Safe harbor

Learning from mooring accidents

A ship's crew faces many hazards at sea. But even when the ship is docked in harbor, safety procedures and equipment are still needed to protect crews and dockside personnel. Of these, the mooring ropes used to keep the ship in place are probably the most important. And unlike other items such as lifeboats and fire extinguishers which only need to be used in an emergency, mooring ropes are used every time the ship is docked and require regular and routine maintenance.

However, even with regular maintenance of mooring ropes, accidents can still happen. What is important is that we learn from them, so that they do not happen again. In the case of the LNG carrier 'Zarga', when a mooring rope snapped, an officer, standing in a designated safe area, was struck by the rope and seriously injured.

When incidents like this happen in the shipping industry, there is a formal investigation to determine the cause. More importantly, the resulting report also provides recommendations on what can be done to ensure that a serious accident never happens again.

What exactly happened?

Operated by Shell International Trading and Shipping Company (STASCo), the Zarga, a Q-Max LNG vessel, the largest in the world, with a storage capacity of 266,000 m3. faced a serious incident. Due to its size, it could only be moored in an exposed location at the South Hook Liquefied Natural Gas terminal in Milford Haven, UK. While repositioning the ship along the jetty during a 'warping' action using the spring-lines, one of the forward spring-lines failed. The rope, which was made of high-modulus polyethylene (HMPE), failed in-board close to the roller pedestal that leads the rope from the winch at a 90° angle to the roller fairlead. The energy stored in the rope's PP/PET (polypropyleen/ Polyethyleentereftalaat) tail resulted in a high-speed retraction of the parted rope. Due to a complex snap-back trajectory, the rope hit the officer monitoring the operation on the back of the head, even though he was in a designated safe area. The other part of the rope (running to the winch) dropped to the deck without significant snap-back.

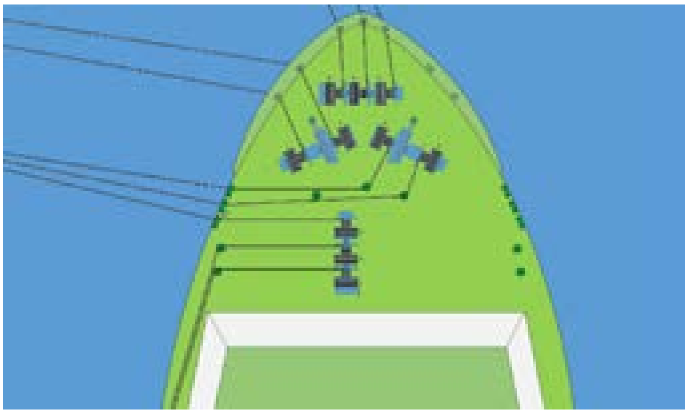

Fig 1: Zarga Mooring Deck (source: MAIB report)

What caused the rope to fail?

According to the report on the incident, from the Marine Accident Investigation Branch (MAIB) of the UK government, there was no single cause. The report states that the mooring rope failed due to overload, after its residual strength was reduced. The MAIB report further states that the reduction in the strength of the rope was the result of a combination of several factors including: high cyclic loading at exposed ports, repeated and prolonged bending and radial compression, shockloading and tension-tension fatigue and was caused by the effects of bending around deck fittings, and high levels of cyclic loading at exposed terminals such as South Hook.

