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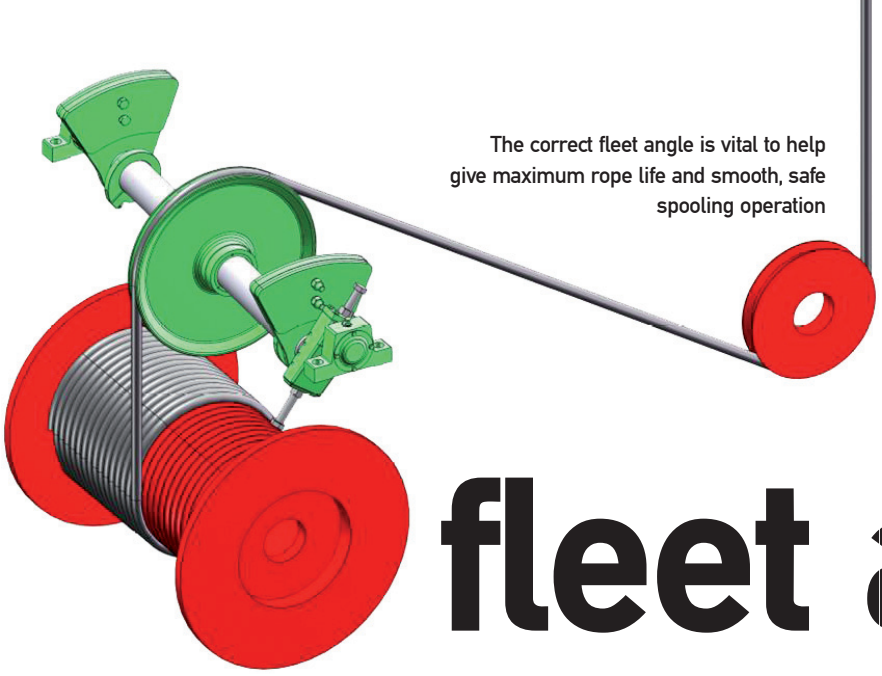
CHINA ■ TRAINING AND CERTIFICATION ■ RENTAL SURVEY ■ WIRE ROPE



The correct fleet angle is vital to help give maximum rope life and smooth, safe spooling operation

Fixing fleet angles

You may know the importance of fleet angles, but do you know the best ways to correct them?

CRIS SEIDENATHER, managing director of Lebus International Engineers, explains how

When spooling wire rope onto a drum, it is necessary for the rope to come onto the drum at a very slight angle, just enough to encourage each wrap to sit tidily next to the previous wrap, and for each layer to ride cleanly onto the layer beneath.

In fact, apart from the design of the drum itself, this angle – the fleet angle – is the most significant factor in the behaviour of a spooling system.

Put simply, optimum fleet angle means maximum rope life and smooth, safe spooling operations.

The fleet angle is defined as the largest angle of the rope between the first sheave and the drum flange, relative to the centre line of the drum. With all types of drum, the rope is subject to a fleet angle which directly influences its behaviour and impacts on its service life. If the fleet angle is too big, the wire will tend to pull away from the flange as the layer changes. It will want to spool towards the centre and so leave gaps. Gaps mean ragged spooling, which means (at best) excessive rope wear, or (at worst) snagging, catastrophic system failure and physical danger to all those around.

If the fleet angle is too small, the rope may not pull away from the flange soon enough. It will pile up on the flange for, perhaps, two or three wraps and then bang down with considerable force, damaging the rope and the equipment. Again, catastrophic failure and personal injury is a real threat.

The angle

Ideally, the fleet angle should be between 0.25 and 1.25 degrees. This is not an absolute rule of physics; it depends on the rope construction. Nor has it been calculated mathematically. Rather, it has been learned from years of experience. While some wire rope experts may cite slightly different numbers, this is the range that Lebus recommends, and we believe we have at least as much experience as anyone when it comes to multi-layer spooling since inventing the original Lebus counterbalanced spooling system in the 1950s.

