



TOWLINE CARE AND SHIP, PORT AND TUG CREW SAFETY

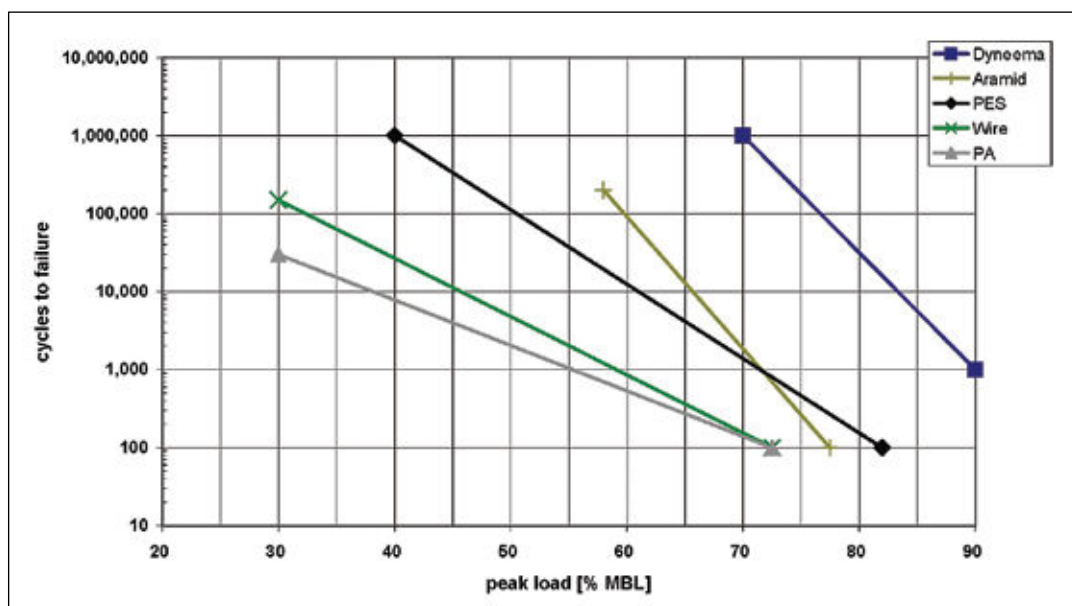
Part 2

The considerable increase in tug power also has certain consequences that are not always fully considered, such as the need for a suitable size and/or power of the tug in relation to the size of the ship to be handled, as has been explained in the article “Big is Better?” (see [1]). However, there are other consequences as well.

The last decades have brought significant changes in tug designs and in tug power. Compared to conventional tugs, changes in tug design have resulted in a considerable improvement of safety of tug operations, as is the case with azimuth tractor drive (ATD)/azimuth stern drive (ASD) tugs, rotor tugs, and those with a carousel system. However, the

increase in power also has other consequences that were already addressed in part 1 of this article, published in SWZ|Maritime's April 2026 issue. This second part goes into important aspects such as fibre rope characteristics and the towline logbook, mitigating measures taken and ways to deal with peak loads.

Photo: Forward tug operating on a steep towline. A steep towline easily causes overload and peak loads (photo Kees Torn, the Netherlands).



Tension-tension fatigue, performance of different fibres. PES = polyester; PA = polyamide (nylon) (source Samson Rope).

PART 2

This is the second and final part of this article. The first part, which discussed risks for ship and crew, also in the wheelhouse, the dangers of snap backs, and presented some examples of accidents with tugs, was published in SWZ|Maritime's April 2026 issue.

Characteristics of fibre ropes

It should be well understood that the characteristics of the different fibre ropes differ greatly, see the graph above. So, peak loads have a larger effect on nylon than on polyester ropes, which means that in case of peak loads, residual strength reduces faster with nylon than with polyester, while Dyneema ropes outperform all other fibre ropes.

Overload and peak loads affect the rope condition too, which is another factor of importance. With respect to this, studies [6] show a strong correlation between internal and external abrasion and residual strength, although rope construction should be considered too. So, the residual strength is affected by two factors: rope condition and peak loads/overload.