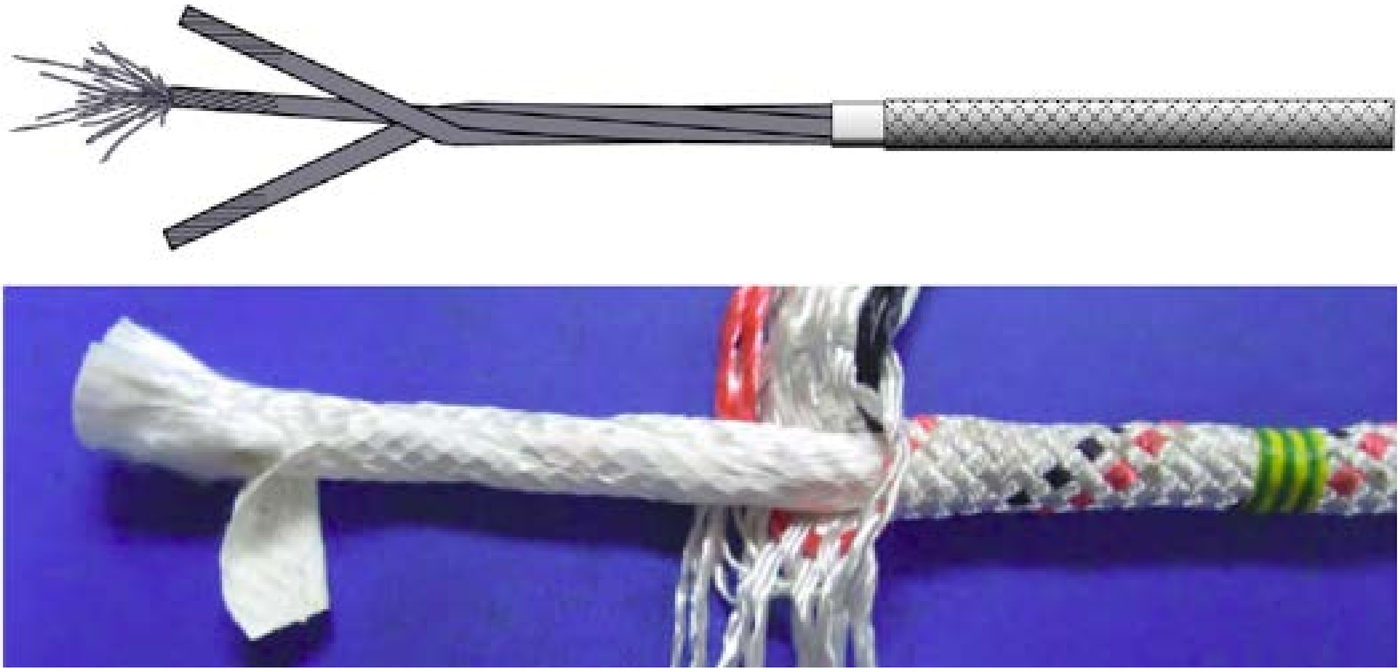

Fig 2: General view of rope with braided jacket (source MAIB report)

The spring line which failed was a 44-mm diameter strength optimized construction of three-strand long lay strands and a jacket. It has a Dyneema® sk75 core, the braided jacket was made from polyester (PET), and the two were separated by self-amalgamating tape. The 275m rope was equipped with a 22m long, 88mm diameter PP/PET tail.

According to the report, one of the problems with the mooring rope was the long lay-length of the rope core and rope-yarn with very low twist, combined with the self-amalgamating tape and the very tight PET jacket. In this type of construction, kinks already introduced into the rope during production become even more severe when subjected to axial compression. It is DSM's believe that this can lead to a local aggregation of fiber which results in kink-zones -because the rope cannot expand due to the tight cover- internal friction increases leading to extreme local abrasion. As a result, the remaining intact rope yarn is more likely to fail through overload.

Fig 3 & 4: Yarn kinks (source MAIB report)

Conclusions and recommendations

The report concludes that, even though the rope was made with Dyneema® sk75 fiber, the method of rope design used was unsuitable for mooring of Q-Max vessels. As a result, the rope supplier has withdrawn the product from the market for this type of vessel. To ensure that mooring ropes fully meet all requirements, DSM recommends a detailed analysis of the hardware, the type of mooring operations, and the environmental conditions at the various ports the vessel calls. DSM can support customers in performing this analysis, advising on rope design, coatings, and end-connections. DSM also recommends performing creep calculations on the mooring ropes to ensure proper lifetime in warm environments like the Middle East. Following this analysis, the rope manufacturer can design a fit-for-purpose rope.

"Dyneema® SK78 fiber provides outstanding advantages over alternative materials for mooring ropes, however, the rope construction and its specific performance requirements needs to be thoroughly defined, analyzed and calculated.", said Jac Spijkers, Application Manager at DSM, and expert witness during the MAIB investigation. "Only by knowing the hardware, the type of mooring operations, and the environmental conditions at the various ports where the vessel calls, can the specific requirements for the mooring ropes be defined and met."The report says that tensile strength of any high modulus synthetic fiber (HMSF) rope will reduce over time, regardless of any maintenance. Therefore, appropriate safety factors and anticipated life expectancy need to be considered, and parameters such as time, temperature and tension need to be monitored.

Recommendations from the MAIB report have been incorporated into the next release of Mooring Equipment Guidelines produced by OCIMF (Oil Companies International Marine Forum) and to which DSM contributed. OCIMF MEG-4 is published in July 2018.

The new guidelines will place more emphasis on rope construction, with recommendations for buyers to not only focus on mooring rope strength but to ask rope manufacturers more pertinent questions on topics like the materials used in the fibers, the construction of the rope, the linear density of the load-bearing core, coatings, and insights into material wear mechanisms. Several new tests will be detailed in MEG-4 that rope manufacturers will have to comply with to prove their ropes are fit for purpose as mooring lines for these large tankers.
"We continue to expand our knowledge of rope behavior and will keep on contributing to industry bodies and regulatory institutions" says Mr. Spijkers. "We support our customers, the rope manufacturers, by providing lifetime performance calculations and advising on rope design, coatings and end-connections. Only by working in close cooperation with the rope manufacturer and end-user, will we ensure long lifetime and safe use."

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> *Jac Spijkers, Application Manager at DSM*

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