The fleet angle can be varied by moving the first sheave closer to or further away from the drum. If the sheave is too close to the drum, the fleet angle will be greater than 1.25 degrees; if it is too far away, the fleet angle will be less than 0.25 degrees.

In general the distance between sheave and drum should be at least 20 times the width of the drum. Ideally a ratio of 23:1 works very well, we have found. Thus, the larger the drum, the further away the sheave needs to be to keep the fleet angle between 0.25 and 1.25 degrees.

It is not always possible, however, to achieve the optimum fleet angle. For example, there are massive winching systems at the top of mountain cable car systems, often housed in compact machinery sheds. There is often no space to rig a sheave the requisite distance from the drum.

For just such cases two additional

The principle of the fleet angle compensator shown in a cable car application

spooling devices are available. One is a fleet angle compensator, which is driven automatically by the rope tension. The other is a level winder that is mechanically driven. Both offer a solution to guide the cable along the drum between flanges, but each has its advantages and disadvantages.

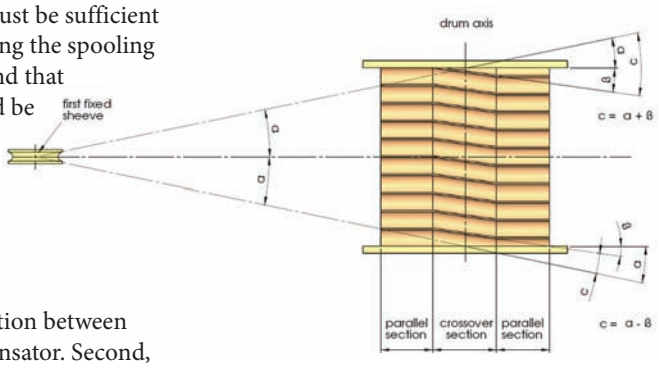
Fleet angle compensator

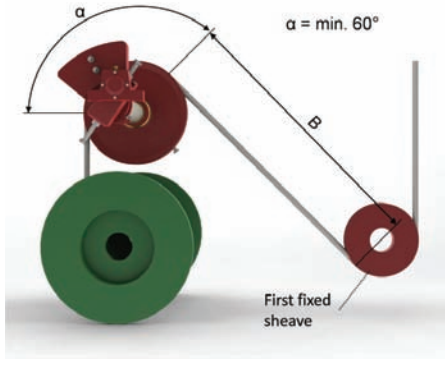
The fleet angle compensator (FAC) is driven by the movement of the wire rope as it goes through the crossover sections of the drum. As the rope winds or unwinds, the FAC shaft slowly oscillates, allowing its sheave to slide back and forth across the shaft to maintain an optimum fleet angle and guide the rope smoothly onto the drum.

Certain operating conditions are necessary for the Lebus fleet angle compensator to function properly. The rope must go from the drum over the compensator sheave with a minimum contact angle of 60 degrees to a fixed point such as a fairlead or fixed sheave. To avoid excessive angles of the rope on the sheaves, the minimum distance between the fairlead (fixed sheave) and the compensator sheave must be at least six times the drum width. If spooling in multiple layers, the drum must have Lebus-style parallel grooving. For a single layer, helical (screw thread) grooving will also work. As always, there must be sufficient tension on the cable during the spooling operation. We recommend that minimum tension should be 1-2% of the wire rope's breaking load.

There are three primary advantages of the Lebus fleet angle compensator. First, there is no mechanical connection between the drum and the compensator. Second, installation is easy and quick. And third, it is completely automatic and, after initial adjustments when the rope is first spooled onto the drum, only a minimum of maintenance is necessary.

