"Haggie Hints"

by George Delorme
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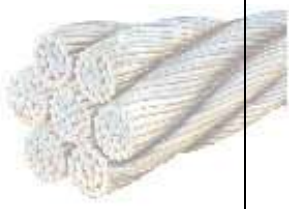

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Koepe Balance Ropes – the care and maintenance of the conventional wire rope designs.

DISCUSSION:

Balance ropes, sometimes referred to as "tail" ropes, are primarily used with a Koepe hoisting system to counterbalance the weight of the hoist ropes. The number of tail ropes may vary but the objective is to come close to matching the total weight of the hoist ropes in order not to exceed the normal recommended maximum T1/T2 ratio of 1.5:1.

While flat rubber coated tail ropes are in use, this bulletin does not cover this type of product.

Although only ropes with non-spin characteristics should be used as tail rope, we nevertheless, strongly recommend the use of swivels at both ends. Without free moving swivels, the loop at the shaft bottom will want to rotate and potentially cause entanglement.

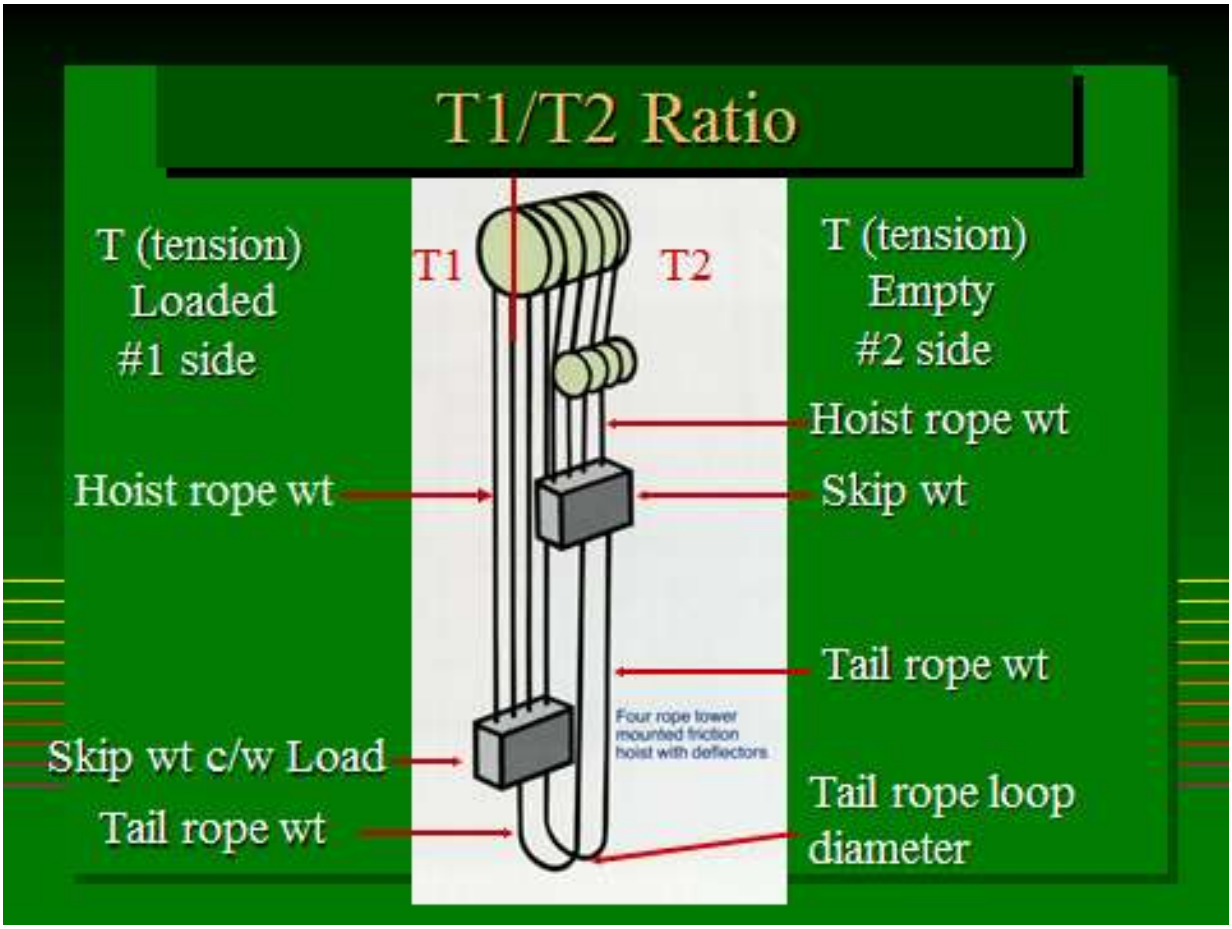

Fig. 1

By taking the various constructions into consideration and knowing the total rope weight required, the actual number and diameter of the tail ropes is generally selected to produce the desired loop diameter at the shaft bottom.

In the hoisting system design stages, it is natural to prefer a fewer number of tail ropes than hoist ropes. The thought being that there will be less maintenance and it will be easier to control the loop but there are many mines operating with the same number and have no problem at all with loop control and overall rope performance.

In fact, there are a couple of advantages in having an equal number of tail and hoist ropes:-

- Less impact on the resulting T1/T2 ratio if a rope was to fail.
- A greater number will result in smaller diameter ropes which are not only easier to handle in lowering underground, but may form a slight "V" loop which is much more desirable than a "bulge" – less movement and better fatigue life (less bending stress).

