Lessons from the pillar wrapping monitoring programme at New Afton

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Abstract

Pillar wrapping refers to a ground support system that uses rope or cable slings. It is commonly used to support the drawpoint pillars in the extraction level of block cave mines. An instrumentation study was conducted at New Afton mine to quantitatively assess the field performance of pillar wrapping used in the B3 extraction level. Instrumented cable slings were installed at two drawpoints to capture the behaviour of the support system through cave initiation and early stages of propagation. Key factors that influence the performance of cable slings during early stages of the caving process were determined through the analysis and interpretation of the field data. A series of practical recommendations have been provided for designing and implementing cable slings.

Keywords

Cave mining, extraction level, pillar wrapping, instrumented cable slings

Introduction

In block caving operations, a major challenge is ensuring that the extraction level remains serviceable throughout the life of the cave block. Consequently, ground support systems need to be selected and designed to ensure their long-term performance for the working life of the extraction level. This requires careful consideration of the evolving stress conditions induced from cave initiation through to maturity—conditions that are often complex and difficult to predict. To address these challenges, yielding ground support systems that incorporate deep anchorage and robust lateral restraint are advantageous, as they can accommodate substantial stress changes and large ground deformations.

Pillar wrapping, which uses rope or cable slings to strengthen pillars where production drives and drawpoints meet, is considered an effective ground support method for difficult extraction level conditions. This method enhances confinement and helps preserve the self-supporting capacity of the pillars. Empirical observations indicate that cable slings, due to their superior elongation capacity, outperform conventional reinforcement elements in controlling large deformations. However, their installation is relatively labour-intensive and costly compared to conventional support systems. There is consequently a need to justify the use of pillar wrapping by quantifying the added value to an operation. A template for an improved decision process has been provided by Stacey and Hadjigeorgiou (2022) through the quantified value created process (QVP). In this context the use of pillar wrapping may result in short-term value destruction (labour-intensive, higher costs) but the medium- and long-term value can be substantial, thus, justifying their use.

This paper presents the results of a comprehensive instrumentation programme conducted at the New Afton mine to monitor the performance of cable slings during the early stages of cave development. Building on an initial instrumentation trial, a broader monitoring initiative was implemented at the B3 extraction level at New Afton, enabling a quantitative assessment of the pillar wrapping system. The findings inform a set of practical recommendations aimed at optimising the use and effectiveness of cable slings in block cave environments.

History of pillar wrapping using cable slings

Cable slings for pillar support were introduced to the cave mining industry in the 1970s by D.H. Laubscher, who first tested the concept at the Shabanie asbestos mine in Zimbabwe. When introduced, 70-tonne Koepp ropes were successfully used to stabilise areas on the verge of collapse (Laubscher, 2000). It was recognised that controlling, rather than preventing, deformation in the rock mass was a more effective philosophy for ground support design.

Since then, pillar wrapping with cable slings has been trialed and implemented at several block cave mines to manage large deformation although their use is not well documented in the technical literature. In the 1990s, refinements to installation methods and performance were documented at the Cassiar mine in British Columbia (Jakubec, 1992). Yanagimura and Hadjigeorgiou (2022) summarised the results of a benchmarking study noting pillar wrapping applications at Finsch, Argyle, Palabora, Northparkes, New Afton, El Teniente, and Oyu Tolgoi mines. Key insights into the design and performance of pillar wrapping systems, drawn from these applications, are summarised in the following.

Application:

Cable slings are most used to support drawpoint corners, particularly the bullnose pillar. They can also be applied to the excavation back where large deformations are anticipated.

Support mechanism:

Across various sites, a consensus has emerged that cable sling pillar wrapping provides high support resistance and yielding capacity, allowing the rock mass to relax without collapsing. The confinement effect of the cable slings helps retain the self-supporting capability of the pillar by preserving the internal cohesion and friction of the rock mass surrounding the pillar core. However, to date, the performance of cable slings has primarily been supported by anecdotal evidence rather than quantitative measurements.

