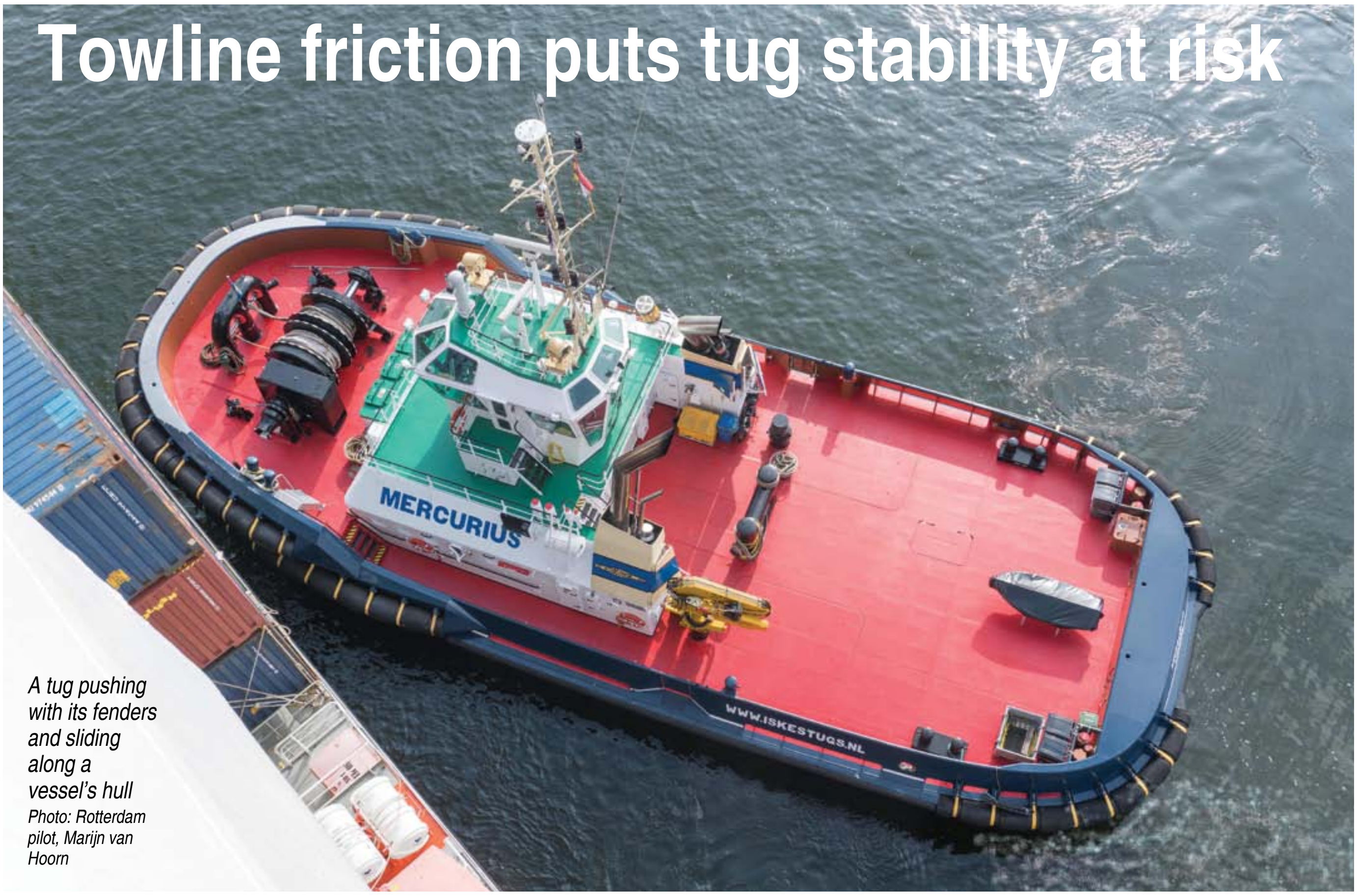
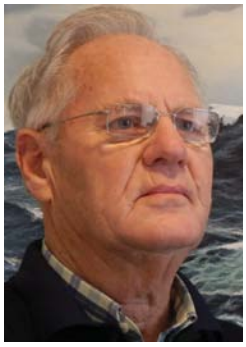
Towline friction puts tug stability at risk



A tug pushing with its fenders and sliding along a vessel's hull
Photo: Rotterdam pilot, Marijn van Hoorn

Marine consultant and author, Capt Henk Hensen has written a paper entitled *Towline Friction and its Consequences* which is available online. Here, in an exclusive preview, he looks at the issues of stability and safety discussed in the paper



► Capt Henk Hensen

In recent years much attention has been paid to innovative aspects of tug design such as environmentally-friendly tugs, underwater hull form, and escort skegs. Several new tug types have also been developed. This focus could create the idea that a tug's deck equipment, such as towlines, towing winches, staples and fairleads, have reached their optimum design. This is far from being the case.

Towrope friction and all its consequences require attention. This is a subject not often discussed, but this towrope characteristic is important because it may affect the working of a winch and, most importantly, stability.

Friction is introduced when one part of an object comes into contact with part of another and relative movement occurs, for instance the fenders of a tug being in contact with a ship's hull, or a towline passing through a fairlead or staple.

