HYDROROPE - Redefining the Hydraulic Hose

Hydraulic hoses are designed to withstand enormous internal pressures and, over the decades since their first conception, they are now at a stage where they can handle internal pressures that only a few years ago would have been considered impossible. However, sometimes a hydraulic hose is required in a situation where it must balance its ability to cope with internal pressure with an ability to withstand intense axial loads as well.

Fig. 1 - Diaphragm wall building process

Axial loading on hydraulic hoses

First let us consider some hydraulic applications which create high-tensile forces in their hydraulic connectors. One of the most obvious applications is the construction of diaphragm walls, where hydraulic grabs and hydromills are the key tools. These large, extremely heavy tools are suspended from cables on a specially equipped crane, and are used to remove earth in a narrow rectangular hole *(fig. 1)*.

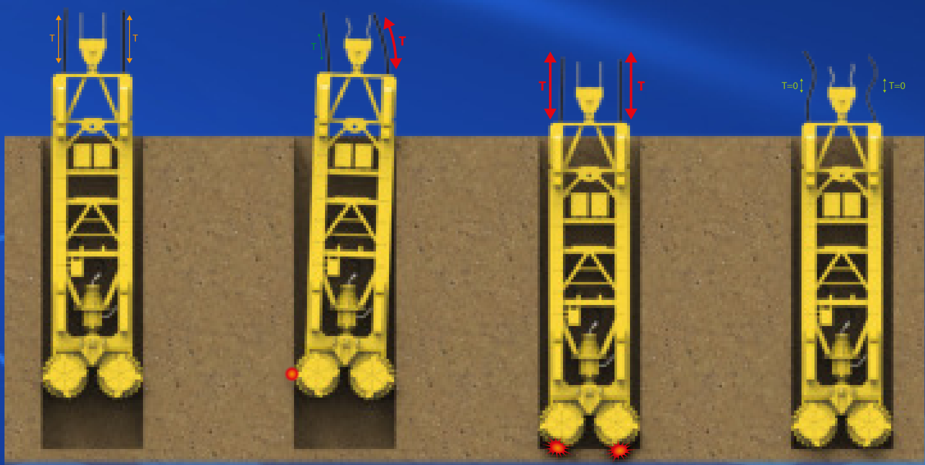

Fig. 2 - Example of a common hydromill operational fault condition which leads to excessive shock loading on hydraulic hoses

The hydraulics on these tools are powered from the crane itself, so the suspended tool could have over 100m of hydraulic hose connected to it, running over a pully at the top of the crane boom and then to winding drums on the crane. Under normal operating conditions the crane cables are intended to take the strain, but in commonly occurring fault conditions the cables can become slack and the full weight of the tool come to bear on the hydraulic hoses as shock-loads *(fig. 2)*. The hoses drums can also get out of phase with each other and cause extreme tension on the hoses.

To make matters worse, these particular fault conditions often start a viscous-cycle of oscillating shock-loads which can continue for several minutes at a time and causing repeated significant tensile

Fig. 3 - Long lengths of suspended hose in offshore pile-driving application

loading on the hydraulic hose.
Another instance where hydraulic hoses can come under significant tensile stress is in suspended hose applications, often found in the offshore pile-driving *(fig. 3)* and mining industries. In these cases hundreds of metres of hose can be suspended from just a few anchor-points, meaning that the entire weight of the hose plus the fluid it contains is creating a large tensile force between the anchor points. A 1½" hose with a suspended length of 150m can exert a tensile force of approximately 850kg, which is enough to cause permanent damage to a traditional hydraulic hose.

Hose failure due to high-tensile forces

In cases where hydraulic hoses are exposed to high-tensile forces there are four potential failure modes which can come into play. The first, most obvious, and thankfully the least likely, is total catastrophic failure resulting in the hose snapping. Fortunately this is extremely uncommon as one of the other three failure modes is likely to occur before this can happen.

The second potential failure mode is when the connection between the hose and one of the fittings at either end of the hose, or an intermediate joint, fails. This can take the form of either a simple fluid leak from the joint or a total failure of the joint leading to the hose becoming completely detached from the fitting.