Installation methods:

The standard installation technique involves connecting and tensioning the cables using connector blocks and grips, with one tail end anchored in the rock mass, as per Figure 1. This method allows precise tensioning, typically in the range of 5 to 8 tonnes, using a cablebolt tensioner to remove slack while avoiding overstressing the cables. Maintaining appropriate tension is critical for providing lateral restraint during pillar relaxation. An alternative technique, Figure 2, uses friction rock stabilisers (split sets) to drive cable slings directly into the rock mass. While effective in rehabilitation scenarios, such as at the Cassiar mine, this method does not allow for direct tension measurement during installation, which limits control. Consequently, it is less widely employed.

Cable restraint:

Cable slings are secured to the excavation surface using either short reinforcement elements (e.g., resin rebar bolts) or long reinforcement (e.g., cablebolts), typically equipped with guide washer plates. These fixtures hold the cable slings tightly against the rock surface while allowing relative movement beneath the plates.

Timing of installation:

Pillar wrapping may be installed as part of the initial ground support during development of production drives and drawpoints or later for rehabilitation of damaged pillars. However, its effectiveness is generally reduced when applied post-failure, as the rock mass has already entered a post-peak state. In such cases, excessive loading can result in failure at the connector blocks or, in some instances, cable breakage.

Interaction with shotcrete:

Application of shotcrete over the cable slings can cause point loading or seizure of connector blocks as deformation occurs, potentially leading to premature failure of the support system. To mitigate these effects, some mine sites use protective pipe covers over exposed cable segments or apply grease to connector blocks prior to shotcrete application.

Site overview

The instrumented pillar wrapping case studies were at the New Afton mine, located approximately 10 km west of Kamloops, British Columbia. This is a block caving operation with three mining blocks at various stages (Figure 3). Current production is mainly from the B3 zone, with the B3 extraction level situated about 760 m below surface—160 m below and immediately west of Lift 1—operating at roughly 8,000 tonnes per day.

The B3 extraction level follows the El Teniente layout, featuring four main production drives spaced 27 m apart, intersected by drawpoint drifts every 16.5 m at a 56° angle. This level contains 65 drawbells, including 24 one-sided bells, with production drives and drawpoint crosscuts designed to be 4.5 m by 4.3 m.

Located 18 m above the extraction level, the B3 undercut level comprises five parallel drifts separated by 13.5 m-wide pillars. A

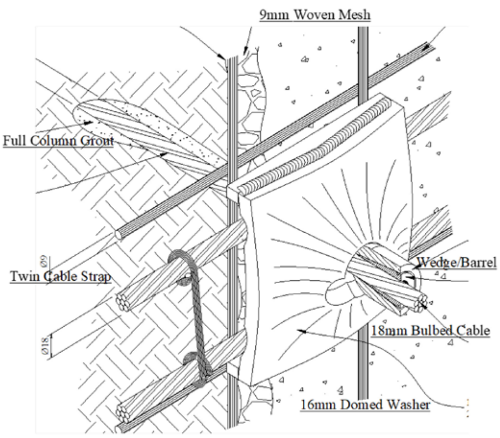

Figure 1—Pillar wrapping cable slings (after Wilson and Talu, 2004)

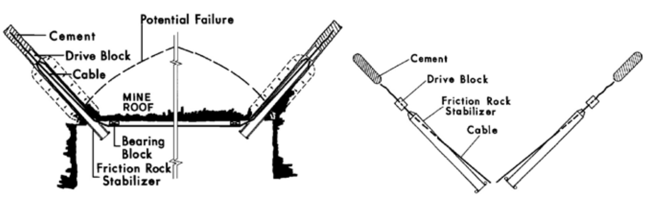

Figure 2—Schematic of Scott-system cable slings (after Castle and Scott, 1982)

