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Technical Report

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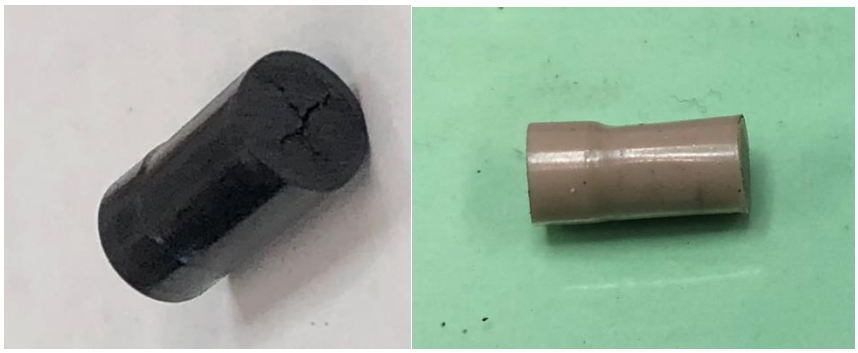
Introduction

In summer 2019 the first AC36 test mules started sea trials. These mules while smaller than the eventual AC75s were configured similarly. Foiling monohulls over 25' were definitely foreign territory. It quickly became apparent that the travelers for these foiling monohulls would be used very differently than any previous America's Cup boat. Listening to feedback from teams Harken saw opportunity for improvement. These foiling travelers were being adjusted very quickly and very frequently. The travelers were seen as more critical than adjusting the mainsheet. The trimmers wanted to keep constant leech tension in the main sail. When the traveler was eased mainsheet load stayed high. Even when eased, there was near maximum working load in the system. There were two areas where teams wanted more than what the current CRX systems were offering. Hardware that was designed win around the world races was showing signs of wear after a few weeks of training sessions. Rollers were having to be replaced more frequently than we had ever seen before. Additionally, the teams were telling us maximum efficiency was of upmost importance even if it came with added mass. A sticky traveler not easing could spell disaster for an AC75.

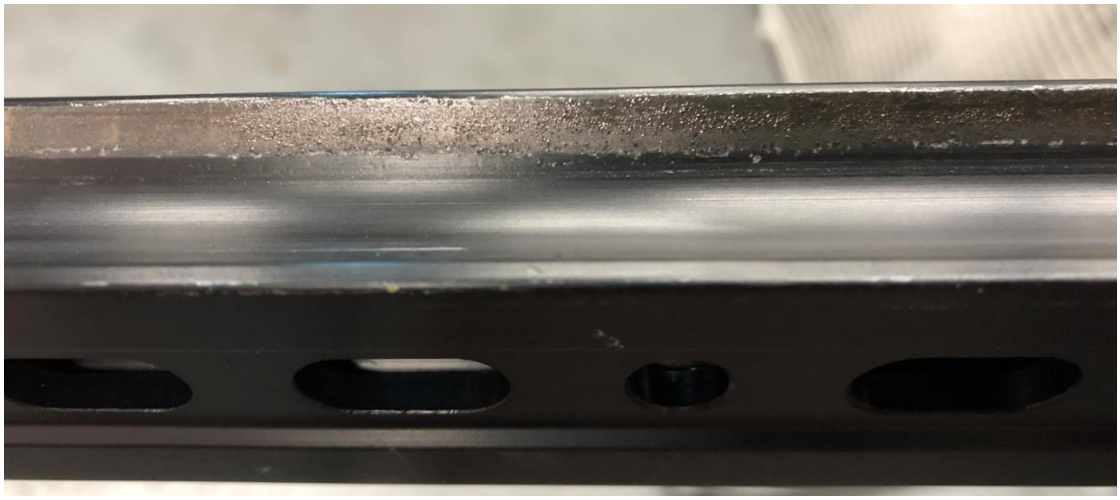
Report

Harken's first approach was to try and keep things as simple as possible. Perhaps the Torlon rollers we had been using for years could simply be swapped for a different material. Previous testing of thermoplastic rollers showed Torlon was the best, but those tests were conducted at lower adjustment speeds typical of displacement boats. Ideally, we wanted to use the same hardcoat anodized aluminum tracks and cars. A new test setup was designed for high speed adjustments under load. Several different thermoplastics were tested as well as bronze. One goal of this new test setup was to have the dead weight used for load be stationary. Having several thousand pounds of lead moving with the car acting as a pendulum seemed unsafe. Results showed Torlon still performed best under these new conditions.