The following figure gives the approximate loop to rope diameter ratio that the various constructions of rope will offer.

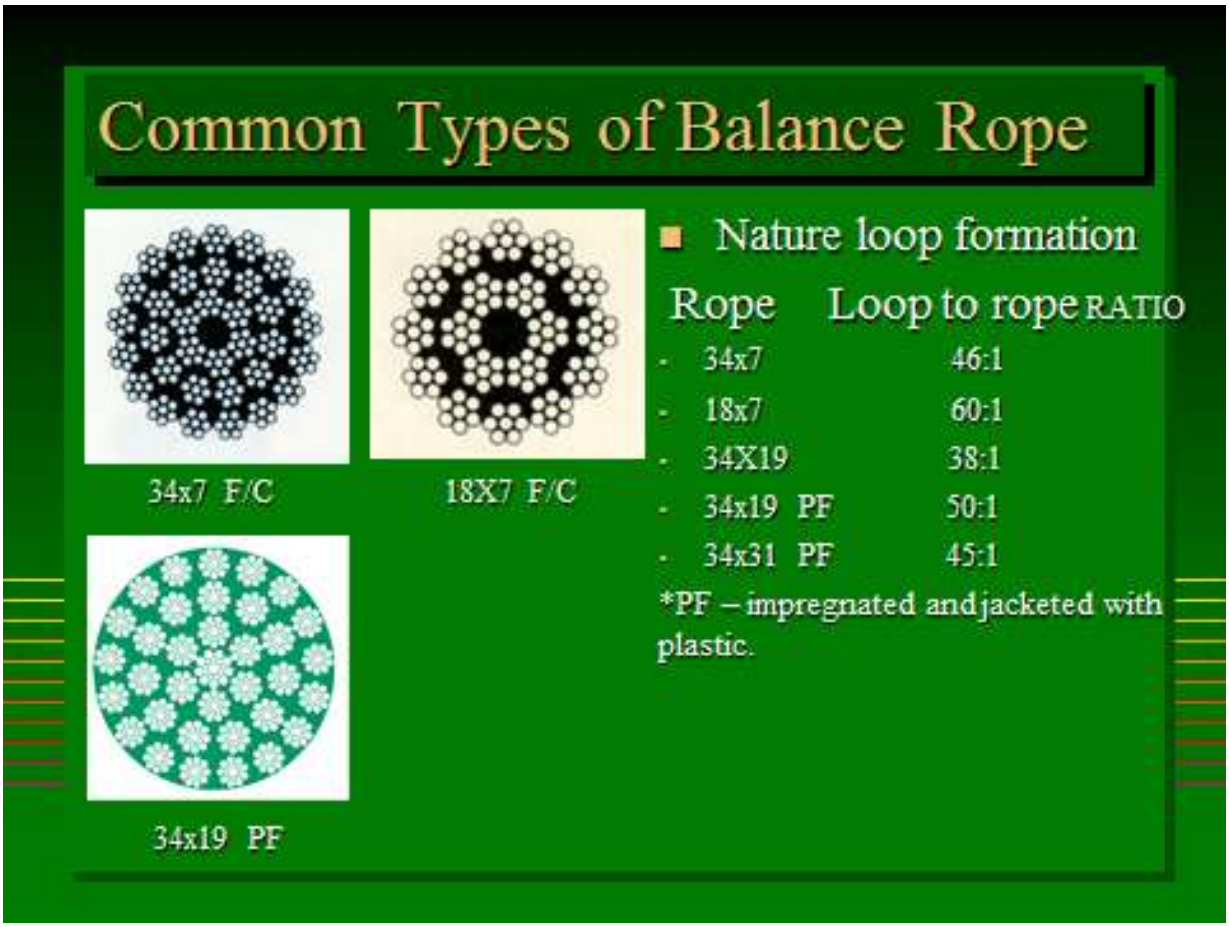

Fig. 2

As previously mentioned, only non-spin type of ropes should be used for balance ropes however, as we know, severe inter-strand contact between the layers of these ropes can lead to wire "cross-cutting" and potentially high losses in overall rope strength. Unfortunately, most EM testing equipment has difficulty in correlating the loss of Metallic area (LMA) to the actual loss in strength. Using a simple analogy, if a steel bar was to be cut in half with a hack saw, the LMA would be insignificant but the loss in strength would be 50%.

In the 1960's, when the experience with tail ropes was limited, the removal criterion in most jurisdictions in Canada was 25% loss of strength as shown by EM testing. Over a period of 5 years or so, there were several complete tail rope failures and as a result, many Provinces reduce the removal point to 15%. After several more failures, most Regulators reduced the removal criteria to the current 10%.

Throughout this timeframe, the industry knew that the ropes were failing a short distance below the conveyance when it was at surface i.e. when the maximum amount of rope weight was suspended, but despite extensive testing, we could not find a significant loss of strength on either side of the failed section to account for the catastrophe. It was not until we tested the exact location below the other conveyance did we find the weakness. After many examinations and destructive tests, it was determined that there are two short sections of rope below each conveyance that are most susceptible. These are exactly where the loop starts to form when that conveyance is in the lowest normal position. See Fig. 3