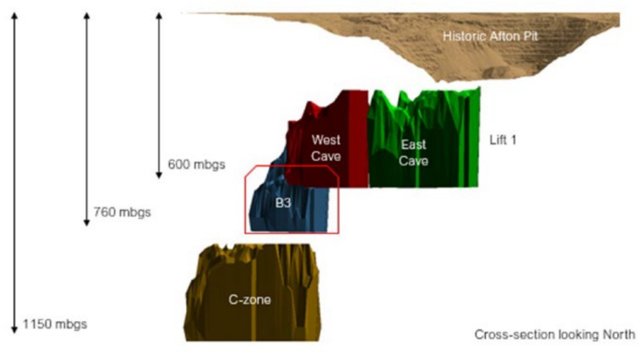

Figure 3—Overview of the New Afton block cave mine

half apex level, 12 m above the undercut, was developed to monitor undercut performance and reduce risks of remnant pillars that could jeopardise early drawpoint stability. Undercutting began in December 2020 and was completed by June 2022, progressing east to west via ring blasts spaced at 1.5 m intervals. After each blast, mucking removed swell, and confirmed connectivity to the apex level.

To mitigate damage from abutment stresses on the extraction level, an advanced undercutting technique was employed. At B3, only the production drives were constructed before undercutting began, so drawbells could be created at least 45° behind the undercut front within destressed rock. Mucking from blasted drawbells was minimised until all were blasted, ensuring even draw and maintaining cave health during initiation.

Geologically, the B3 extraction level is primarily composed of volcanic fragmental breccia (BXF), with monzonite and diorite intrusions to the southwest and picrite to the south (Figure 4). The Kamloops sedimentary domain is absent at this level. Face mapping during development indicated fair to poor rock mass quality, with RMR89 ratings between 47 and 56 (Bieniawski, 1989), largely due to fault structures intersecting the level. Regional structures parallel the production drives along the extraction level's boundaries, while local extensional features cut some drawbells obliquely.

Ground support in the B3 zone was a critical component of development and early production. Primary ground support included a first pass of 50 mm – 75 mm fibre-reinforced shotcrete, 6-gauge welded wire mesh pinned with 2.4 m D-bolts, 2.4 m MD bolts, or 2.1 m hybrid bolts (46 mm split sets with #7 rebar), effectively spaced at 1 m. Following the completion of primary support, drawpoint construction proceeded.

Secondary support comprised three rows of modified geometry cablebolts in the walls and back at 1.4 m – 1.5 m ring spacing, with self-drilling anchors (SDA) installed at the sill to control low-wall deformation. OSRO straps were applied along cablebolts, oriented parallel to the drift. OSRO straps are high-energy absorption elements made of a series of longitudinal, parallel, round, smooth bars attached together with strapping crossbars. The crossbars are loosely twisted around the longitudinal bars, as opposed to welded, allowing for a free rotational movement of the longitudinal bars. Where cable slings were used, three rows of double strand cable slings were installed over OSRO straps at drawpoint corners, bullnose, and camelback pillars (Figure 5). They were secured to the wall with cablebolts fitted with guide washer plates. Finally, a second pass of fibre-reinforced shotcrete was sprayed to protect support from equipment damage.

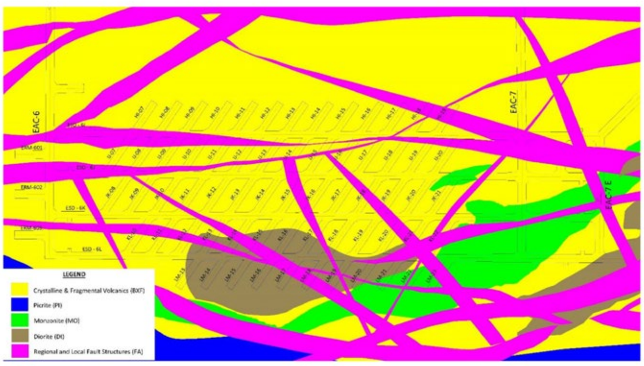

Figure 4—Lithology at the B3 extraction level

Instrumentation strategy

To monitor strain and load in the cable slings installed on New Afton's B3 extraction level, it was proposed to replace selected cable slings with instrumented cablebolts. Stretch measurement to assess reinforcement technology (SMART) cablebolts, commercially available from Mine Design Technologies (MDT), were selected for the instrumentation programme. SMART cablebolts incorporate a miniature multi-point borehole extensometer (MPBX) recessed within the king wire of a seven-wire strand. By combining the load-carrying capacity of a conventional seven-wire cable with the displacement-monitoring capability of an MPBX, SMART cablebolts enable direct measurement of strain and load distribution along the cable length. The instrument measures displacement at up to six anchor points distributed along the cable as it elongates under tensile loading. SMART cablebolt performance has been demonstrated through laboratory and field trials since 1998 (Hyett et al., 1997; De Graaf et al., 1999). Laboratory testing reported accuracy better than 1.4% (as a percentage of full-scale reading) and a high degree of repeatability (De Graaf et al., 1999).