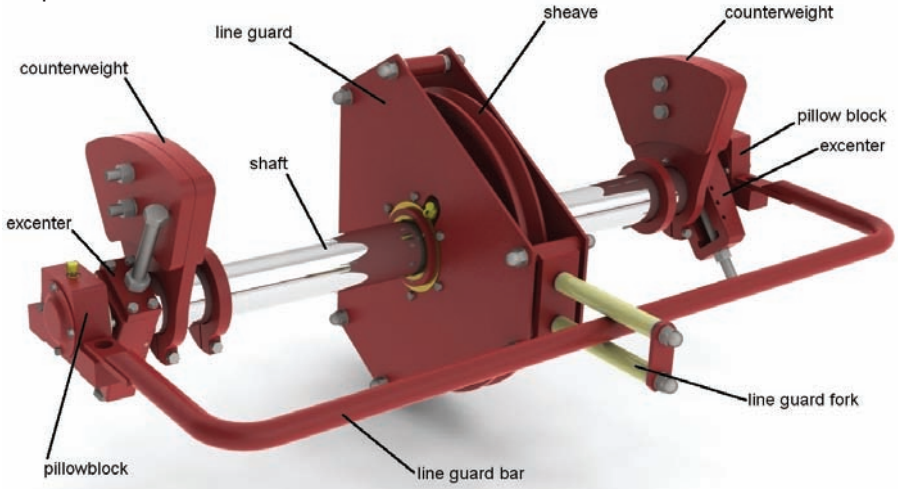
A "two dollar" solution is a kicker plate on the flange of the winch drum





Explanation of the fleet angle of wire rope winding onto or off a winch drum

Component parts of a fleet angle compensator



A level winder

Level winders can be quite sophisticated, hydraulically or electrically driven and computer controlled. But mechanical level winders also work perfectly well and have much less to go wrong. In our experience, it is generally best to keep things simple and so Lebus usually recommends the mechanical solution.

A mechanical level winder comprises

a main shaft (the lead screw) with helical screw grooving along which the rope feeder travels. The rope feeder housing includes two vertical roller bars and one horizontal roller or, alternatively, a wire rope sheave. The lateral movement of the housing is generated by a chain drive sprocket ratio between drum and lead screw, as shown in the image. The automatic level winder fitted is designed and engineered to be compatible with the grooving on the drum. Perfect, controlled spooling is guaranteed regardless of the number of layers and slight changes in wire rope size.

The level winder unit – also sometimes called level wind pay-on gear – must be installed in front of the drum in line with the first fixed sheave when using the vertical rollers to guide the wire rope.

Alternatively, a sheave can be integrated and installed within the housing frame. In this case, the system can be set up anywhere around the drum.

The level winder is engineered to be compatible with the parallel grooving on the drum. It is adjusted for the specific rope diameter, and the gear ratio is fixed (using a standard sprocket-chain connection) to match the ratio between coils of wire on the drum to the pitches on the lead screw. The result is perfect and controlled spooling, regardless of the number of layers or slight changes in wire rope size.

As before, certain operating conditions are required for the level winder to function properly. The rope must go from the drum through the vertical rollers or the level-wind sheave to a fixed point such as a fairlead or fixed sheave. To avoid excessive angles of the rope on the sheaves, the minimum distance to the fairlead or fixed sheave must be at least seven times the drum width. There must be a minimum tension of 1 to 2% of the wire rope's breaking load when spooling more than one layer.

The advantages of level winders are that they keep the rope spooling properly even if there is slack in the line. As with the fleet angle compensator, once it is set up no more adjustment is necessary and very little maintenance is required. In case of damage to a mechanical level winder, parts are easy to replace and there is nothing electrical or hydraulic to worry about.

Oceanographic installations that spool rope up to 46 layers have demonstrated that level winders give synchronised and totally controlled spooling in the very harshest, most testing conditions.

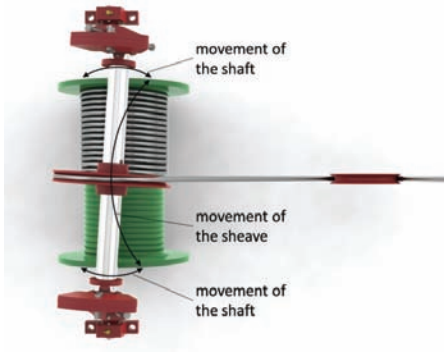
The disadvantages of level winders is that they do require a little more space than fleet angle compensators and they are sensitive to high axial forces and shock loads.

