Hoist Ropes for Double-Drum Winders — A New Concept

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ABSTRACT

In April 2000 Mount Isa Mines installed hoist ropes of a new design on the double-drum winder at their P49 shaft. The ropes, CASAR Duroplast, were about three times as expensive as the previously used triangular strand ropes.

The P49 shaft is situated at Mount Isa Mines' George Fisher Mine, located some 30 km north of Mt Isa. This shaft used the tried and proven 6 × 33 triangular strand style ropes. The rope life attained by these ropes at the time was acceptable due to many years of satisfactory performance.

The following study indicates the improvement of service life using CASAR Duroplast rope in P 49 shaft, which depends on shaft and winder parameters of that particular shaft and cannot necessarily be generalised to other shafts.

PREVIOUSLY USED WIRE ROPE DESIGNS

Until April 2000, Mount Isa Mines had used triangular strand ropes on the P 49 shaft. These ropes had achieved an average lifetime of 17 months and 70 000 cycles, hoisting 1 862 000 tonnes in the P 49 shaft. The best lifetime achieved by triangular strand ropes corresponded to 24 months and 100 000 cycles (2 660 000 tonnes hoisted).

The reason for discarding the triangular strand ropes was due to broken wires at both the coil crossovers and the layer crossover from first to second layer. Both areas suffered about the same time. All damage was through wear and wire breaks.

THE NEW WIRE ROPE CONCEPT

CASAR Duroplast ropes are characterised by eight compacted outer strands, an independent steel wire rope core and a plastic layer between the steel core and the outer strands (see Figure 1).

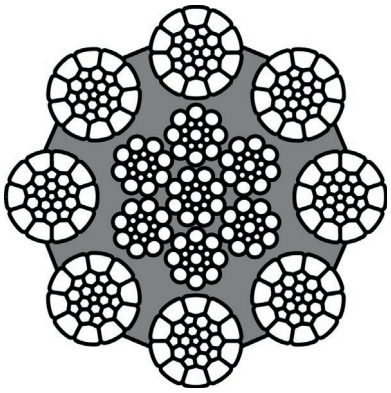

FIG 1 - CASAR Duroplast.

CASAR special wire ropes with a plastic infill have been successfully used in the crane industry for more than 30 years, and the first installation of these ropes in mining applications, both in Europe and in Australia, dates back 15 years.

The eight-strand design provides a round wire rope cross-section; the compacted Lang's lay outer strands provide superior abrasion resistance and smooth coiling on multilayer drums. The plastic infill protects the steel core from moisture and loss of lubricant. It prevents metal-to-metal contact between the steel core and the outer strands and thereby reduces the risk of internal wire breaks. Last but not least, the plastic layer increases the torsional stiffness and stabilises the wire rope geometry.

Initially, CASAR provided a service life calculation that indicated a significant improvement in wire rope fatigue life was possible. In order to facilitate a decision to change to a more expensive rope design, CASAR offered pro rata payment terms.

Mount Isa Mines ordered the first set of CASAR ropes for the P 49 shaft following discussions on the rope and shaft details with rope specialists from A Noble and Son Ltd and CASAR Drahtseilwerk Saar GmbH.

THE P 49 SHAFT

The P 49 rock winder is a double-drum winder installation located at George Fisher Mine. The most important shaft data is shown in Table 1.

Figure 2 shows the P 49 tower and Figure 3 shows the machinery hall with the drum winder.

TABLE 1

Shaft data – George Fisher Mine.

Hoisting depth	1003 m
Drum diameter	6100 mm
Sheave diameter	6100 mm
Skip weight including attachments	11129 kg
Payload	13300 kg
Hoisting speed	12 m/s
Type of coiling	parallel grooved

FIG 2 - The P 49 shaft installation: tower.

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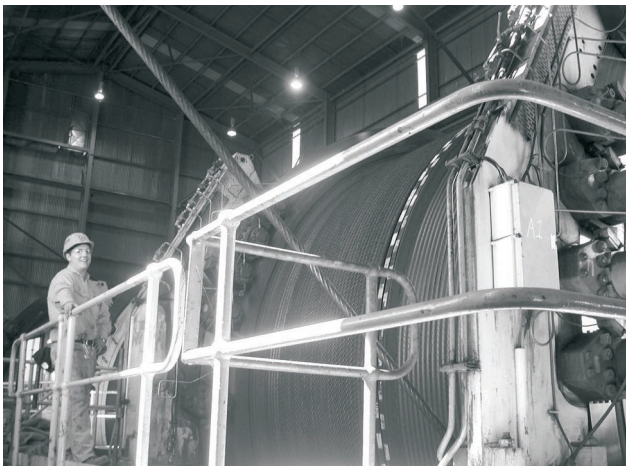

FIG 3 - The P 49 shaft installation: drum winders.