The characteristics of ropes made of high modulus polyethylene (HMPE) are in general very beneficial for tug ropes, however, the misunderstanding with these materials is that the strength versus lifetime goes linear. Actually, the residual strength remains about the same during use and at a certain moment it decreases fast. This may make an assessment of safe usage of such a rope more diffi-

cult and registration of rope failures more important. Compared to generic HMPE fibres, the Dyneema SK78 has a built-in lifetime buffer. A possible rope failure lies much further in time compared to other HMPE fibre types, see the next paragraph.

Towline logbook

For rope usage, the residual strength is a crucial factor for replacement and avoiding early parting and snap backs. Therefore, the important question is: how can the residual strength of a towline be determined while it is in use? Unfortunately, this is not possible without destructive strength tests, after the towline or pennant has been removed from the winch.

When towing companies and tug masters keep a towline logbook and record the number of jobs, results of regular checks of the towline and pennant, changes with respect to towline and pennant, incidents, and results of residual testing when the towline is removed, this will give insight into the behaviour, condition, and residual strength of their ropes/pennants.

Rope manufacturers are given guidelines on when and how to check the condition of the towline and pennant, see also reference [7] and BTA Guidelines [4].

Actions taken for improvement

The hazards of rope and pennant parting mentioned

How can the residual strength of a towline be determined while it is in use?

have been recognised by various companies. Actions that have been taken to improve the situation are mentioned below. Improvement of HMPE has been achieved by the earlier mentioned introduction of Dyneema SK78 fibres, which have the so-called life-time buffer, which ensures more reliability. With this fibre type, the life of the rope becomes much longer, ensuring that the significant drop in breaking strength happens much further away in time (up to four times later compared to generic HMPE), which is a significant improvement [8].

Damen Shipyards constructs wheelhouses of new tugs with Damen Safety Glass. This is shatterproof glazing that protects the operators in the event of a towline snapping.

Hampidjan Avant has developed a jacketed polyester towing rope, which can be used for the main line and for the towing pennant and prevents snap-back incidents. The rope has a central core with extra stretch and less strength than the main rope [9].

Sureline Sensor Technologies offers sensors that can be used as a single-point rope sensor or deployed with multiple sensors in different ropes to offer real-time information during towing operations. It can show live rope tension, rope angle, slew angle, peak loads, and so on. This allows Sureline to provide new insight into towing rope dynamics.

These are all excellent improvements and very welcome. However, the basic problem of towline parting is not solved, or not solved adequately.

How can towline or pennant parting be prevented or reduced?

From the foregoing it can be learned that a) overload and peak loads and b) deteriorating rope condition are factors that affect the lifespan of towing lines considerably, although depending on the type of fibre rope. Fibre ropes have been there for years and will continue to be there for years. Therefore, preventing or minimising the effect of these factors is a necessity for port safety, the safety of ships, and safety of tugs and tug crews. This will require both study and creativity.

To keep the towline in as good a condition as possible, the towline should be handled professionally and the deck equipment of the tug should be such that the towing winch is in a good condition. A towline should not pass sharp corners, or corners or bends with a too small radius, nor pass anything that could damage it or cause extra abrasion, such as rust or rough surfaces.

The crucial question that rests is how overloading of and peak loads in a towline and pennant can be prevented. Although it depends on the rope type, avoiding overloading and peak loads has many advantages, such as:

- Lifespan of rope will increase.
 - Strength reduction will be less, because internal and external abrasion will decrease, drum compression will be less and rope damage by tug and ship's deck equipment will be less.
 - Rope fatigue will decrease.
 - Fibre breakage will reduce.
 - Tug and ship deck equipment will not suffer from (too) high loads.
- Overload of the towline can be prevented, or the load can be de-



Fairlead pulled from deck. Can be caused by overload or peak load (photo Arie Nijgh, Australia).

created by the tug master by, for instance, reducing tug power or changing the tug's heading, depending on the situation. The tug should then be equipped with a tension meter to be able to read the tension in the towline, which is mostly the case on modern powerful tugs.

The instrument, which has been used for reducing (the effect of) peak loads for many years, is a nylon stretcher. A simple tool that absorbs high peak load tensions in the towline and reacts immediately. Furthermore, the breaking strength of the stretcher is always

related to the minimum breaking strength of the towline and pennant.