Instrumented cablebolts are widely used in the mining industry to assess ground support performance (Gauthier et al., 2000; Hyett et al., 1997; De Graaf et al., 1999; Bawden, 2024). However, to the authors' knowledge, they have not previously been applied as part of a monitoring strategy to evaluate the performance of pillar-wrapping cable slings. The SMART cablebolts used in this study were designed to align with the ground support layout and the design specifications of the pillar-wrapping cable slings used in the B3 extraction level.

A prototype configuration was first implemented at K12N (the southern drawpoint of the JK-12 drawbell) and assessed through a trial to confirm instrument functionality and refine the installation methodology (Yanagimura, Hadjigeorgiou, 2022). The prototype was subsequently modified for a comprehensive instrumentation programme at the JK-16 drawpoints (J16S and K16N), which is reported in this paper.

B3 EXT pillar wrapping instrumentation programme

As part of the instrumentation trial at the K12N, the cable slings in the middle row, located 2.2 m from the sill installed in the bullnose

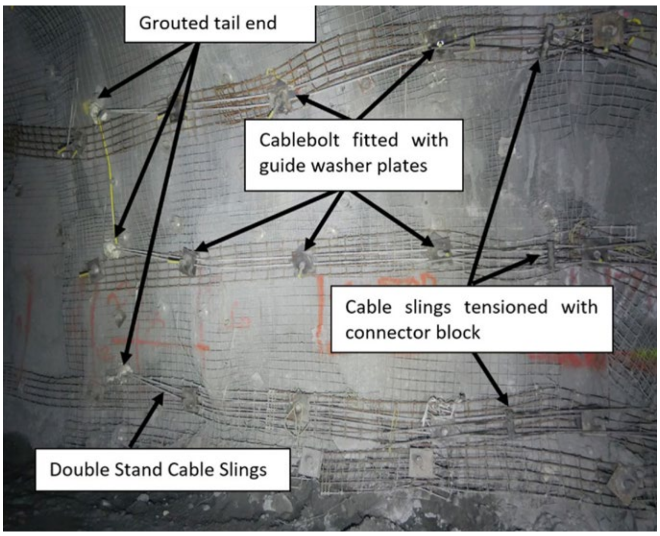

Figure 5—Pillar wrapping cable slings installed in B3 extraction level

and camelback pillar of the K12N drawpoint were instrumented (Yanagimura, Hadjigeorgiou, 2022). Modifications to the instrument length and anchor node locations were made so that the connector block (Figure 6) was better placed on the bullnose to protect from equipment damage and anchor nodes were equidistantly spaced around the bullnose corner (Figure 7).

At JK-16, every row of the double-strand cable slings was instrumented. Installation of both instrumented and non-instrumented cable slings at the J16S drawpoint commenced on March 29, 2022, and the system was fully tensioned by April 7, 2022.

To confirm the final instrument layout relative to the drawpoint pillars, survey pickups of the drillhole collars, anchor nodes, and connector block locations were completed after installation. These pickups provided an important compliance check, verifying that the installation was executed in accordance with the design. Figure 8 shows the layout of the instrumented cables and the corresponding anchor locations along the pillar surface at the J16S drawpoint. Each anchor location was assigned an identifier (e.g., A1.3) based on its distance from the anchor closest to the connector block (A0). Figure 9 shows the completed installation at the J16S drawpoint.

Data analysis and interpretation

This section presents the analysis and interpretation of data collected from the instrumented cable slings installed at the JK-16 drawpoints, covering the period from installation in April 2022 through 1 October 2022. During this interval, advanced undercutting was completed in June 2022, while cave initiation for the B3 mining block remained in progress with ongoing drawbell construction.