THE P 49 ROPES

In April 2000, Mount Isa Mines installed two CASAR Duroplast ropes. The specifications of that rope, as well as the triangular strand ropes used previously, are given in Table 2.

TABLE 2

CASAR Duroplast and triangular strand rope specifications.

Rope construction	CASAR Duroplast	Triangular strand 6 × 33
Nominal rope diameter	54 mm	56 mm
Rope lengths	2 × 1299 m	2 × 1299 m
Rope lay	Right-hand Lang's lay	Right-hand Lang's lay
Tensile grade	1770 N/mm²	1900 N/mm²
Finish	Galvanised	Bright
Specific rope weight	12.889 kg/m	13.32 kg/m
Minimum breaking strength	2278 kN	2257 kN
Rope factor of safety	6.125	6.07

THE ROPE PERFORMANCE

The CASAR Duroplast ropes were removed from service in March 2005; they had worked on the installation for 59 months, achieved 387 947 cycles and hoisted 10 417 472 tonnes of material. A cycle is the bank-to-bank movement of one skip.

The ropes were discarded after the projected lifetime, although NDT of the ropes and visual inspections failed to find any broken wires in the total rope length. Compared to the previously used triangular strand ropes, this represents a 5.54 times increase in hoisting cycles and a 5.59 times increase in tonnage.

The ropes stretched far less than the previously used triangular strand ropes. In addition, the rope wear at the crossovers was so much less, that the interval between two drum end crops (back-ends) could be increased step by step from 15 000 cycles to 55 000 cycles. This reduced the maintenance costs and the downtime of the installation significantly.

COST-BENEFIT-RELATION

A set of two triangular strand ropes costs about $A100 000. A set of two CASAR Duroplast ropes costs in the order of $A312 000 – a 312 per cent cost difference (see Figure 4).

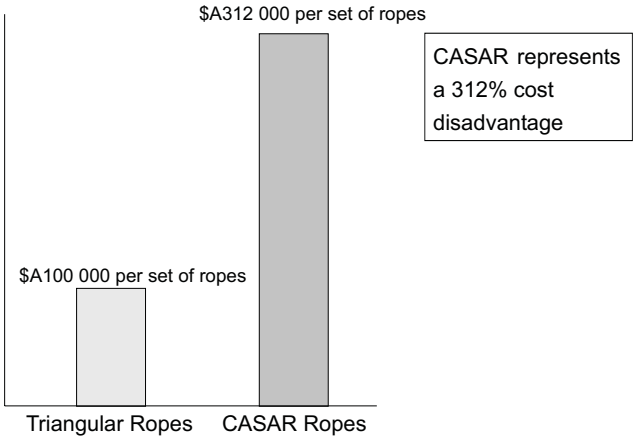

FIG 4 - Comparison of purchase prices.

The cycles of the triangular strand ropes averaged approximately 70 000 cycles. The following calculations are based on an assumed life of 90 000 cycles. Mount Isa Mines were offered a warranty of 250 000 cycles, just under three times the current rope life. The costs based on rope cost only for this number of cycles was now about even (see Figure 5).

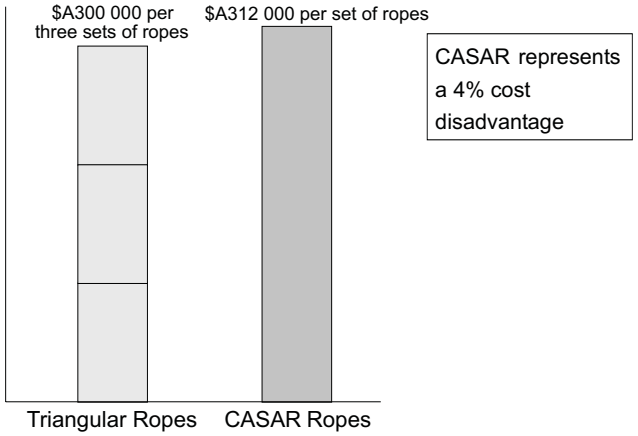

FIG 5 - Comparison of purchase prices for lifecycle equivalent.

With the projections of a three times rope life advantage by using a CASAR rope, the benefit of avoiding two additional rope changes needs to be brought into the equation. Mount Isa Mines provided information on the P 49 shaft installation, its past rope performance, type of eventual failure and maintenance costs. To convince Mount Isa Mines to use this special wire rope a lifecycle cost argument was necessary – the purchase price would not in itself be conducive to placing an order. Due to the higher capital cost of the CASAR ropes, the real cost structure of the triangular strand ropes needed to be established. The installation cost, including estimated cost of production downtime, is $A916 000. The cost-benefit-relation for the warranted rope life of 250 000 cycles is given in Figure 6.