Test Bench Set up #1



Examples of roller wear, deformation, and cracking

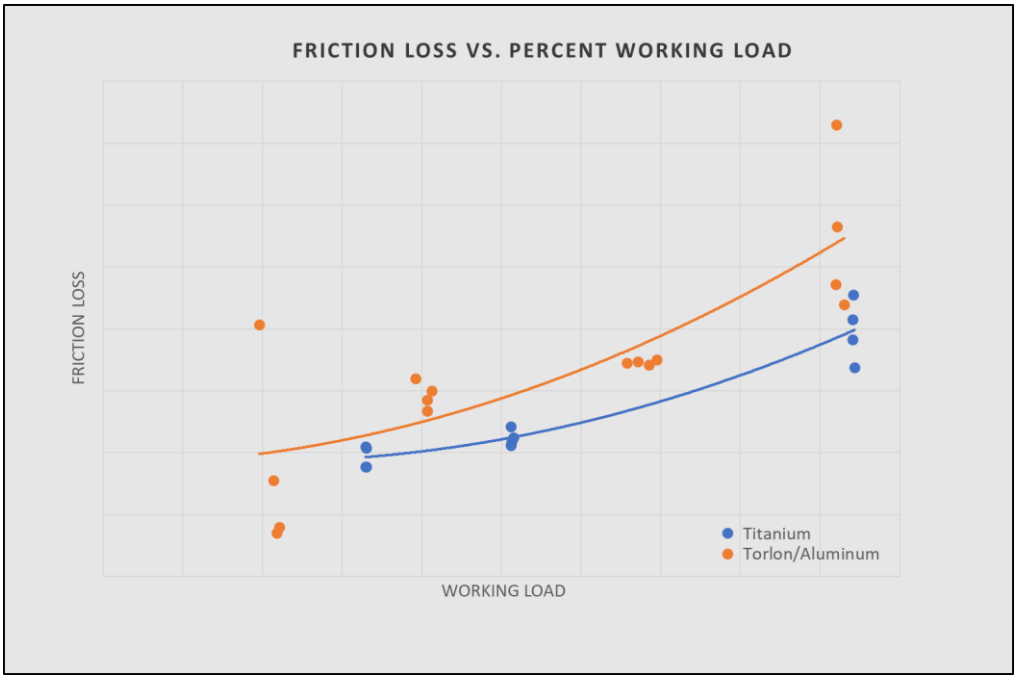


Bronze rollers wore away the anodizing and left containment particles

The next steps would be more dramatic. Current CRX traveler systems were analogous to a Black Magic Block. What if we designed a traveler system that was analogous to a V Block? This was no small task as we knew from the onset there would be significant difficulties and costs in manufacturing such a system. Black Magic blocks use aluminum races with Torlon rollers, while V Blocks use titanium races and rollers with winch grease for lubrication. Timelines are tight for the America's Cup, there would not be opportunity for multiple design iterations. The material and tooling needed for a titanium track would have a long lead time, we couldn't afford mistakes. Oh, and we'd never bent titanium track before. The teams wanted the tracks to be curved to match the arc path of the boom. Was our track bender strong enough? Would the titanium crack in the bender? Would internal stresses cause unintended side effects like an induced vertical bend? These were all unknowns.

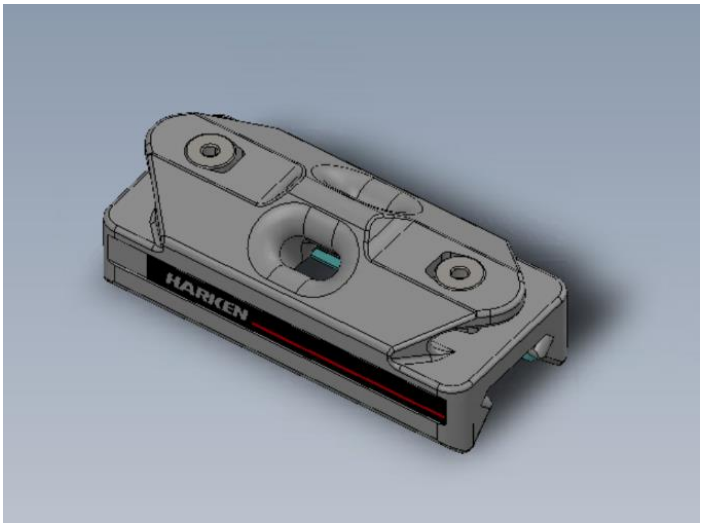
By early 2020 an all new traveler system had been designed using a titanium track, cars and rollers. To test this Titanium CRX design we again designed a new test setup. In order to achieve even greater car speeds a quadrant was used to amplify the speed of the cylinder. The test setup was a reverse of the previous setup. This time the cars would be stationary, and the tracks would move. Different speeds and loads were tested for both the Ti CRX as well as the older Torlon and aluminum CRX. Additionally, durability testing of 3.5km of car travel was tested.

Test Bench Setups 2 & 3 for higher car speeds



These tests were all done on straight track. One team asked for more testing using curved track to more accurately represent what will happen on the water. This meant yet another test rig needed to be designed. This one would be similar to the setup used to test the thermoplastic rollers at high speed, but this time a hydraulic motor/spool would be used rather than a cylinder. Additionally, some stainless components would be tested. While heavier than titanium, if there was an increase in efficiency, the trade off may be worth it.

Further complicating matters at this point was also the onset of lockdowns due to the pandemic. After 14.5km of car travel, it was determined an all titanium CRX system was a good solution for not just the traveler, but also a few other areas of the boat. Now all that was left was the easy part – designing systems specific to each team (early enough for the structural bulkheads under the track to be designed by the team), then manufacturing/shipping them in time to be installed before the teams launched their second/final AC75. Finally, wait for on the water feedback and adjusting accordingly. Now that the cup is over, we at Harken are asking 'what's next?'



Car Concept

Final Product ready to ship