The third potential failure mode is the development of micro-cracks and tears within the hose inner-tube due to the hose stretching under tensile loads. This inevitably leads to leaks as the hydraulic fluid seeps out through the holes. Micro-cracks and tears are often due to cumulative damage due to repeated high-tensile loading, but tears in particular can also occur suddenly due to a single instance of excessive tensile loading.

The final potential failure mode is the hose bursting due to the straightening of the reinforcement wires. In most high-pressure hydraulic hoses there are multiple layers of wire spirals which are wrapped at an optimum angle to ensure the best resistance to internal pressure. Elongation of the hose effectively straightens these spirals, making them less effective at resisting the internal pressure and therefore more likely to result in the hose bursting.

Solving this problem

For many years the issue of premature hose failure in these, and other, applications has been handled passively. In most cases preventative maintenance has been the only way to ensure hose integrity during operation, however, given the lengths of hose involved, the cost of replacement parts and down-time is very high.
Manuli Hydraulics has instead opted to address the cause of the problem directly, by developing a hydraulic hose that is capable of withstanding these destructive axial loads, whilst still offering the required level of performance in terms of pressure rating, impulse cycle resistance, etc. After an intensive design process, working in partnership with some of the world's largest OEMs, Manuli developed **HydroRope**™.

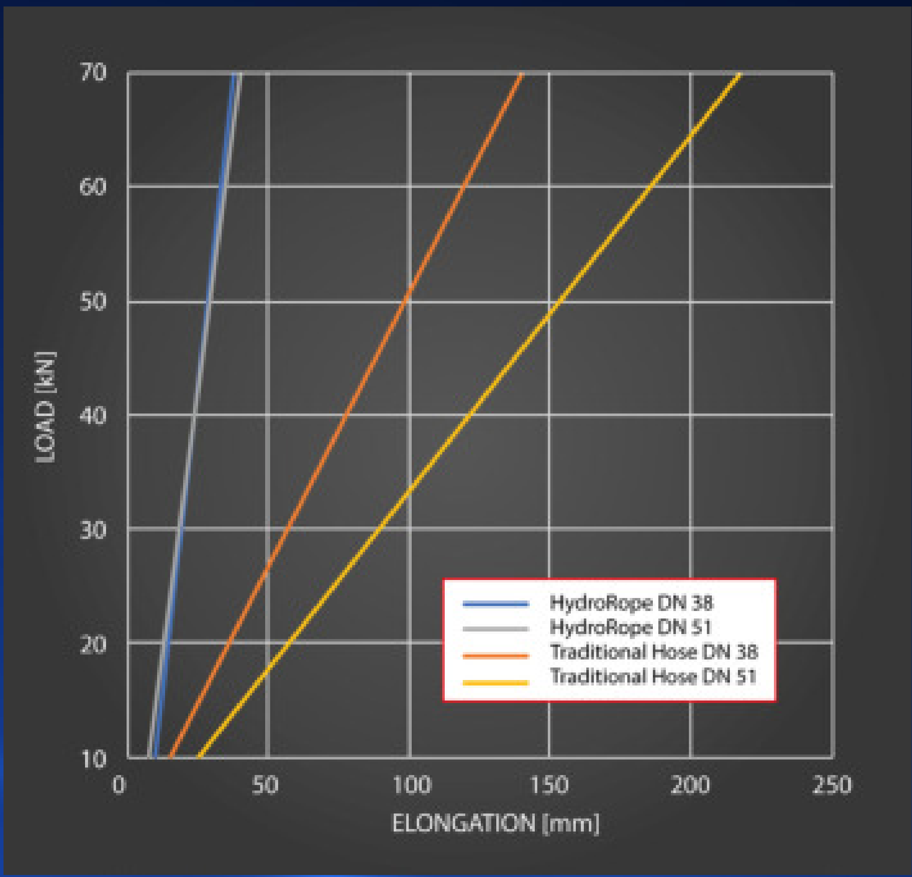

Fig. 4 – Tensile test results of HydroRope vs. Traditional R13 hose

The defining features of HydroRope are its incredible durability and minimal elongation even under the most severe tensile loading. The real-world performance far exceeds that of typical hydraulic hoses, allowing it to be safely used in situations where both static and dynamic loading is present. The amount of tensile force that HydroRope can withstand increases with the size of the hose diameter, but all sizes of HydroRope can comfortably support large static loads, which are far higher than standard hoses could support, without it having a detrimental effect on the hose performance or lifespan.
Tensile testing at the hoses' maximum working pressure and carried out by independent laboratories showed significantly reduced elongation when compared to other hydraulic hoses typically used in these applications *(fig. 4)*. This means that the development of micro-cracks and tears in the inner tube is, for all practical purposes, eliminated; as is the potential for hose bursts due to straightening of the reinforcement wires.