On the triangular strand ropes, drum end crops were undertaken every 15 000 cycles to move the turn crossovers. The objective set initially for the Duroplast ropes was 30 000 cycles, thereby reducing drum end cropping by half. Including the costs for drum end crops, this puts the CASAR rope into a more favourable cost position (Figure 7).

An overall cost saving estimate over the actual life of the ropes is shown in Figure 8. The values used in calculations are based on what Nobles believe were the costs incurred. These figures are not the official Mount Isa Mines costs. The savings are

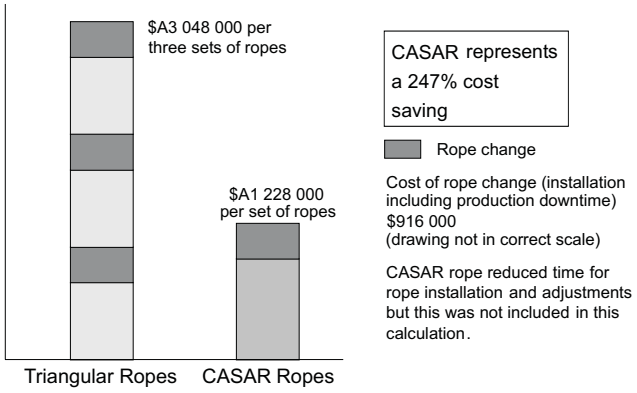

FIG 6 - Comparison of capital cost for lifecycle equivalent plus rope changes between triangular ropes and CASAR warranty.

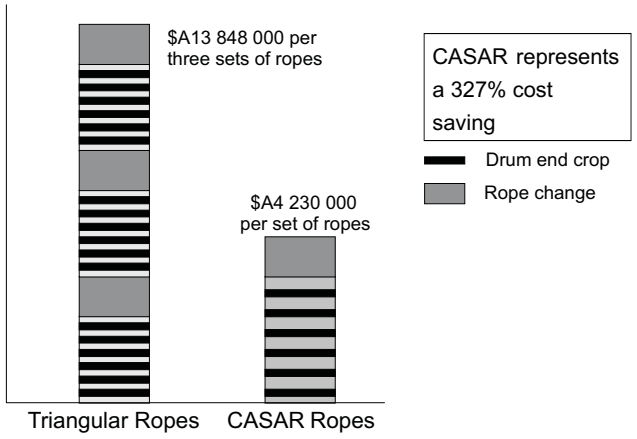

FIG 7 - Comparison of capital cost for lifecycle equivalent plus rope changes plus drum end crops between Triangular ropes and CASAR warranty.

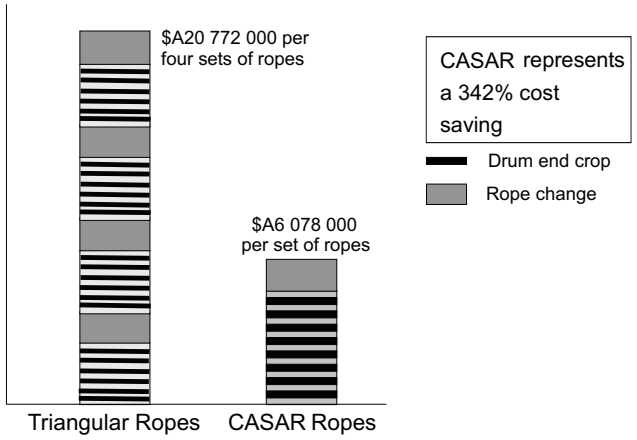

FIG 8 - Comparison of capital cost for lifecycle equivalent plus rope changes plus drum end crops between triangular ropes and actual CASAR rope life.

immense overall, irrespective of what labour rate is chosen. This demonstrates that the CASAR product will save money overall despite its upfront cost, ie value for money.

The estimated cost per tonne hauled was reduced from $A1.98 to $A0.58 and the cost per cycle from $A53.54 to $A15.67. In total, Mount Isa Mines has saved the cost of three triangular strand ropes, three rope installations and 16 drum end crops. Including the costs of production downtime, Mount Isa Mines has saved approximately $A14.7 M (8.52 million euros) using the more expensive special wire rope.

