Martensite

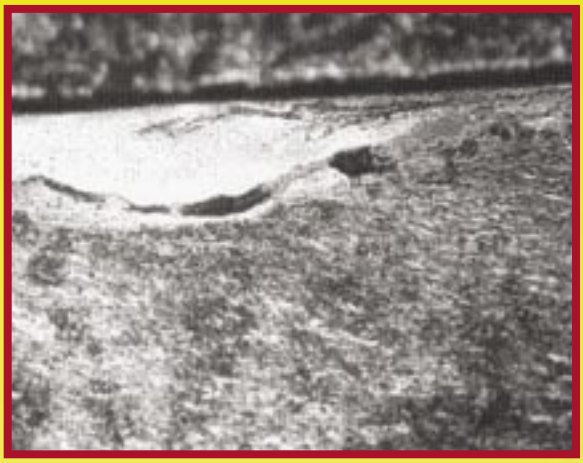

Figure 1: Photograph of the microstructure of martensitic wire. There is a heavy layer of martensite build-up, and cracks are beginning to develop.

Martensite is a brittle constituent of steel formed when the steel is heated above its critical temperature and then rapidly quenched. In wire rope, martensite occurs on the outside wire surface as a result of frictional heating on the rope surface, followed by a mass cooling effect from the cold steel beneath. Martensite is the hardest and most brittle microstructure that develops in steel and it cracks very easily.

Figure 2: Photograph of a martensitic wire. The cracks, which developed as a result of martensite, extend into the unaffected wire area (normal microstructure), leading to wire fatigue fractures.

Such cracks can propagate from the martensitic wire surface throughout the entire wire. When ropes are "burned", martensite develops and can be so severe that subsequent bending will produce complete wire fractures. This explains why some ropes appear to be in excellent condition one day and deteriorating with many wire breaks the next day.

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Figure 3: Burning the ropes

Surface martensite is a result of field conditions, particularly burning the rope. Burning occurs under several operating conditions.

- Martensite can develop if the drag rope is continually pulled through the roll at the front of the dragline.
- The roll must be pushed down to prevent the ropes from sawing through the dirt and rocks during bucket loading. When the ropes are pulled through the roll, burning is frequently observed as sparks flying from the ropes during operation. Some mines have gone to a double stepback from the cut to reduce walking time and increase digging time. However, this usually has a negative effect on rope service life because inevitably the ropes are pulled through the roll and burned.
- Sheaves (especially with large mass) may overspin, and under varying loads and speeds may cause martensite development on the outer rope wires.
- Tight sheaves and/or oversized ropes, especially under heavy loading conditions, may cause martensite on the rope wires as the rope is forced into the grooves. This action causes heavy friction and super heating of the wire surface followed by a quench cooling from the base metal.
- Hoist ropes are subject to martensite development if tight sheaves, sheave overspin, or ropes jumping out of the sheaves occurs as a result of operating conditions.
- Ropes rubbing against each other on the drums or against other objects such as the steel superstructure (missing or worn slap boards) will cause martensite.
- Frozen guide rollers or support sheaves will also cause increased heat from friction on the rope surface, producing martensite.

Once martensite is produced in a rope, there is no corrective action to reverse its effect on wire breakage. Wires will fatigue and break at a higher than normal rate, resulting in short service life for the ropes. Therefore, it is most important to avoid burning the ropes if the best rope performance is desired.

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