes the hole size in which they were tested. The results vary widely, most likely due to the taper in the tines and probable inconsistencies in the material.

Although many people use them, this test shows that using fork tines is a poor idea. There is absolutely no consistency or predictability.

Styrene Fork Tines
(Yeah, people use them!)

# of Pins	Peak Load (lbs)	Peak Load (Each Pin)	Notes
3	8.833		#2 Holes
3	1.414		#2 Holes
3	55.191		#4 holes
3	102.927		#4 holes
2	24.527		#2 holes
2	65.254		#4 holes

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