This level of tensile resistance is the result of the unique *(pat. pending)* structure of the hose *(fig. 5)*, which incorporates a layer of high-tensile braided steel wire as well as multiple layers of high-tensile steel wire spirals. In a standard R13 hose there would only be the wire spiral layers, and these can be straightened relatively easily under axial load. As the wire spirals straighten the rubber inner tube is free to stretch.

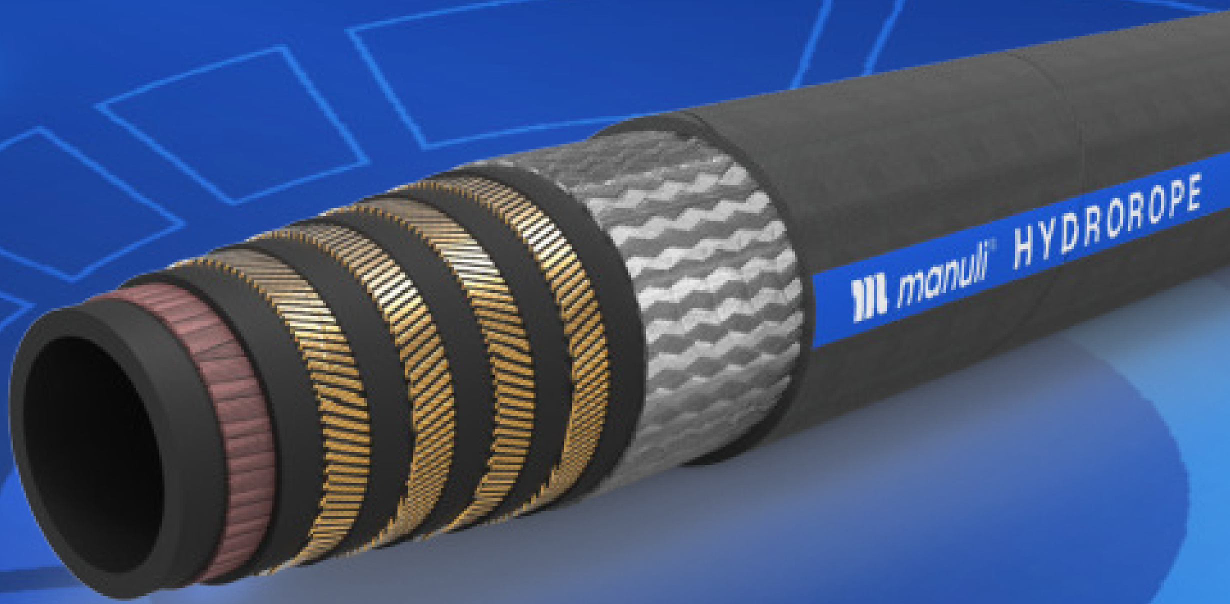

Fig. 5 – HydroRope has a unique (pat. pending) structure which actively resists elongation under axial loading

