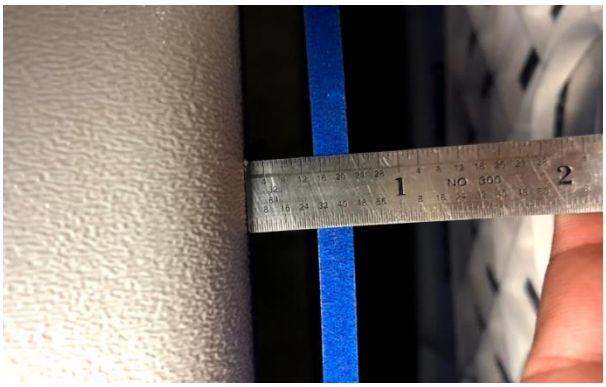
Lander Load Test Procedure

The team at AndyMark defined 5 tests. These tests were a combination of small, realistic loads for long time scales, high loads for shorter times and a load to failure.

1. 45 pounds on each position overnight
2. 75 pounds on various locations as a proof load
3. 100 pounds on various locations as a proof load
4. Twin robot, load until failure
5. 45 pound cyclic loading and uploading tournament simulation

For each test, we applied the load and measured the max deflection in the internal wall with respect to the flange of the top dome.



For the first test, we loaded each of the 4 robot positions with 45 pounds for 20 hours (overnight). At the end of the test period, we checked the lander results such as deformation or fracture. We wanted to investigate how sustained loads would affect the lander structure, if any of the plastic components would creep, or if the zipties would fail or slip.

The second and third round tests investigated static loads of 75 and 100 pounds on the lander. While competition loads will be lower, robots will apply dynamic loads higher than their static loading. A 75 pound load represents a 42 pound robot at 1.8g, while a 100 pound load represents a max weight robot at 2.4g. After each load was positioned, we measured the max deflection.

The fourth test investigated the load which would result in a failed lander. The two-opposed robot configuration was found to be the worst case scenario for greatest deflections (picture referenced below). This was the configuration that was selected for the failure load test. During this test, equal weight was added to the two robot positions at the same time until the lander failed by falling apart.

The final test investigated the effect of frequent loading/unloading cycles on the lander to simulate an FTC tournament. We used between 42 and 50 lbs at each position, throughout this test. For each simulated match, four ‘robots’ were loaded aggressively onto the lander hooks, let hang for 30-60 seconds while they wait for the match to start. Then, the robots were removed and reloaded to simulate hanging at the end of the match.

Results

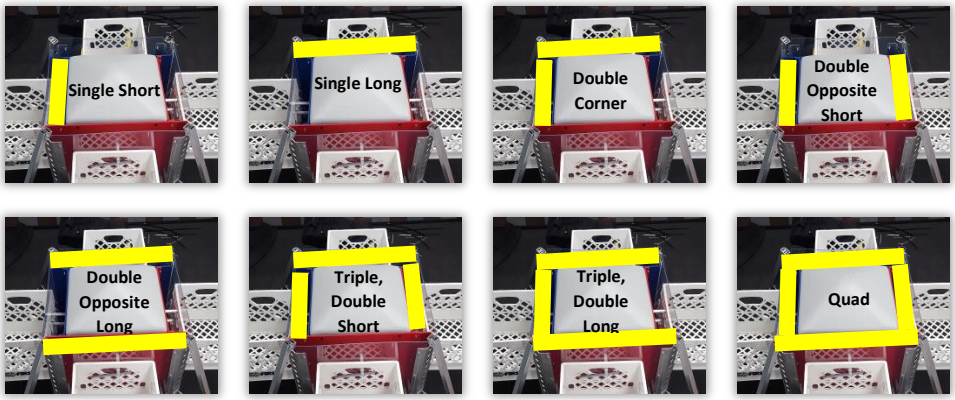
Test 1 – 45 Pound Overnight Load

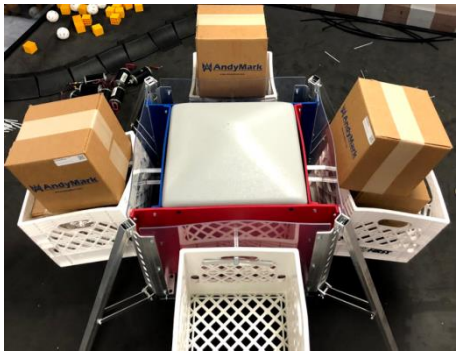
The lander was evaluated after a 20 hour load test. No permanent deformation was found. From these encouraging results, we proceeded with further testing.

Test 2&3 – Proof Loads

The gap data for each test is listed below. For each test, the weight was gently applied and the max gap in the PVC foam was measured. At no point through this test were any cracks or permanent deformations noticed.

Proof Loads Deformation Data								
Load	Single Short	Single Long	Double Corner	Double opposite short	Double opposite Long	Triple, double short	Triple, double long	Quad
Test 2								
75 pounds	8/32	13/32	8/32	18/32	18/32	8.5/32 - short	12/32 - long	4/32 - short
			4/32	15/32	18/32	12/32 - short	10/32 - long	0/32 - short
						0/32 long	0/32 - short	5/32 - long
								4/32 - long
Test 3								
100 pounds	19/32	18/32	8/32	21/32	20/32	22/32 - short	12/32 - long	5/32 - short
			8/32	18/32	20/32	15/32 - short	11/32 - long	0/32 - short
						0/32 - long	2/32 - short	12/32 - long
								7/32 - long
Maximum gap is measured in inches								





(Triple robot, Double Short wall test with 75lbs per position)

Test 4

These tests were run until something on the lander failed, in the production configuration the cap popped off at 207.5 lbs per side (4.93g of a standard robot). This was repaired without any tools and prepped for a second test. A fifth zip tie was added from short to short wall spanning the test section, after this weight was again added until an energetic-disassembly occurred. The cap came off, and PVC foam failed between 207.5 and 232.5 lbs per side (5.54g).

(First Load to Failure test, 207lbs held by each side of the lander)

Test 5 – Tournament Loading Simulation

The lander was inspected before, midway and after the test, at no point did we see any reason why the lander would not be able to continue at the tournament or cause a field fault. There were no failures or breakages and no lasting indications of any damage throughout the test.

Conclusions

From this battery of tests we feel the lander has demonstrated its ability to handle the loads that will be applied throughout the course of an FTC tournament season and use by a team. The kit will contain 4 zipties internal to the Lander. Given its performance we've elected not to add the 5th and 6th zipties spanning the middle of the lander. This testing provided a wealth of knowledge and reassurance that the lander and the internal zipties will be fully capable throughout the year.