Figure 6—Connector block used to tension pillar wrap cable slings at the New Afton mine

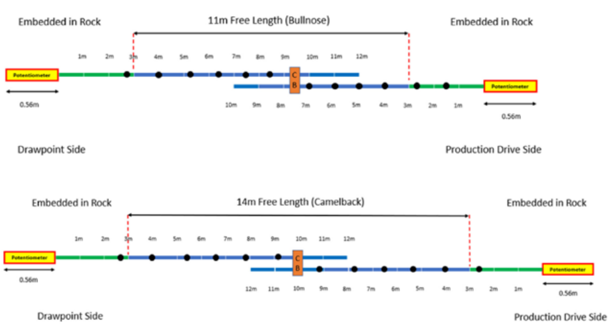

Figure 7—Schematic of SMART cablebolts used to instrument cable slings for the JK-16 instrumentation study: Note that "CB" denotes the planned location of the connector block

Load on instrumented cable slings

Using the relative displacement measured at A0.0—the anchor node farthest from the potentiometer and closest to the connector block—it is possible to estimate the average load mobilised along the full length of each instrumented cable sling. The resulting load estimates for the instrumented cable slings installed in the camelback and bullnose are shown in Figure 10.

At the J16S drawpoint, the cable slings were initially tensioned on 1 April 2022 and re-tensioned on 7 April 2022, after slack was observed in several slings (green arrows in Figure 10). The drawbell blast was fired on 29 April 2022 (red arrow in Figure 11).