There are several tugs with render-recovery towing winches, which reduce peak loads too. Such tugs have a tension measuring system of which the data is transferred to the render-recovery system. If the tension is higher or lower than preset values, the winch will be activated to keep the tension between the two values. This all costs some time. In port areas, however, a render-

It would be good to investigate to what extent a stretcher reduces the variety in peak loads

recovery system is seldom used amongst others because of the often limited manoeuvring space. Tugs with a render-recovery system are then towing on the brake, as other tugs without a render-recovery system do, and, thus, the problem of high tension peak values remains in port areas. Overload and peak loads can occur in port areas as well, such as due to inaccurate or swift tug manoeuvres, steep towlines, waves of passing vessels, waves in the port approach, and so on.

It would be good to investigate to what extent a stretcher reduces the variety in peak loads, taking into account stretcher characteristics.

REFERENCES AND ACKNOWLEDGEMENT

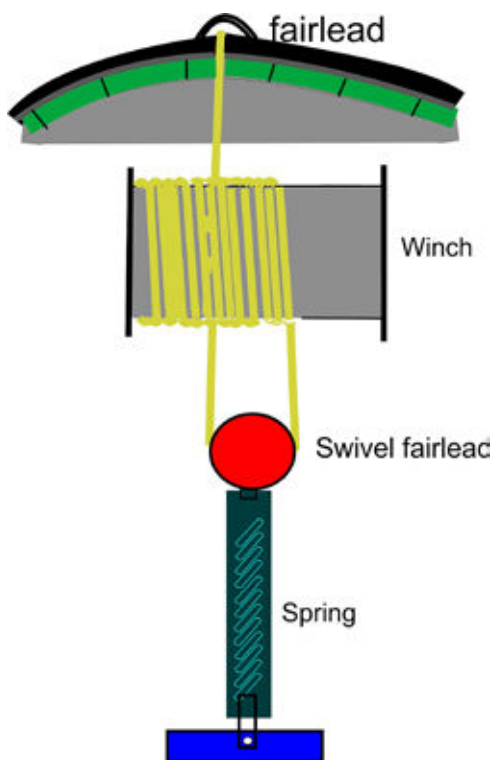
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Towards a mechanical system?

In summary, if care has been taken that the tug's deck equipment is constructed and maintained in such a way that it does not harm the towline, it will remain in a rather good condition, provided that the towline is also handled professionally by the crew.

Towline overload can be prevented by adequate tug handling. What remains are the peak loads, the most critical factor. With respect to this, the use of a stretcher has been evaluated. It is a simple, but not an easy to handle tool and is also subject to strength reduction.



A sketch of a simple peak reducer. Lead of the towline goes from the winch drum to swivel the fairlead and then underneath the winch drum toward the tug's bow fairlead. Winch operation is not needed.

If a comparable, but mechanical system could be made, which also activates immediately in case tension in the towline becomes above the recommended level, neutralising peak loads, and adjustable for various bollard pulls and strong enough for peak loads, it would be a very large improvement in towline care with all the advantages mentioned before. It would make stretchers redundant. It would be best if such a system, the workings of which do not reduce over time, would operate near, but independently from the winch in order to keep the towline at approximately the same length. Such a system would have a great positive impact on the condition and residual strength of fibre ropes and pennants, and will reduce or even prevent the dangerous snap backs.

It could minimise peak loads not only in port areas, but also outside the breakwaters where it may contribute to the workings of a render-recovery system, with the same large advantage of increasing the life of not only towlines and pennants made of HMPE, but also of, for instance, polyester towlines and pennants.

Most of the earlier-mentioned improvements remain absolutely welcome and can even benefit from a mechanical peak-reducing system. A careful assessment of the towline and/or pennant for retirement remains necessary.

Just a simple idea is shown with the sketch of the figure to the left. Hopefully, the above idea will be picked up by some rope, winch or other relevant specialists. A real challenge. It would allow them to contribute to safer ship handling with tugs, safer tug operations in ports, and increased safety of tugs and their crews.



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