HISTORY OF PLASMA ROPE IN TDI-BROOKS JUMBO CORING SYSTEMS DEVELOPMENT

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In 2004 we developed our first generation Jumbo Piston Coring (JPC) system by starting from the general design of Marsco. Marsco later sold their rigs to C&C Technologies, after abandoning their premise that such coring could be performed by them safely and efficiently. We made several improvements to the Marsco JPC design concept, including developing the ability to remove the trigger assembly from the main line by first relieving tension with an innovative way. Marsco had not been able to come up with a way remove the trigger system from the main line under the tension of 7,000+ lb, and had struggled with retrieving the core rig after essentially every drop (per Dan Lanier of GEMS, with whom I spent a great deal of time in the initial stages of our design). C&C Technologies then offered to sell the Marsco rig to TDI-Brooks in 2007, after they could not get it to work (per Thomas Chance, President of C&C).

One of the main problems with the JPC systems of that day was that the rope being used as the main wire was steel cable, and was subject to recoil upon the triggered release of the rig at the seabed. This is because the wire rope would tend to “un-lay” with increasing load, allowing the suspended load to rotate, and actually make the wire longer due to such rotational stretching. The rotating load was disastrous to the trigger system of the JPC rig, which comprised a horizontal arm attached to the wire rope with a trigger weight suspended from it. As the JPC rig was released at the seabed by the trigger system, the rope, now relieved of its load, would instantly try to “re-lay” itself, causing it to spin and recoil. The spinning rope (with the trigger arm jutting laterally outward) would spin, thus winding the trigger line around the JPC core rig and barrels upon pullout from the seabed.

To make matters worse, the recoil of the wire rope would violently yank the piston upward through the core barrel at a rate faster than the intended equivalent of free-fall velocity. This caused quality problems such as poorer recoveries and disturbed soils in the sample. Upon retrieval to the sea surface, it was typical to find the trigger wire wrapped several times around the core barrel. Retrieving such a mess to the deck was inherently dangerous, unpredictable, time-consuming, demoralizing, and not conducive to efficient process design. One method of attempting to solve this problem was to use a much larger diameter of main line wire rope, so as to reduce the extent of the “un-laying” of the rope with load (this has the same effect as simply reducing the load on the smaller wire, and is the reason that the problem is not nearly so great with 2,000 lb 3-in diameter piston coring performed for decades). However, using 1.25 in diameter steel rope instead of 0.625in diameter, for example, added substantially more weight in the water and required much larger and more cumbersome and expensive draw works. Various components such as sheaves and terminations had to be sized up correspondingly. The bend ratio for steel rope over a sheave should be 16:1 or 18:1, depending on the lay, so a 24in diameter sheave was required. This, in turn, required a higher, larger, and stronger A-Frame, and ultimately, a larger vessel to handle the up-sized draw works and A-Frame.

For these reasons, Woods Hole Oceanographic Institute, arguably the premier oceanographic research center in the world, had switched to Plasma (ultra high molecular weight polyethylene) rope for their large coring systems. We also noted that other Oceanographic institutes, including the vessels of UNAM in Mexico (funded by Pemex) were using Plasma rope, and we got some experience coring with it on a job we completed using their R/V Justo Sierra.

We studied the design and performance specifications of Plasma, and noted that the strength of the rope was significantly higher than wire rope, for any diameter comparison. For example, the 0.625 in diameter Plasma rope that we use for our JPC systems has a breaking strength of about 51,000 lb. The same for 0.625 in diameter wire rope is about 36,000 lb. Even more significant, the stretch, and resulting recoil upon load release of Plasma rope is perhaps only 10% of that of wire rope, depending on the lay of the wire. Additionally, the Plasma rope weighs nothing in water, whereas the wire rope adds several thousand pounds to the deployed gear, putting more demands on the A-Frame, sheaves, shackles, and draw works.

We tested the Plasma rope with more than 150 deployments and retrievals over a two year period, and developed a method of consistently measuring the recoil distance upon load release. We compared these measurements to those we had made using wire rope, and found, for example, that a 6,500 lb JPC rig trigger-released from 2,000 m of deployed 0.625 in. diameter Plasma rope, caused the rope to recoil about 1-2 feet. This compared very favorably to the 13-15 feet of recoil measured when using wire rope of the same length and diameter (now we only mechanically program to correct for an anticipated 0.6 feet of recoil, for a Plasma main line rope that has been in service for more than 10 drops). Moreover, we seldom brought a rig back to the sea surface with the trigger wire wrapped around the core barrel, and this almost always happened with the wire rope (we eventually completely eliminated this wire-wrapping by changing to a rotation-resistant pendant). We looked into using rotation-resistant wire rope for our main line, but still had the stretch issue.

We were astounded upon each of two JPC pre-triggers with Plasma rope (in our history to-date) that we actually did not lose the core rig! Note that a pre-trigger in deepwater means that 7,000+ lbs of load free-falls for 75 feet before being stopped abruptly by the main line rope going taut. This compares favorably to our experience with many dozens of pre-triggers of our 2,000 lb coring system, with which we have taken over 12,000 cores since 1996. We have never, to my knowledge, retained a core rig on the wire after a pre-trigger, but have lost every one (usually to a termination failure).

We noted that the lack of recoil of the Plasma also significantly improved the quality of the core. We reduced the incidence of soil separation in the bottom of the core, and eliminated the stretching of the core material (due to piston yank) when we optimized our JPC system settings for Plasma rope.

As we continued to test and to use Plasma rope on both JPC vessels, we found that the main issue was the protection of the rope from extended time in the sun, and we trained our staff not to step on it. We learned how to terminate the Plasma rope such that the termination retained 100% of the rope strength (as opposed to 80% of rope strength with our wire rope terminations). We trained and certified selected staff on this Tuck Splice termination, using a detailed video supplied by the rope manufacturer. We learned how to effectively inspect the rope and when to take it out of service. We then designed rope assembly kits for the various tugger winch systems of the JPC system, and started to manufacture, load-test, tag, certify, and stock them as spares. That way, a rope taken out of service could be instantly replaced with a pre-tested and certified kit, rather than have someone re-terminate the rope at sea under non-ideal conditions. This allowed us to also track the history of a rope assembly by use of our Lifting Register. All of these developments increased the morale and pride of our staff, and, unlike the wire-rope days, everyone wants to be a part of a JPC job now.