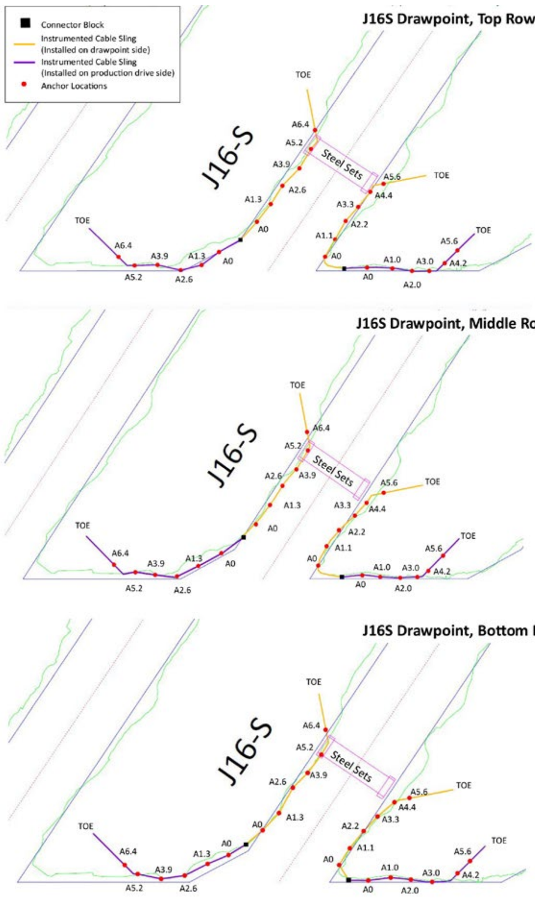

Figure 8—Configuration of SMART cablebolts Installed at J16S drawpoint

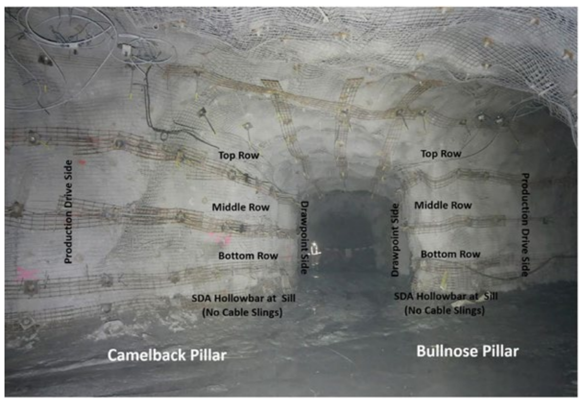

Figure 9—Instrumented cable slings at the J16S drawpoint

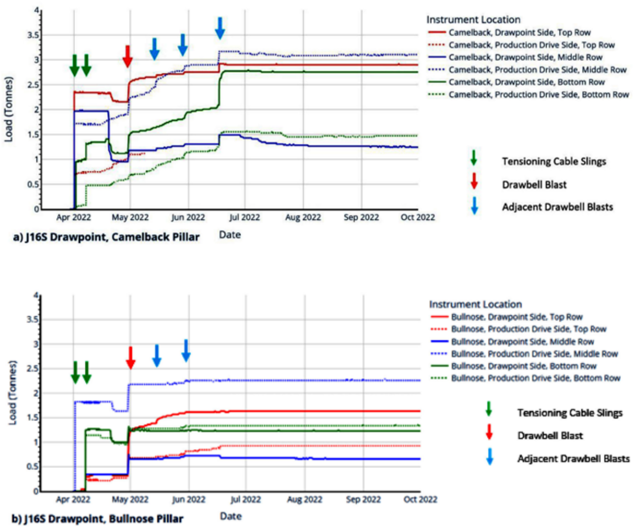

Figure 10—Average load in the J16S cable slings

Table 1

Blast Dates for Drawbells around JK-16

Blast location	Blast date
IJ-15	21 April 2022 day shift
JK-16	29 April 2022 night shift
KL-17	14 May 2022 day shift
IJ-16	29 May 2022 day shift
KL-18	15 June 2022 night shift
JK-17	16 June 2022 night shift

Mining activity, drawbell blasts near the installations, non-intentional contact on cable slings and potentially the heavy use of fibrecrete for steel sets and cover can influence the performance of pillar wrapping cable slings. Table 1 provides the dates of drawbell blasts between April and June 2022, that triggered a response in the JK-16 drawpoints.

A closer review of the load–time history in Figure 10 indicates that several cable slings experienced pronounced unloading between 20 April and 21 April, 2022. Unloading initiated on 20 April at approximately 15:30 and continued progressively until about 21:00 for the camelback (drawpoint side; top and bottom rows) and the bullnose (drawpoint side; bottom row) instrumented cables. For the camelback (drawpoint side; middle row), the unloading response began earlier—on 19 April at approximately 14:30—and continued steadily until approximately 21:00 on 20 April. For the remaining instruments (bullnose, production-drive side; middle and bottom rows), unloading initiated on 21 April at approximately 17:00.

These unloading responses appear to reflect the cables' sensitivity to mining activities in the vicinity of the drawpoint, including work associated with steel-set installation. The unloading observed on 21 April is attributed to the IJ-15 drawbell blast, with the bullnose cable slings at the J16S drawpoint being closest to the blast location.

Relative displacement of the grouted cable tail end

The instrumentation was designed such that the anchor node(s) closest to the potentiometer toe were embedded within the grouted tail end of the cable. Referring to Figure 7, these correspond to A6.4 for the camelback instruments, A5.6 for the bullnose instrument on the production-drive side, and A5.6 and A4.2 for the bullnose instruments on the drawpoint side. The relative displacement time histories (Figure 11) were used to examine the behaviour of the anchor nodes located within the grouted tail relative to those along the free cable length.

The results indicate that the grouted tail at the J16S drawpoint performed as intended. For a well-bonded cable, the shear stiffness of the grout–cable interface is expected to restrict displacement within the cable tail as tensile load is transferred from the free length back into the rock mass. Consistent with this behaviour, displacements measured at the grouted anchor nodes were very small compared with those measured along the free length following sling tensioning and the drawbell blast. At the time of tensioning, displacement at the grouted anchors remained near zero, reflecting the relatively low initial tensile load applied to the sling and the effective restraint provided by the grouted section.

In effect, when the grouted tail is functioning properly, the available interface shear resistance exceeds the shear demand induced by tensile loading and any pull-out forces mobilised within the pillar-wrapping system. This limits displacement in the grouted tail and enables the tensile load carried by the sling to be mobilised primarily within the free length and transferred back into the rock mass through the grout–cable interface.