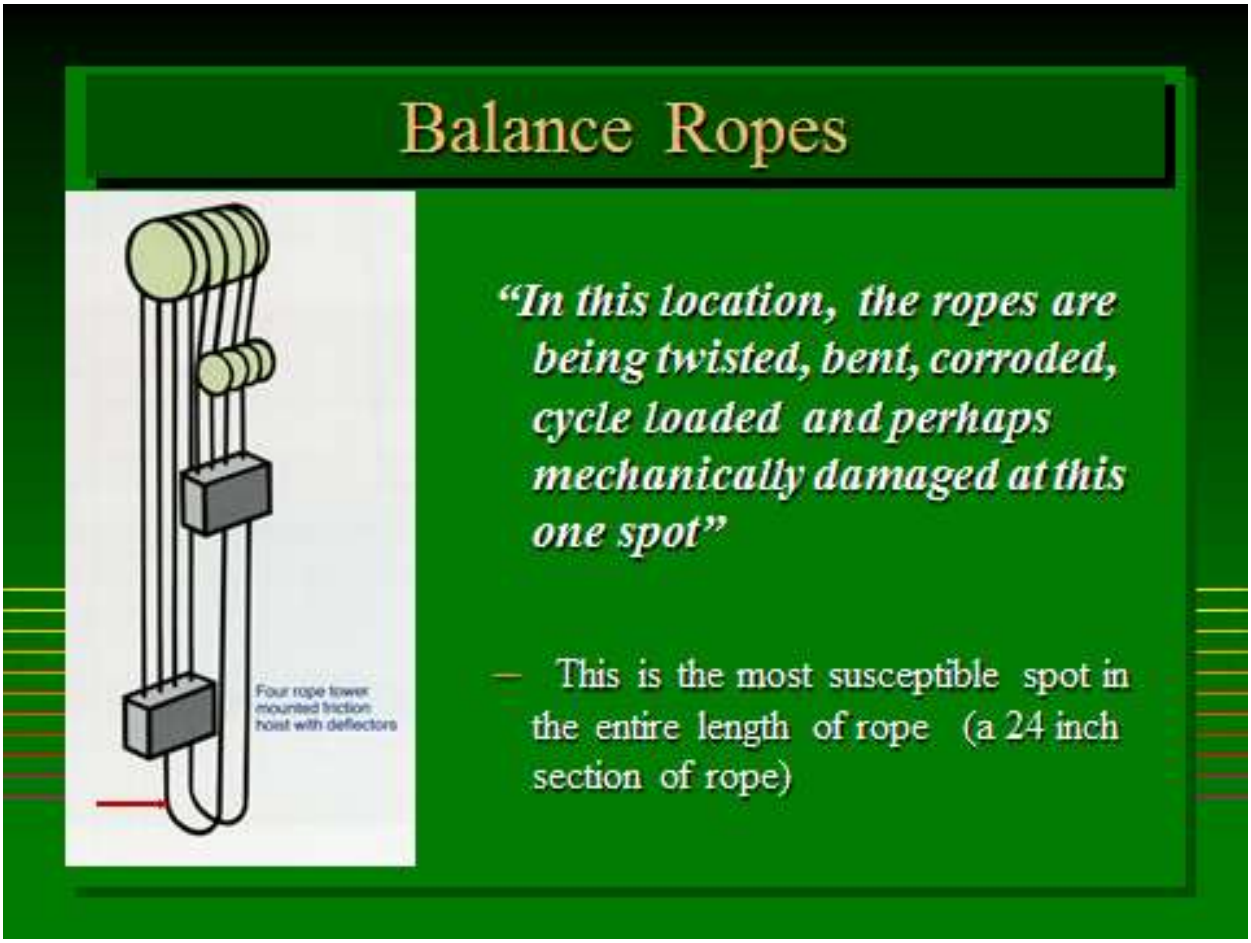

Fig. 3

While it was felt that the removal criterion set at 10% should help prevent more failures, there was still some concern about the possibility of a rapid change in the rope's internal condition because of the different shaft corrosive conditions and maintenance practices. It was in this period of time that several rope manufactures started to investigate the use of plastic impregnation to minimize the effects of the serious cross-cutting between strands. Fig. 4 shows some examples of the effects of cross-cutting.

