Limiting maximum loading in hydrometric cableways

Many sites built in the last 20 years have no design records to allow their capacity to be checked. A survey of such sites can produce an assessment of the visible installation but it is difficult to determine the adequacy of foundations and anchor blocks.

Examination of a large number of sites over the past six years has also revealed a wide variation in the rigour of the design and in some cases, a complete lack of understanding of the requirements. Often, the steel sections chosen for the supports are adequate but the base plate and holding down bolt arrangement is not. But equally, the sections chosen are sometimes too light and would fail before the main cable.

At some sites the main cable specification is excessive so that the potential maximum load on the installation is very large compared to operational loading. Even at normal working, the tension in a heavier cable is greater for the same point load. The figure below compares the tension in a 10mm and 14mm cable for the same point load at mid span.

It is often possible to make alterations to an installation that would limit maximum loading on supports and foundations while leaving a suitable factor of safety for normal working.

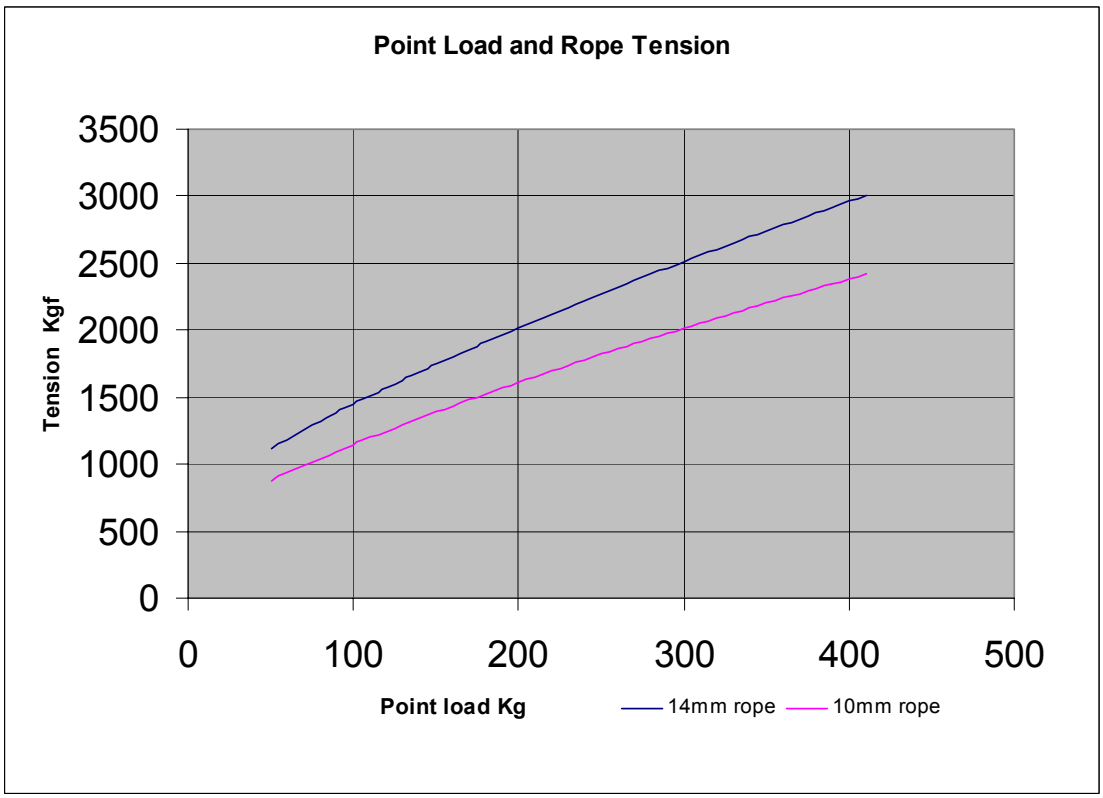
The most obvious first step is to ensure that the cables in use are optimum, that they provide adequate, but not excessive, operational capacity and durability. BS EN ISO 4375 gives guidance on this.

However, it may not be possible to comply completely without major reconstruction work. In this case other measures may be considered to allow continued safe use.

Weak Links

Weak links are often put forward as a simple means of limiting load. However, for manned installations the uncertainty associated with the sudden release of stored energy as a weak link breaks makes them unsuitable, especially if, when the main cable fails, the load bears directly onto the traversing cable and causes it to break. This cable passes through the winch in close proximity to the operator and a broken end could recoil into the winch cabin.