The $2 solution

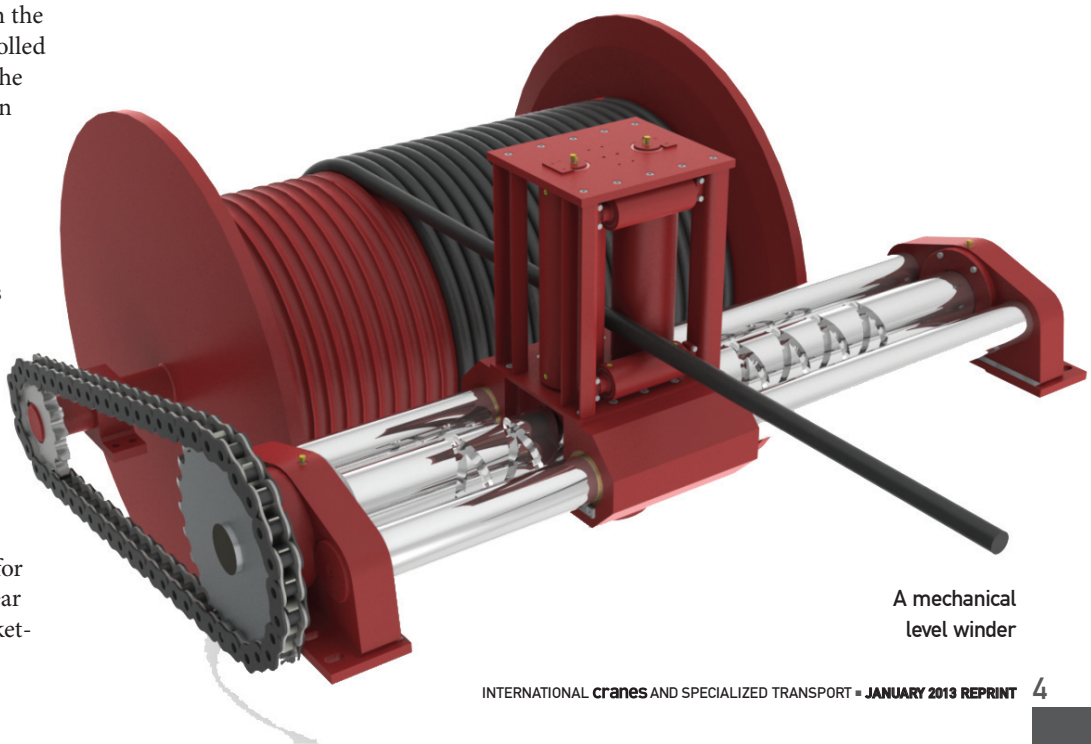
If the fleet angle is just a bit too small, there is a really rather simple solution. A flat iron plate, which we call a kicker plate, is welded or bolted onto a specific point on the flange of the winch drum. This kicker costs no more than two dollars. Since the Lebus parallel grooving pattern on the drum controls the movement and spacing of the wire rope between the flanges, and from layer to layer, it is easy to identify the location on the drum circumference where the rope must return (kick back) from the flange to regain the proper position to assure proper spooling for each repeated layer.

This is where the kicker is placed. Once installed near the centre line of the groove crossover sections, the rope is given a kick after each complete wrap to take its proper position on the patterned drum.

A final option for adjusting the fleet angle, if it is not possible to move the fixed sheave, is simply to reduce the width between the flanges. The parallel grooving of the drum will continue to act effectively to provide smooth multi-layer spooling with a narrower drum, even if – as is likely – the number of layers on the drum needs to increase as a consequence of narrowing the width. ■



Plan view of a fleet angle compensator in operation



A mechanical level winder