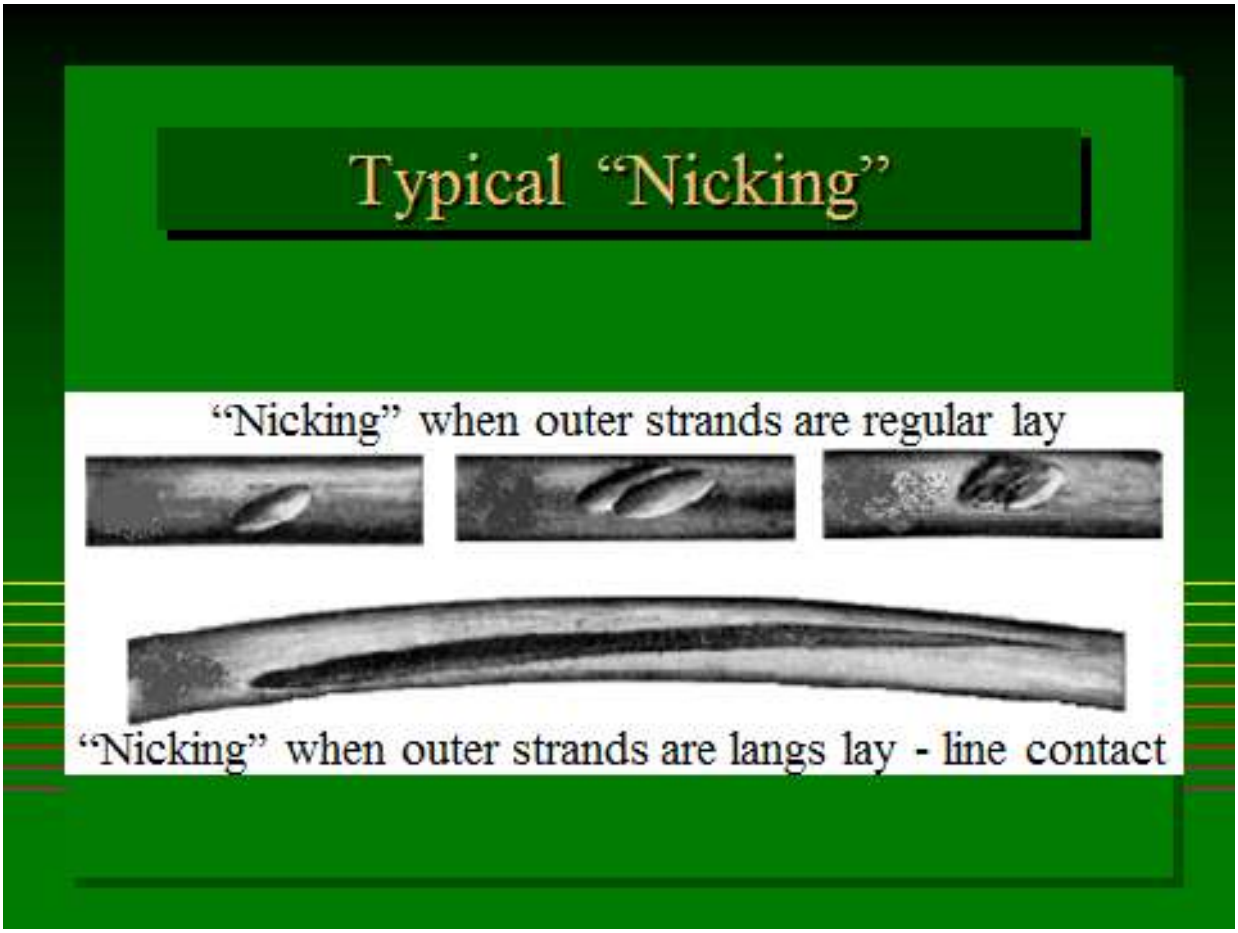

Fig. 4

Plastic impregnated and jacketed tail ropes from various suppliers have been in service since the mid 80's and none have failed with one exception for which there was a unique situation.

Fig. 5 shows the minimal amount of cross-cutting within such a rope after it had been in service for 2-1/2 years working in a corrosive environment. It should be noted that the elimination of heavy wire nicking ensures that the results of the EM testing are considerably more accurate.

Fig. 6 outlines other side benefits achieved by using plastic enhancement of the tail ropes.

Plastic Enhanced Tail Ropes

Fig. 5

Plastic Enhanced Tail Ropes

- Other than eliminating "Cross-Cutting"
  - (which leads to an accurate EM test)
- Advantages are:-
  - No lubrication required
  - Improved spin resistance
    - Less rope movement
    - Reduced torsion stress in "loop"
  - Minimal stretch
  - Will not "Stick" together if contact is made

Fig. 6

A WORD OF CAUTION:

With the current trend of upgrading production through increased payloads, Hoist ropes need to be stronger and thus heavier as do the Tail ropes. In many cases, the compartment centers are the same as in the past, but with the larger ropes, the available "loop to tail rope diameter ratio" is too small for plastic enhanced tail rope which are stiffer than conventional non-plasticized ones. One solution being offered is a more corrosion resistant type of galvanizing but with no plastic enhancement. The concern here is that the problems of the past with cross-cutting will return – it may take longer to develop but it will occur.

BALANCE ROPE ATTACHMENTS:

Tail ropes can be attached to the underside of the conveyance by using any of the most common types available. These are shown below.

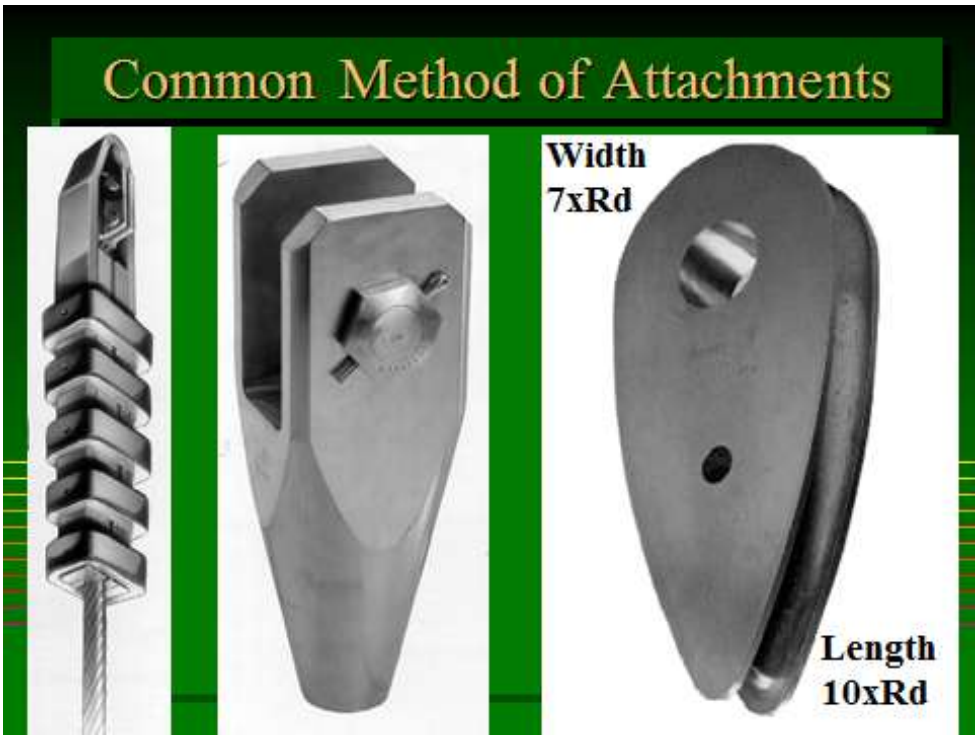

Fig. 7

In some cases, if plastic enhanced tail ropes are used, the outer cover may have to be stripped off depending on the type of attachment used. Figures 8, 9 and 10 list recommendations depending on the type of rope and attachment used.

