Hoisting steel coils with polyethylene fibre slings that are one-eighth the weight of wire rope equivalents means faster hoisting times

Synthetic switch

Faster, safer, easier – those are three of the goals for crane operators performing heavy lifting, says JORN BOESTEN, industrial market segment manager at sling manufacturer DSM Dyneema in the Netherlands. Boesten explains how round slings made with ultra-strong polyethylene fibre are boosting performance and lowering system costs

Lifting and rigging companies are upgrading from traditional lifting slings to those made with new synthetic materials. This is due to a range of challenges, such as a shrinking labour force to do this physically demanding work, concerns about protecting crews and valuable or vulnerable items, requests to lift larger and more complex loads, and the perennial need to control costs.

At first glance, replacing steel wire rope and chain, and even conventional synthetics such as nylon and polyester, with high-performance polyethylene (HPPE) does not appear to be a radical change. In reality, however, this ultra-strong yet soft and lightweight material can have a major positive impact across the board. It can improve safety, reduce potential for damage, speed up the lifting process and require fewer workers, all of which mean a consolidated sling inventory, and increased flexibility of operations.

Traditional a burden

Steel wire and chain slings: Although wire and chain are still widely used for heavy lifting slings they have many drawbacks. First, steel wire is very heavy and chain is even heavier. Large steel slings can need a separate, small crane just to hoist them into position. In addition, because the slings add so much weight to the total load, companies typically must stock a wide range of slings so they can select the one with the precise load capacity required and no more.

In addition, steel poses a number of safety and liability issues. Carrying, attaching and manipulating these heavy slings can cause back injuries. "Fishhooks" of cut strands can cut workers' hands. Because steel wire has a rough, unyielding surface, this material can easily damage delicate objects or scratch painted and otherwise coated surfaces, leading to claims against the crane operator. Similarly, chains can damage items being hoisted.

Other issues with steel slings include corrosion, permanent kinking (dog-leg) from being bent over sharp edges in the load, and handling problems from twists induced in the steel wire.

Polyester and polyamide slings: To mitigate steel's disadvantages, some suppliers offer polyester and polyamide (Nylon) round slings and web slings. These slings are significantly lighter than steel wire and chain. To provide sufficient strength, however, for hoisting very heavy loads, they must be made very thick and bulky. This can get to the point where these slings may become so bulky they cannot be used with standard shackles and eyes.

Although they are soft and smooth, unlike steel, the covers of polyamide and polyester slings are also surprisingly delicate. Easily torn or abraded, ➔

Lifting a ship's propeller at a Korean shipyard

the slings typically must be replaced frequently, sometimes after only a few uses.

While polyester or polyamide add less weight to the load than steel, they introduce a new challenge: elongation. The core material in these slings stretches significantly under load, causing difficulty in achieving exact placement of the load. Elongation can also cause the sling to slip along the load's surface when the lift commences, which can abrade the sling cover and possibly damage the item being hoisted.

HPPE for diverse challenges

The migration from steel and conventional synthetics to high performance polyethylene in lifting slings is gaining momentum. Dyneema, manufactured by DSM Dyneema, is a leading HPPE widely used in fibre for rope and netting – and now, heavy lifting slings.

HPPE offers many advantages over steel wire and conventional synthetics for heavy lifting operations.

HPPE solves the problem of delivering enough strength to hoist the heaviest loads without increasing the weight and mass of the sling to an unacceptable level. An HPPE fibre sling weighs one-seventh as much as a steel wire-based sling of similar diameter. In comparison with polyester, an HPPE sling is about 75% of the diameter and less than half the weight.

Benefits to crane operators include the ability to lift heavier net loads, fewer crew members are needed to handle the sling and, sometimes, even the flexibility to transport a sling in a car instead of requiring a truck.

Low elongation

Minimising elongation of the sling is important for precise lifting, manoeuvring and placement of the load – and for safety. While steel chain and wire slings do not stretch, they have many other drawbacks. The ideal sling combines low elongation with light weight and high strength. Dyneema HPPE fibre offers very low elongation, plus weight and strength advantages as described above.

The working life of a sling can be affected by many environmental and usage factors: abrasion, bending fatigue, tension fatigue and degradation from exposure to sunlight, chemicals or sea water. Slings made with HPPE exhibit excellent resistance to these wear factors. The material is not affected by salt, and is resistant to most chemicals and UV light. It has superior tension fatigue performance, surpassing polyester, nylon and steel wire rope by several degrees of magnitude.

The lighter weight and smooth surface of HPPE slings help protect crews from hand or back injury. These slings are easier to handle than steel wire slings, they do not pose a risk of cuts from frayed wires and they minimise scratching the load surface. Abrasion and other load damage that can occur with steel chain or wire slings is also avoided.