Friction has three direct negative effects:

- Friction introduces energy loss; where friction plays a role it costs extra power to move an object. For example, when a tug is sliding with its bow fenders along a vessel's hull, it requires power to move the tug with its rubber fenders along the steel hull. In the case of water lubricated fenders friction is reduced and consequently less power is needed.
- Friction causes heat where it takes place. This is the reason a towrope under tension gets hot when passing at an angle through a fairlead. Deterioration increases rapidly above a certain temperature and care should be taken that this temperature is avoided.
- Friction causes abrasion and the greater the friction the greater the abrasion. This effect assumes a sliding surface, for example where a towrope slides through a fairlead. The rougher the surface of the fairlead, the greater the friction and, consequently, the abrasion.

The friction coefficient (C_f) gives the relation between the friction force (F_f) and the force working perpendicular to the surface of friction (F_n), and has a constant value. This means that if the force F_n doubles, the friction force F_f doubles as well, and consequently the friction coefficient C_f does not change.

When the towrope has a large contact area with the fairlead or staple and the towline forces are high, friction plays a significant role. This can be in the following situations:

- When operating in the indirect towing mode when the towline has a relatively large angle with the centre line of the tug, and consequently a large contact area between towline and staple;
- When tugs are operating in the powered indirect mode, which results in an even larger contact area;
- When conventional tugs and ASD-tugs, operating in conventional mode, operate in such a way that the towline has a relatively large angle with the centre line of the tug and thus also a large contact area with the staple.

The consequences of high friction are that the working of a render-recovery winch is affected; higher forces in the towline, increase the risk of damage to the vessel's bitts and fairleads; greater abrasion and heating of the towline; a higher risk of parting of the towline; and a decrease in the longevity of the towing line.

Furthermore, if the towing line is near right angles to the tug, the higher towline forces experienced before the winch starts to render, causes a larger heeling force on the tug. This can be risky in cases where the tug's stability is not optimum.

The situation can be improved by reducing the friction and there are a few options for doing so:

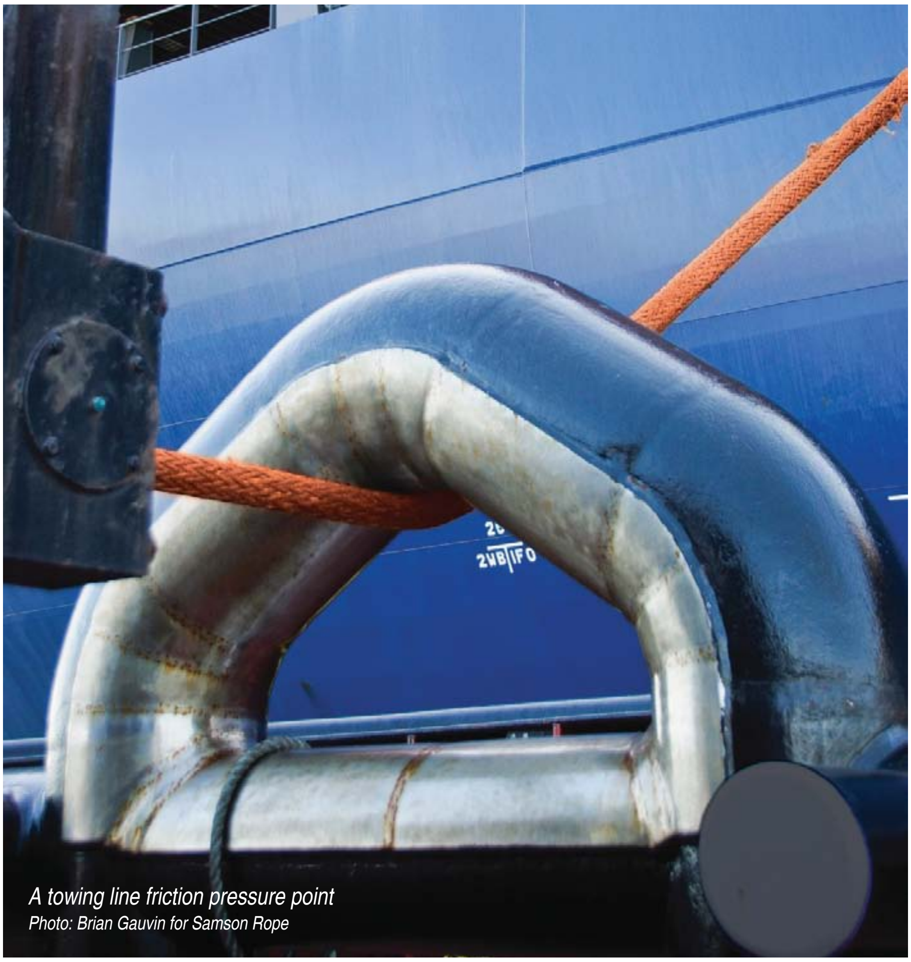
- The use of ropes with low friction coefficients, such as ropes made of Dyneema. The low friction coefficient only applies when the rope is not covered by some other material;
- The use of appropriate roller staples or roller fairleads;
- The use of an Azimuth friction-free towing point.

At present the most practical solution would be the use of low friction ropes, such as ropes made of Dyneema or Spectra. These are already in use on many tugs, but mainly because of their light weight.

However, additional problems may arise. HMPE ropes (Dyneema or Spectra) have hardly any elasticity and as a result high peak loads will be generated in the towline.

A crucial question is: will this be adequately compensated by a render-recovery winch? If not, although friction has reduced and the working of the render-recovery has improved, forces in the towline may reach higher values, with all the risks that involves.

These questions and solutions are discussed in more detail in my paper, *Towline Friction and its Consquences,* written in close co-operation with Dr Markus van der Laan, and available at http://www.imcgroup.nl/downloads/Towline_Friction_and_its_Consequences.pdf



A towing line friction pressure point
Photo: Brian Gauvin for Samson Rope