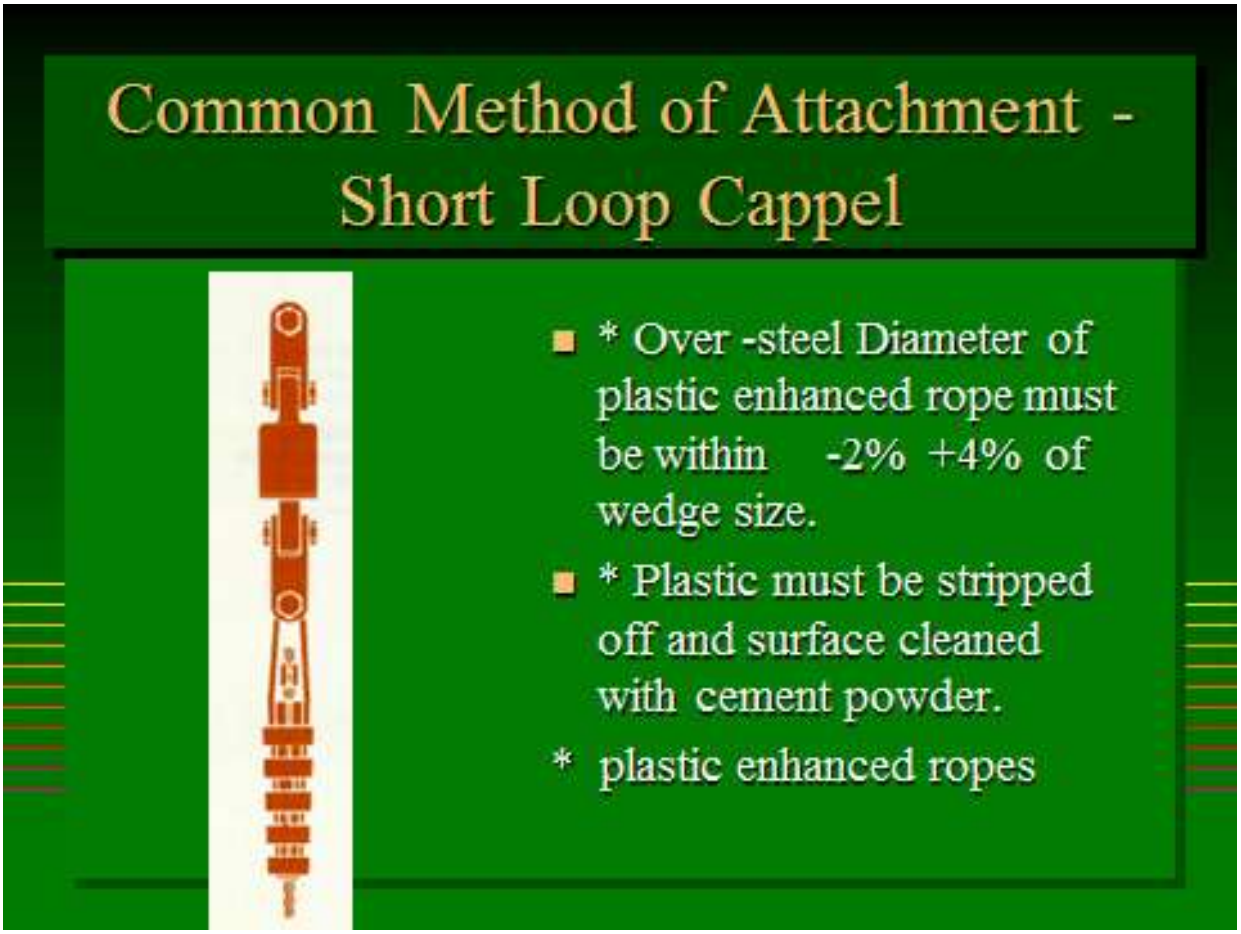

Fig. 8

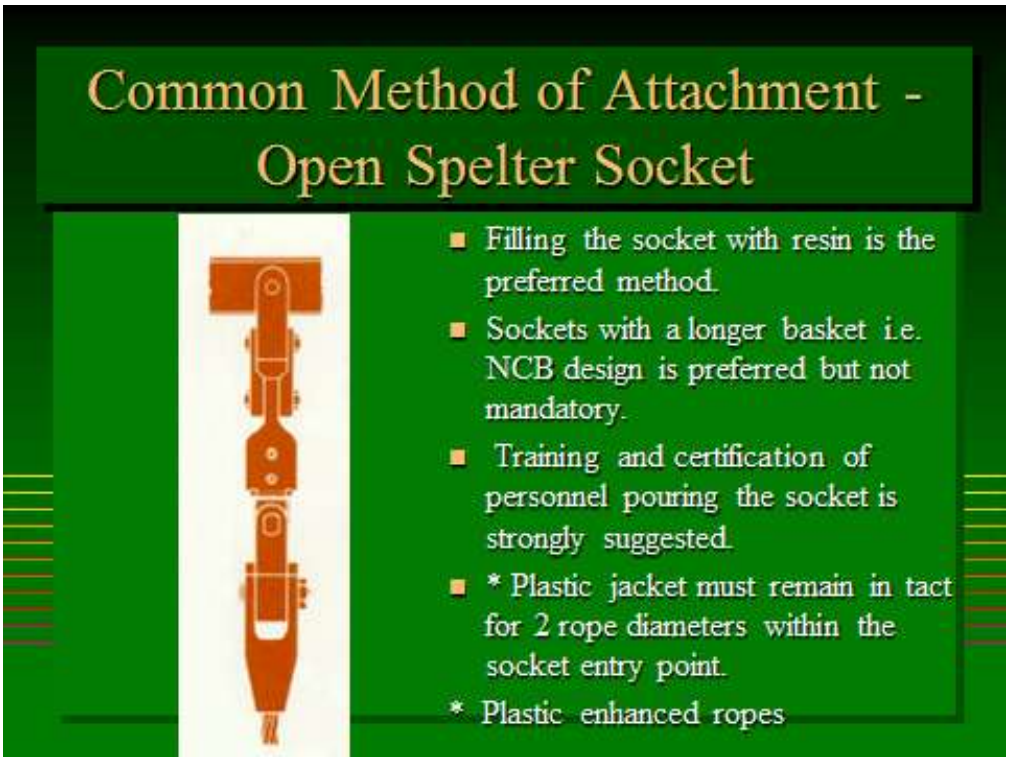
Common Method of Attachment - Open Spelter Socket
Filling the socket with resin is the preferred method.
Sockets with a longer basket i.e. NCB design is preferred but not mandatory.
Training and certification of personnel pouring the socket is strongly suggested.
* Plastic jacket must remain in tact for 2 rope diameters within the socket entry point.
* Plastic enhanced ropes

Fig. 9


Common Method of Attachment - Thimble and Clips / Clamps
* If conventional wire rope clips are used, then the plastic jacket must be stripped off for both the "live" and "dead" sections of the rope.
* Specially designed three part steel clamps may be used over the plastic jacket.
* plastic enhanced ropes

Fig. 10

MAINTENANCE ON TAIL ROPES:

Loop Dividers

The first concern is to properly control the loop during the hoisting cycle. Obviously, the correct diameter and construction of tail rope needs to be selected so that a "U" or a slight "V" loop is formed. It is natural for the loop to move towards the ascending compartment especially during acceleration but if the ropes selected form a bulge when stationary, this movement will be substantial and contact with steel work may result. If the shaft steel work is such that contact is unavoidable, then synthetic wear pads such as Teflon should be considered. Some mines have even installed low inertia, plastic coated rollers to prevent excessive wear of the tail ropes.

As a note of interest, tail rope sheaves have been used at the shaft bottom in some Countries but because of maintenance requirement and the effects of spillage, most of these systems have been replaced with free hanging tail ropes.

Assuming the tail ropes are suited for the compartment centers, well designed "rope dividers" must be installed and maintained. Many mines use timber dividers but my preference is for electrical cables such as used behind power shovels – they are easy to handle, have an abrasion resistance jacket with a soft copper center and meet the desired features shown in Fig.11.

