Basic Causes of Cable Failure

Although it may seem like more, there are actually only four basic causes of field failures (open cut or underground) in trailing cables and drag cables. They are:

- **Mechanical Damage**
- **Exceeding Recommended Bend Radius**
- **Current Overload**
- **Excessive Tension**

Individually, or in combination, these can result in significant downtime. Awareness of symptoms, or other symptoms of problems, can aid cable users in determining the problem and how to correct it. After one of the four basic causes occurs, the cable is either immediately rendered unusable or a series of subsequent problems begins which make it appear that the cable is at fault.

■ Mechanical Damage

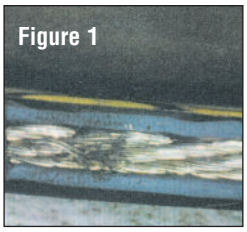


Figure 1

Obvious Condition: Outer sheath is usually torn or crushed open and has rough edges or abrasion marks leading up to the opening.

Obscure Condition: The sheath may have little or no marks on the outside, but the conductor insulation inside is ruptured – either partially or totally. If this is not a total electrical failure, it will lead to leakage current, nuisance tripping, and downtime. ***Figure 1*** shows mechanical damage that was hidden beneath a small mark on the outer sheath.

Possible Causes: Sharp rocks, roof falls, sharp edges on shuttle car reeling devices or run-over.

Corrective Action: Cable handlers, machine helpers, and other operations personnel need to be made aware of the sometimes delicate nature of soft copper stranding and the rubber materials inside the cable. Developing an appreciation for the product capabilities and limitations will go a long way toward reducing mechanical damage.

■ Exceeding Recommended Bend Radius

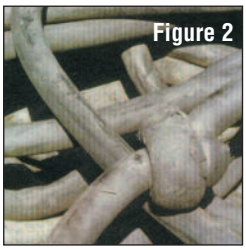


Figure 2

Mechanical damage to inner components also occurs when the cable is bent in a radius far smaller than the manufacturers' recommendations. When dragging cables, be sure to work all kinks, knots, and loops out of the run. Otherwise, the loop will become taut around the cable and end up one times the cable diameter (***Figure 2***) instead of the normal twelve- to sixteen-times the cable diameter. As a result of exceeding AmerCable's bend radius recommendations, damage to all conductors and insulation is imminent. Small diameter ropes can cut the sheath and/or squeeze the core until insulation damage occurs.

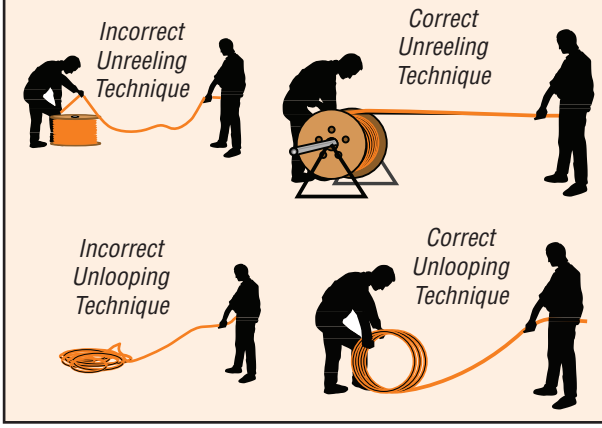
Possible Causes: Poor dragging procedures / deployment technique.

Corrective Action: Training on proper bending radius. Use of large diameter ropes or slings can reduce handling damage.

Kinks Are Avoidable

Kinks begin as loops, caused in most cases by "pulling" rope from a stationary reel and can never be satisfactorily removed. Kinks result in permanent "weak spots."

Never "pull out" a loop, always "unfold" it. To unwind rope straight without looping, "roll" the reel or coil.



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AmerCable® AUSTRALIA

■ Current Overload

Condition: Cable insulation carries a 90° Celsius rating, but sheathing compounds have no temperature rating. Sheaths are compounded for the highest mechanical strength, since this is its primary function. If power conductors are run at 90°C in free air and no greater than the rated amperage, the cable will perform for its anticipated life.

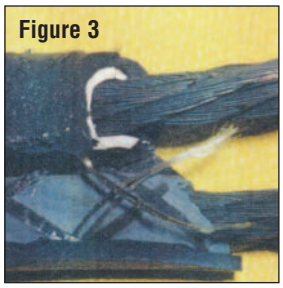
Figure 3

Problems arise when the cable is:

1) wound up on a reel without the proper derating factor applied;
2) stacked in a "pile,"
3) direct buried without increase of conductor size; or
4) run at maximum amperes and voltage drop.

In these cases, the power conductor can reach temperatures up to 200°C (392° Fahrenheit). This melts the tin coating and darkens the conductors color. The sheath vitrifies and cracks open. ***Figure 3*** shows the changes in the strand and ***Figure 4*** shows the changes in sheathing after high heat.

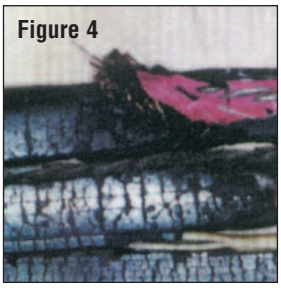
Figure 4

Possible Causes: When no longer in free air, the cable cannot dissipate heat created by the energised power conductors into the atmosphere. Heat builds up inside the cable, the conductors surpass their temperature rating, and the sheath heat-ages at a rapid rate.

Corrective Action: Always perform amperage calculations prior to ordering cable for new or rebuilt equipment. Be sure to derate for multiple layers of cable on the shuttle car reel. When upgrading the horsepower of mining equipment, a larger conductor size becomes necessary. On particularly long runs of cable, calculate voltage drop prior to ordering cable. High current at low voltage can also overheat a cable.

■ Excessive Tension

Condition: Excessive tension can manifest itself rapidly, but most of the time the damage is hidden. When cables are operated somewhat above manufacturers' limits, the flexible stranded power conductor's start a fatigue process of high wear at intimate points of contact. This is particularly true where the center bunch's outer wires intersect the six-bunch layer's inner individual wires. Under normal tension and wear, a little "dust" is the by-product. Under higher tension, "notching" occurs, as shown in ***Figure 5***. Individual wires literally abrade in two against each other. Once several wires fatigue-break, the ends continue to flex against surrounding wires and an exponential growth rate of broken wires results.

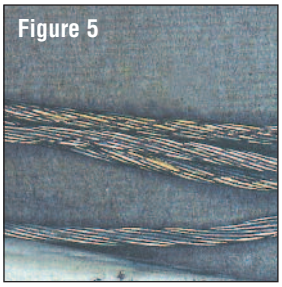
Figure 5

Possible Causes: Shuttle car reel tensioning is the single biggest cause. When the cable does not want to rise up off of wet mine floors, operators increase tension on the reel. For drag cables, expediency precipitates long lengths being dragged.

Corrective Action: Keep the shuttle car reel set so that 4.5 to 6 metres cable is suspended between the shuttle car and the mine floor during reeling and de-reeling. Keep the anchor-point back in a cut through and not in the main haulage way. This spreads the tension of the "dynamic reel reverse" over 4.5 to 6 metres of cable instead of 1 to 1.5 metres.

When dragging cable, a rule-of-thumb is to not exceed 60 metres when pulling by one rope or sling. Add extra slings and pull the cable up in loops of 60 metres.

If you want a more exact calculation to determine the maximum length of cable that should be dragged from its center-point, use this formula:

$$L = \frac{T}{f \times W \times 10}$$

L = Total Maximum Length of Cable (m)
f = 0.5 (coefficient of friction)
W = Total Weight of Cable (kg/m)