COLLABORATION ON ROPE MAINTENACE

The above success would not have been possible without forming a close relationship with mine staff and being able to access mine records. Based on information gleaned from old records, a new maintenance regime for these new ropes was introduced. Procedures were changed when needed, arising from the continued review of rope performance. Many adjustments over the life of the ropes were made. These were based on the observations of the rope performance. A partnership was formed between the three parties – CASAR, Nobles and Mount Isa Mines. Nobles acted as the provider of data and regularly serviced the mine. Advice and views were freely discussed with all parties. To obtain the maximum rope life all parties needed to contribute, including the rope handling crews and other rope monitoring personnel. This was done very effectively and contributed to the success story.

The first rope crop was carried out at 26 000 cycles, almost double the standard. The second was done after a further 45 000 cycles and the third at 63 000 cycles as the boundaries were pushed even further, but the rope began to develop stress fractures at the crossovers. Due to the partnership, this was detected very early, so no rope structural damage occurred. It was decided from then on to crop at 50 000 cycles, a figure known to be safe. This was over three times the previous crop periods and produced a large cost saving due to less downtime. To coincide with this, the capel crops were moved to coincide with the drum crops saving even more downtime. The ropes proved much easier to handle in both drum and capel cropping, with no spin being detected. The test samples were easier to prepare. This has reduced the time for the crops by some four hours.

NDT was carried out every 25 000 to 30 000 cycles, thereby monitoring the rope for deterioration in all areas, including at the drum. It was determined that two critical areas could lead to rapid deterioration if not monitored closely. These were the acceleration area over the head sheave tangent and at the coil crossovers (also whilst under acceleration) and in some places on the rope both these zones coincided. The NDT of the ropes established the critical length to examine. After discussion it was decided to do much longer capel crops every 150 000 cycles. This was done and the damaged rope, when moved away from this area, remained the same over the remaining life. New areas were presented to accept the forces until they too were suffering. Three of these crops were undertaken. The balance of the rope showed no signs of reduced integrity.

THE FUTURE

In close cooperation with the experts from A Noble and Son Ltd and CASAR Drahtseilwerk Saar GmbH, Mount Isa Mines will modify the crop procedures in order to attempt to achieve a rope life of 500 000 cycles, increasing the average service life by a factor of 7.1 and producing additional savings.

A second set of ropes is now in service, installed on 15 March 2005. They should have completed approximately 40 000 cycles by the time of this publication. The data obtained from the first set has been analysed and a new maintenance procedure for set number two has been implemented. The target for this set of ropes will be 435 000 cycles, with the aim to eventually move to 500 000 cycles, possibly with a slightly different rope configuration.

The NDT has now been set at different cycle levels for separate sections so that areas can be monitored based on the last rope findings, allowing decisions to be implemented if necessary.

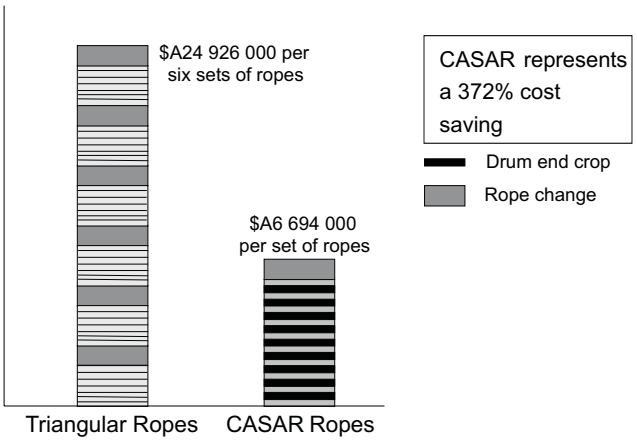

FIG 9 - Comparison of capital cost for lifecycle equivalent plus rope changes plus drum end crops between triangular ropes and expected CASAR rope life (indicated future opportunities).

This will monitor the heaviest working areas within the rope more often, but will not test the full rope each time. The sheave tangent points will now be moved every 55 000 cycles using smaller crops. This is also now the new benchmark for rope crops, a ten per cent increase over set number one. Other programs within the maintenance schedule will continue as normal.

The authors claim that a rope life of 435 000 cycles will provide the longest life of any rope on a double-drum winder in Australia by over five per cent, exceeding the previous level of 417 000 cycles set by a CASAR Turboplast Rope at WMC Roxby Downs Whenan Shaft.

Should 500 000 cycles be achieved, the overall cost savings will be enormous. The projected savings are indicated in Figure 9. The success is measured by the overall cost benefits, ie value for money, and to this end all parties are extremely pleased with the outcome.

ACKNOWLEDGEMENTS

A Noble and Son and CASAR acknowledge the role played by Tony Ross of Mount Isa Mines in deciding to install CASAR Duroplast ropes at the George Fisher P 49 shaft.