DSM Dyneema

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Use of synthetic ropes and ropes with Dyneema® on drum winches

Introduction

In fig 1 a drum winch is depicted. A drum winch consists of a barrel with flanges at each side and a drive system.

Drum winches are also referred to as single-drum or "load drum" winches.
The natural opposite to a "load-drum" handling high line pulls is a "storage drum" as with traction winch systems which handle relatively low line pulls.

Big advantage of a drum winch is the limited space needed to store large lengths of rope.

The remarks and recommendations given in this document can be used as general guidelines and are based on experiences gained in a variety of projects with drum winches and ropes with Dyneema® in the past.
The information can be used in discussions with end-users, rope manufacturers and winch designers.

Key to success of using ropes with Dyneema® is a combination of winch design, a suitable rope design and proper handling and operation.

Points of attention for the use of drum winches are:

- **Cross-over points**

At cross-over points the cable or rope will be subjected to a bend diameter equal to that of the actual cable or rope diameter, resulting in possible damage to the rope.

- **"Burying" or "Diving" into underlying layers of rope**

In addition, under extremely high tension, the cable may also pull down with a force great enough to penetrate into underlying layers on the winch drum.
This will happen sooner when the rope is spooled onto the drum with low tension and the unwinding is done with high tension.
Although synthetic ropes are more sensitive to this problem also steel wire ropes face this problem. With synthetic ropes the buried rope can be loosened again without damaging the rope. With steel wire rope burying can result in the need to discard the rope due to structural deformation.

In the rest of this document we will refer to the definition “burying”.

- **Capacity loss of the winch**

With increasing number of layers the capacity of a drum winch drive will be reduced due to increasing torque (longer arm from center of barrel to layer of rope.

- **Spooling**

Fig .. Drum winch with flat cylindrical barrel.
Notice that this drum has a spooling device mounted (front left) which also helps improving spooling.

To guide the steel wire ropes better and improve life time a helical groove was developed. This helical groove has the problem that the rope at the flanges may bury more easily. As a rule of thumb ropes can be spooled up to maximum 8 layers.

A helical groove has a constant helix around the drum barrel. It is much like a screw thread. This type of groove provides a positive path for the cable to lay in and keeps it in place while the loading operation is taking place. Since the cable is laying in a groove, the scrubbing is kept to a minimum. Higher fleet angles are possible with a helical groove because the groove will tend to hold the cable in place. Also since it is a continuous groove, there is no harmonic motion induced into the cable. The groove will support the cable and help to keep it from flattening out due to high cable loads. The helical sleeve can be mounted to a flat barrel by either welding in place or bolting through the drum core. (Make sure for synthetic ropes that bolts etc are covered to prevent abrasion, cutting etc.!).

Drum winch with helical grooved barrel.

In case of multilayer winding it may require the special LeBus grooves. LeBus developed and patented (meanwhile expired) a worldwide used groove which is parallel to the flanges but with every half turn of the barrel (180°) switches to the right side by half a rope diameter. The LeBus System cuts down the cross winding to approximately 20% of the circumference of the drum while 80% of the wraps are parallel with the flanges. In view of this pattern, each layer of wire rope then becomes the groove pattern for each succeeding layer.
The LeBus groove makes it possible to spool up to 20-25 layers.

Sleeve with LeBus groove ready to be mounted on drum barrel. In the yellow area a half rope diameter shift can be seen. On top one can see that the groove runs parallel to the flange.

Take Care! In case sleeves with grooves are mounted onto flat barrels make sure that the bolts are worked away into a clean surface (welding, rubber stops etc) in order to not damage the rope.

SPECIFICS FOR SYNTHETIC ROPES / ROPE WITH DYNEEMA® ON DRUM WINCHES.

Below some recommendations are given bases on experiences achieved in several projects with drum winches and ropes with Dyneema® in the past.
Most advises like e.g. fleet angles etc. are determined in practice and might need further in-depth research to link e.g. rope design to these parameters. However the indications given here could be used (without any liability) as a starting point for discussions with designers and users of these winches.

- **Fleet angle**

The lower the fleet angle the better, however sometimes it is unavoidable to use fleet angles. Roughly we can advise the same fleet angles as for steel wire ropes with a maximum up to 1.5°.

- **Nr of layers**

It was already mentioned that one could use the rule of thumb of 1, 2-3 and 20-30 for flat, helical and Lebus grooved barrels respectively. This has however to be tested under practical circumstances for the concept under study (incl. rope design, line pull levels, fleet angles etc).

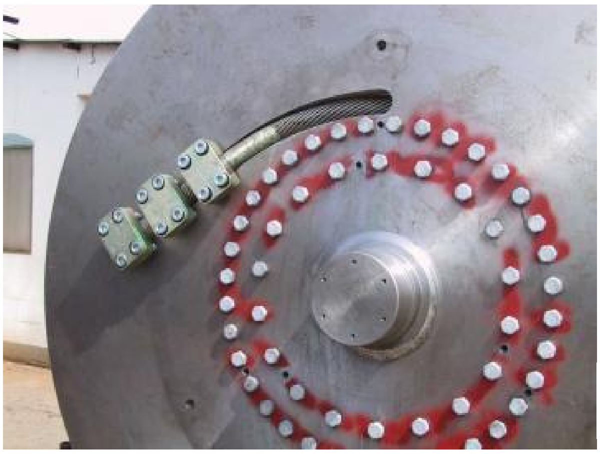
- **Installing of synthetic rope.**

  - Tension during installation.

New ropes need to be spooled onto the drum with high tension to reduce the risk of burying during unwinding under tension (with load).
The same tensions as advised for steel wire ropes can be used: 10% of MBL. However synthetic ropes have more constructional elongation (introduced during rope manufacturing) and should be respooled a few times to take out this constructional elongation. Ideal would be some 5 spooling exercises at as high as possible tensions (e.g. 20-25% MBL). In practice this may be problematic due to the high payloads to be used. In case of towing tugs they connect the rope to a bollard, go out and return back to the bollard via the tow rope spooling onto the winch under sufficient line pull.

  - End connections.

Installing will show to be far easier than with steel wire ropes. Important is to make sure that the end connection of most winches is developed for steel wire ropes.



Bolted end connection on outer side of the flange developed for steel wire ropes. Not ideal for synthetic ropes!

Mostly clamping systems are used which will not work for synthetic ropes (the diameter of synthetic ropes will reduce under load and slip out of these clamps. Our experience is that ropes with Dyneema® will slip out at approximately 25% MBL).
To overcome this problem make sure that there will also be preferably 8 minimal 6 wraps on the barrel to build down tension getting to this end connection. These are also called “dead wraps”, so not in use.

- **Drum capacity.**

Calculating drum capacity for steel wire ropes can be done fairly easily due to the rigid form of these ropes.
Most synthetic ropes are softer and will fill up the free space between the ropes and layers. (Some people see this as an advantage since it may reduce burying).
Due to this phenomenon more length of rope will be stored on a drum when compared to steel wire rope. Even with heat set ropes on 8 layers some 10-30% more length can be stored.

- **Tensions during operations.**

Higher line pulls during operation will have an effect on rope performance. High line pulls may cause higher stresses on cross-over points, cause sliding of rope-on-rope or against flanges resulting in increased abrasion and eventually structural deformation of the rope (structure).
Again it is of utmost importance to have enough tension on the rope during rewinding onto the spool. Comparable to steel wire rope at least 10% of MBL should be used.