Careful tensioning of the cables is also required as a small amount of over-tensioning can dramatically reduce the point load required to cause the weak link to fail. Similarly, a weak



link installed to limit the maximum load transferred by an over-specified main cable will fail with a lower point load on the cable than with a smaller cable in similar circumstances. The additional elongation of the smaller cable under tension produces a greater sag for a given point load. This gives rise to a lower tension in the smaller cable compared with the larger cable for the same point load. This is shown in the graph above. With a weak link calibrated to fail at 2t in a 100m span set up to operated with a 2% sag, the installation with the 14mm rope will fail with a point load of 200kg against 310 kg for the 10mm rope. Not insignificant.

A weak link should not be used instead of reducing the main cable to an appropriate size.

An alternative to introducing a weak link is the use of a mechanical load limiter which will release a reserve of cable at a controlled and preset tension, or allow controlled slippage in the traversing system to control overloading of the sounding cable. These facilities can usually be retro-fitted to existing installations.

Main cable load limiter

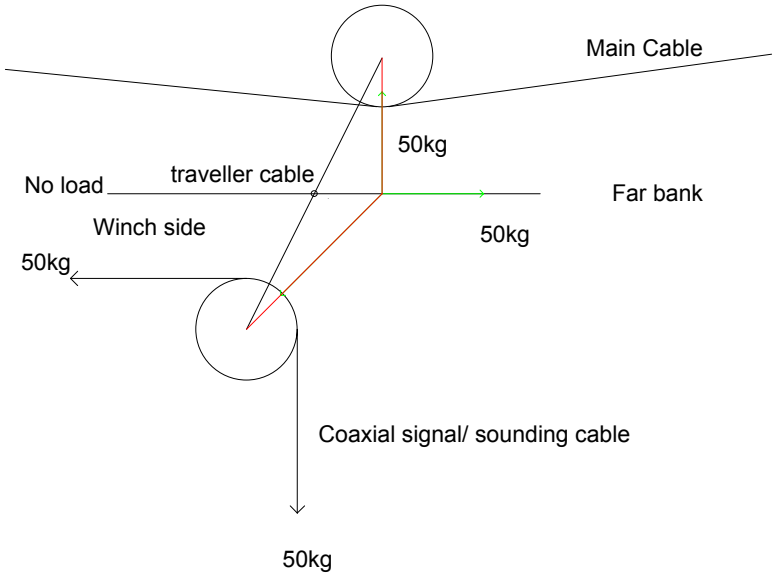
Installing a load limiter that allows spooled cable to be paid out under overload conditions allows the sag to increase under the influence of the excessive point load. This allows the geometry of the cable way to change so that the limited tension can support an increasing load. If the point load continues to increase the cable is eventually released.

For example, with a cable reserve of 1.5m and a 100m span, the sag may be increased from 3.94m at the point where the load limiter begins to operate, to 9.5m at the point of release. So, while the load limiter may be set to operate with a point load of 250kg (5 x 50kg), it requires an increase in the point load to 670kg to extend the cable to the release point while limiting the load on the supports. The figures quoted are based on a cableway with a span of 100m of 10mm wire rope, set up to operate with a sag of 2% of the span with a 50kg sinker. With smaller spans the point load required to release the cable is greater, for the same load on the supports.

An example of such a device is shown above. An additional advantage is that it is not sensitive to initial tension. If the main cable is initially set too tight the load limiter will slip, if necessary, to restore an appropriate tension without releasing the cable.

Load limiter on traversing cable

The tension in the sounding cable is balanced by the traversing cable which goes to the far bank and returns around the far bank pulley and back to the winch. It is then wrapped round the winch drive pulley and is lead out and attached to the traveller. As it grips the winch drive



Normally the initial tension in the traversing cable would be greater than the maximum suspended load to ensure traction is maintained on the winch drive pulley.

Balance of forces on a traveller with 50kg sinker and initial tension in traveller cable of 50kg

pulley, a torque is applied to this pulley in proportion to the tension in the traversing cable caused by the load on the sounding cable. A load limiter may be incorporated in this pulley to allow it to slip at a preset tension in the sounding cable. The figure above shows the action of the forces at the traveller. If it is not practicable to add a load limiter to the winch, it is possible to incorporate it into the traveller.

Load Limiting Traveller

The force on the traveller is at all times equal and opposite to the force applied by the sounding cable on the bottom pulley of the traveller. Normally the traversing cable is terminated on the traveller or the traveller draw bar. However, it is possible to attach the traveller to the traversing cable so that it slips at a predetermined load.

Under the action of the sounding cable, the traveller will be forced towards the bank housing the winch. It can be set to slip at twice the maximum sinker weight. The load transferred to the main cable is limited to a point load equal to twice the maximum sinker weight.