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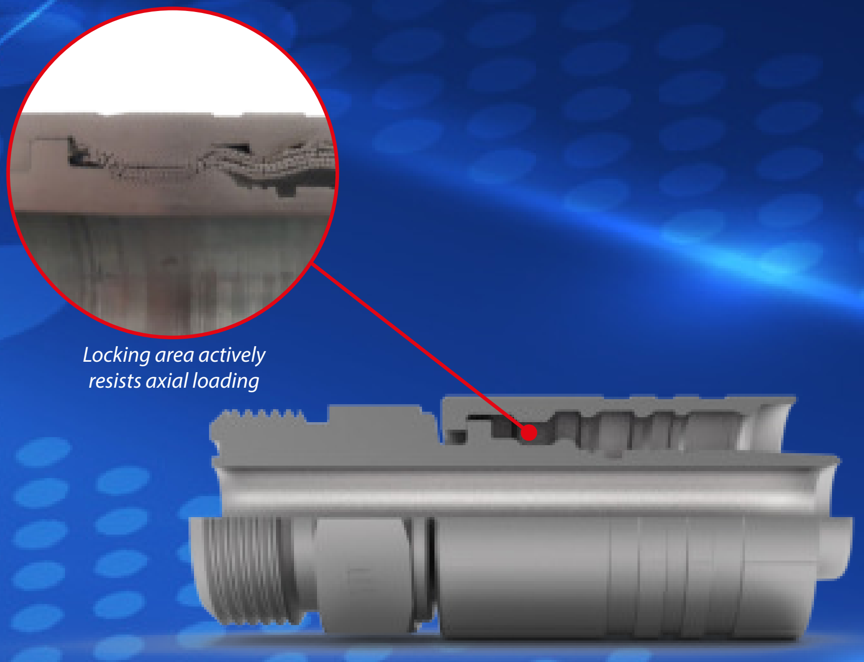

Fig. 6 – The Interlock range of fittings have a dedicated locking area which grips the hose reinforcement directly

The unique structure of HydroRope minimises elongation because the wire braid layer actively prevents the wire spirals from straightening, and therefore keeps the inner tube from being stretched to a degree that would cause damage.

Choosing the right fitting

Having addressed the issue of hose elongation, Manuli also ensured that HydroRope would not be susceptible to the other common failure mode mentioned earlier - that of fitting failure.

As the global leader in providing fully integrated hydraulic connector solutions all Manuli Hydraulics' hoses have dedicated fitting solutions that guarantee the highest possible standard of assembly, and HydroRope is no exception. HydroRope is paired with the most robust and secure fitting solutions in the Manuli product range, **Interlock Plus**™ and **Interlock Super**™.

The Interlock range of fittings is especially well suited for use with HydroRope because they incorporate a special locking area which "bites" the steel reinforcement wires, creating the most resilient possible connection between the hose and fitting *(fig. 6)*. The connection reliability of the Interlock range of fittings has been successfully proven over many years of being used in some of the toughest imaginable hydraulic applications, and is the go-to hydraulic fitting solution for a large number of world renowned OEMs.

Setting the standard for the future

As hydraulic applications evolve and become more demanding, the same is true of the components that make up the hydraulic systems. HydroRope is not only an example of how innovative thinking can lead to the development of new and better products, but also of how a single product can drastically improve standards and expectations within established industries.

With HydroRope Manuli is sending a clear message to OEMs and end-users alike that they don't have to accept premature hose failure as an inevitable aspect of their day-to-day operations. With a little creative thinking and the drive to solve problems, rather than simply manage them, Manuli has introduced a new generation of products that have already begun to shake-up the industry.

More and more OEMs are beginning to adopt HydroRope for their high-tensile applications *(fig. 7)*, and it is reasonable to assume that it will soon become the standard to which every other hose for these applications is compared to.

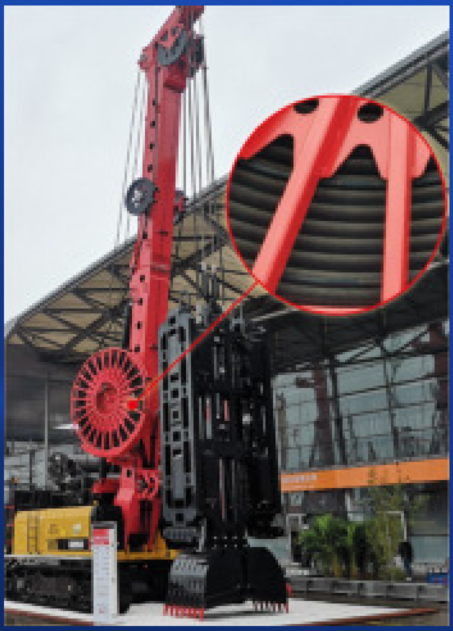

Fig. 7 – HydroRope on hydraulic grab equipment

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