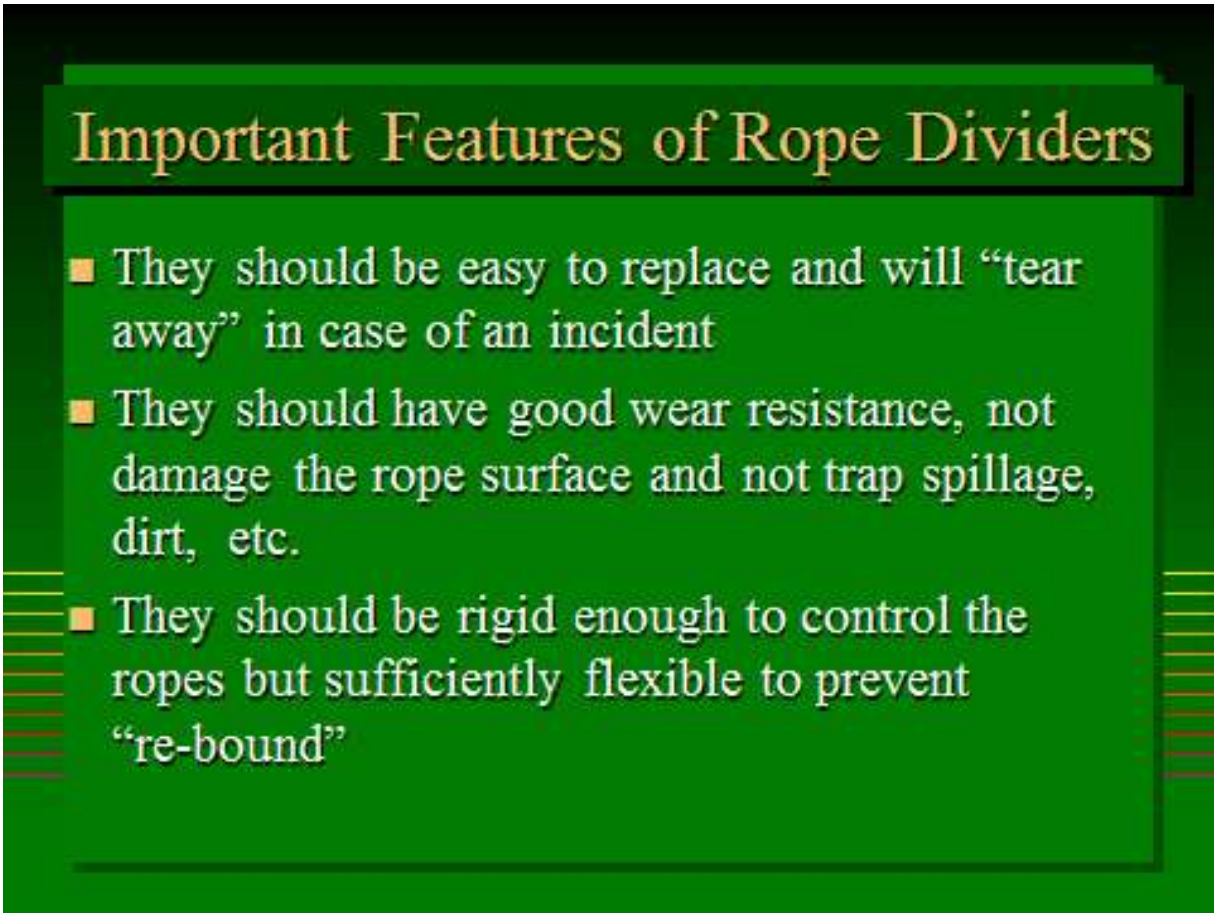

Fig.11

The location and configuration showing clearances etc. of dividers are shown in Fig. 12.

Tail Rope Repair

Slight "bends" caused by minor spillage can be repaired with a "Pipe Bender" or in the case of non-plastic enhanced ropes, with a Post-former. A true kink rarely occurs in a tail rope but if one does, it cannot be repaired and the rope must be replaced (refer to Haggie Hints # 6). Minor gouges on the jacket of a plastic enhance tail rope can be repaired with a heated plastic injector gun.

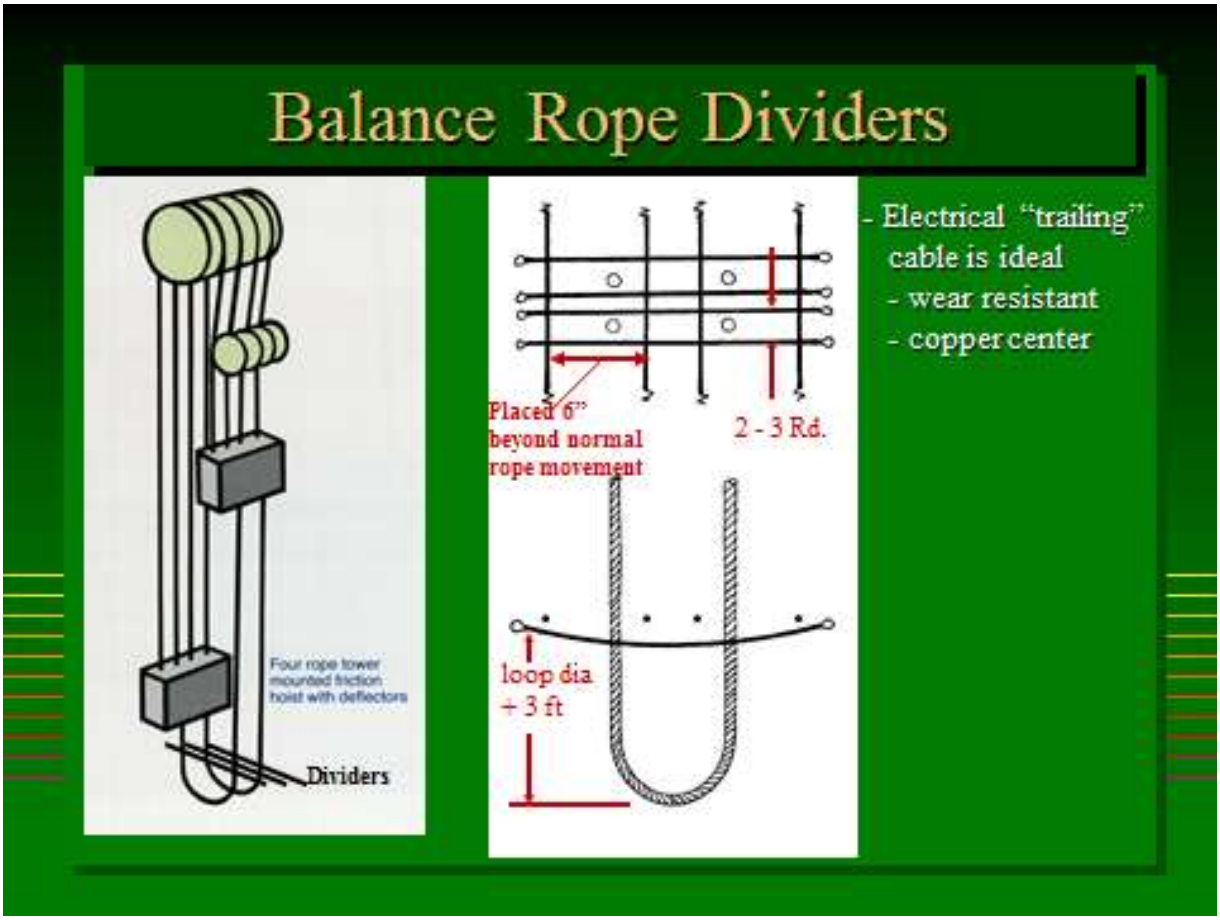

Fig.12

Swivels

As previously mentioned, swivels must be used at both ends and must rotate freely. On a regular basis, the free movement of the swivels must be checked by hand with the conveyance at the surface when the maximum load is on the swivel. They should rotate easily with no sticking or tight spots. Most good quality swivels have very effective seals to prevent the ingress of shaft water and have grease fittings for regular lubrication.