Compelling for cost reduction

With all these benefits, one might wonder why the heavy lifting industry has not made a wholesale conversion to polyethylene slings. For an insight, it is interesting to look at the ship mooring industry, which is much further along in the adoption of this engineered material. About 15 years ago, only steel wire and low-performance synthetics were used for mooring lines. Initial acceptance of lines made with HPPE fibre was slow, as the initial cost of these ropes is higher than steel wire or polyester lines. Since then, however, the industry has seen how the lifetime costs of a mooring system can be significantly reduced using HPPE – primarily as jobs can be done faster and lines last longer. Mooring lines made with Dyneema fibre are now the standard on, for example, new LNG (Liquefied Natural Gas) tankers.

Like mooring ropes, low-weight HPPE slings can dramatically reduce the overall cost of heavy lifting operations, more than offsetting their initial purchase price. The following are key areas in which crane operators can achieve cost savings.

- **Faster operations:** Lifts can be completed faster and more precisely because HPPE slings are easier to attach and manoeuvre, and are less prone to stretching and slipping than conventional slings. The soft, flexible slings form tightly around sharp curves and unusual shapes, unlike stiff steel wire. It is less bulky than other synthetics, allowing the use of small attachment points.

  Recently 90 stainless steel coils were unloaded at Dundalk marine terminal (port of Baltimore USA) using HPPE slings, manufactured by Slingmax Inc., saving 1.5 hours versus braided chain slings.

- **Fewer crew members and less equipment:** With the increasing difficulty of

A 350 tonne steel truss lifted using multiple high performance slings at Dulles International Airport in the US

finding workers for physical labour such as lifting operations, streamlining crew numbers becomes more important. Replacing steel wire or chain slings with HPPE slings can reduce the number of workers needed for rigging. A steel sling, for example, that requires three people to handle it might require only two with a sling from Dyneema fibre.

In addition, these lightweight, compact slings can be rigged by hand instead of having to bring in an additional crane to hoist them and they can be transported in a car instead of needing a truck.

- **Lower risk of injury and damage:** Another area of cost reduction is insurance payments. With a lower likelihood of worker injury and damage to the load, operators can reduce liability and workers' compensation insurance rates.

For the installation of offshore wind farms in the Irish Sea, international marine contractor Mammoet Van Oord used heavy lifting slings made with Dyneema polyethylene fibre. The special round slings, manufactured by the Unitex Group, are designed for loads up to several hundreds of tonnes.

Lighter weight makes handling the slings easier, especially in rough seas, and helps prevent back injuries that are caused most frequently by manoeuvring the heavier steel wire slings. In addition, wire carries a high risk of worker injury because loose threads can act like fishhooks and inflict serious cuts to hands and arms.

Sling safety steer

New guidance issued by the Occupational Safety and Health Administration (OSHA) in the US is designed to help employers select and use the appropriate slings when handling and moving materials.

"OSHA's current general industry standard is more than 30 years old. This guidance document will aid users in the safe selection and use of slings, including synthetic round slings, which are not covered in OSHA's standard, as well as the newer grades of materials being used in alloy steel chain and wire rope slings," explains Edwin Foulke, OSHA assistant secretary of labour.

Improper selection or use of slings can result in sling failure or load slippage, added OSHA, which, in turn can lead to injuries or death. Indeed, OSHA accident data for 1994 to 1996 shows that there were four fatalities in general industry involving the misuse or failure of slings.

- The document *Guidance on Safe Sling Use*, is available at: www.osha.gov/dsg/guidance/slings/sources.html

- **Smaller sling inventory:** Slings made with HPPE fibre help cut inventory in two ways. Steel wire and chain slings add so much weight to the load that riggers need to use a sling with the exact work load for the particular job – resulting in a large inventory, for example, comprising 5, 10, 20, 30 and 40 tonne slings. In contrast, a 40 tonne HPPE sling could easily be used to hoist loads of 15 tonnes, while still retaining weight and handling advantages. So, a company might only need to stock a few slings, for example, 10 tonnes and 40 tonnes, to cover all their lifting needs.

Machinefabriek Amersfoort, a worldwide specialist in machining, heavy milling and turning of large metal parts, has begun using Dyneema fibre lifting slings. The fibre's strength-to-weight ratio allowed the company to replace multiple polyester slings with fewer, lighter weight slings, simplifying part handling and reducing storage.

Future trends

Another potential application for HPPE fibre in heavy lifting is replacing steel wire running rigging for cranes to increase the net load capacity of a crane. Crane hoisting lines could potentially be replaced by (non-rotating) braided rope made from Dyneema, saving more than 80% of the weight of the line.

This would pay off quickly with tall tower cranes constructing the high-rise buildings in Asia and the Middle East where the weight of the steel wire hoisting line starts decreasing the net payload of the crane when these reach a few hundred metres high. Replacing steel wire with rope made from Dyneema could more than double the payload on the taller cranes. ■