Lubrication

While plastic enhanced tail ropes need not be lubricated, conventional ropes should be treated regularly. Application with some type on injector unit is best because the aim is to lubricate the interior to help with the cross-cutting between strands. Tight wiping the surface to remove an excessive build-up of lubrication is also desirable because it is possible for tail ropes to touch one another and since they are moving at the same speed and rotating slightly, excessive lubricant may cause them to stick together. This has happened in the past when two ropes entangled themselves and as this section went through the steel work of the crash beams, sever damage to both ropes resulted.

Measuring Rope Diameters

As was previously discussed, we know where the two weakest spots are located along the tail rope length. To supplement the EM test results, I cannot over emphasize the importance and value of monitoring rope diameter loss both for hoist and tail ropes that are stranded non-spin constructions. A 5% reduction in diameter of a settled rope (please refer to Haggie Hints # 7 for details) should be a "Red Flag" and a very close inspection at that location should be performed and rope removal seriously considered. This applies to all types of stranded non-spin ropes.

Figure 13 illustrates the two critical spots to monitor. More locations can be checked but efforts should be made to always go back to the same locations.

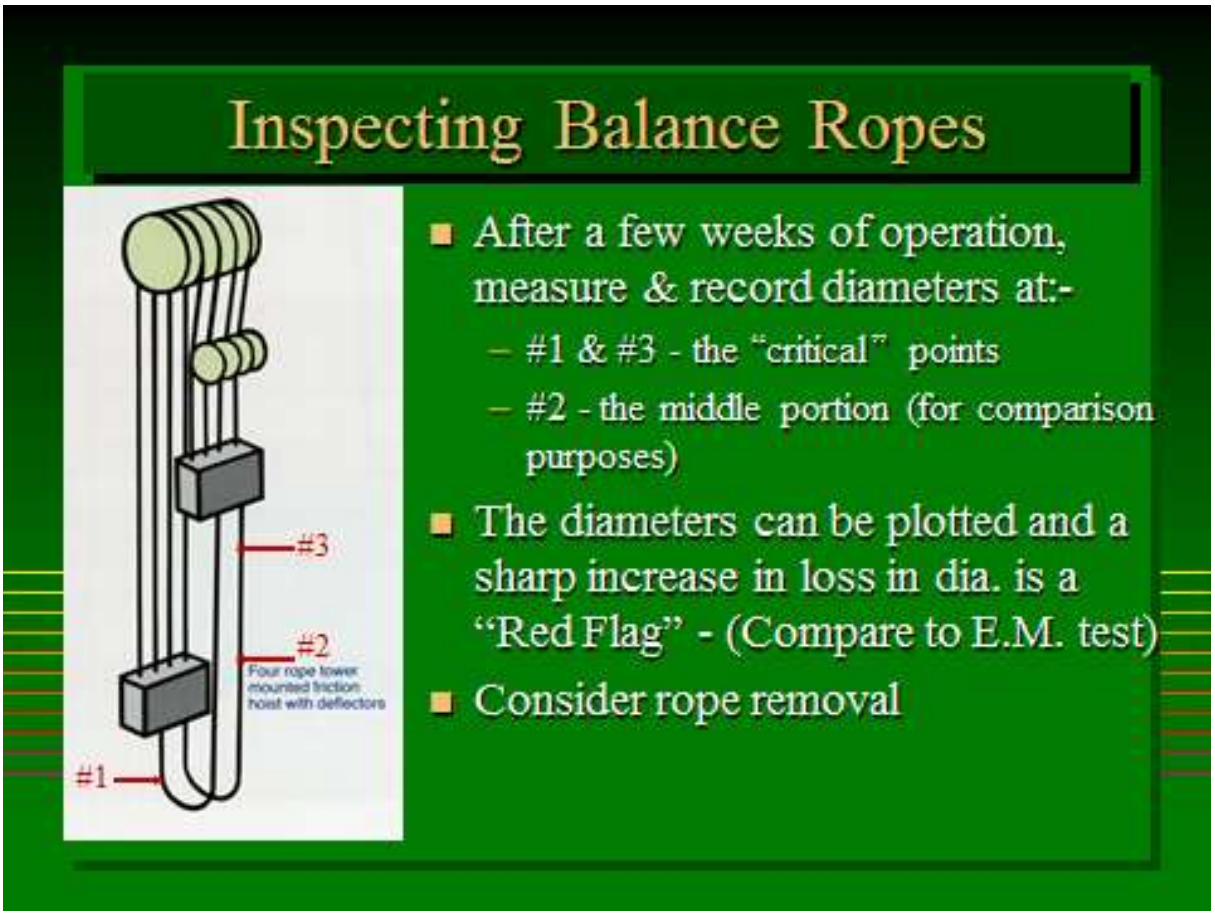

Fig. 13

SUMMARY;

Balance ropes are often over-looked as being a potential problem because they basically only carry their own weight and "go along for the ride" however as past history has shown, we have had more catastrophic failures with them than with any other type of rope on a hoisting system. They need attention and care!