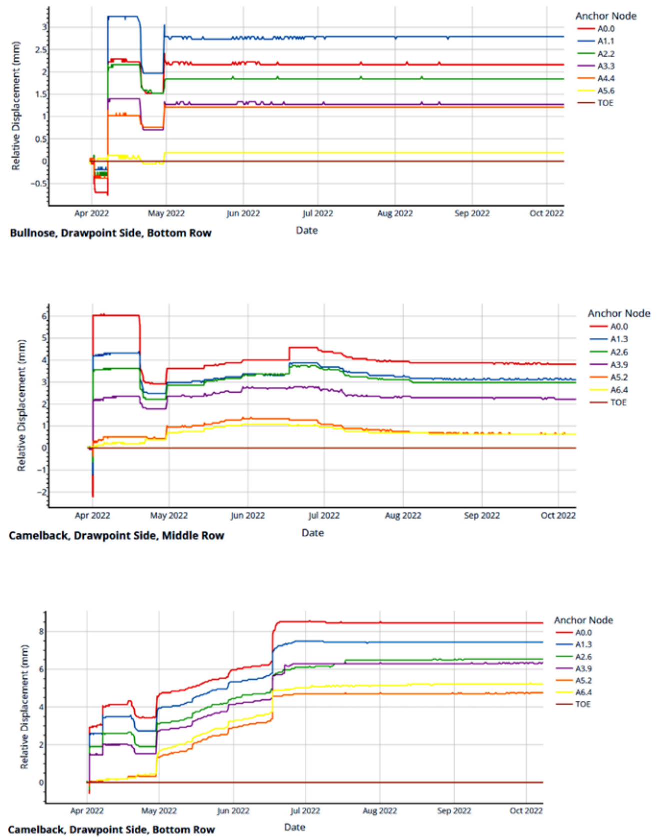

Figure 11—Instrumented cable slings from J16S drawpoint showing limited displacement at grouted tail end. Note that the instruments have one anchor node, A5.6 or A6.4, in the grouted tail end

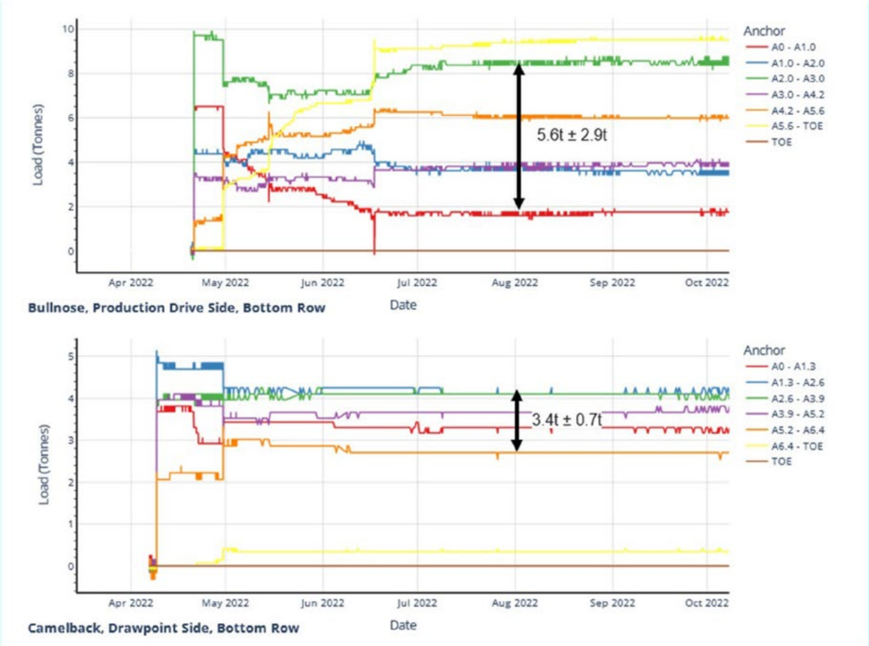

Figure 12—Load distribution along the pillar wrapping cablebolts at JK-16

Load distribution along cable slings

A review of the instrumentation data indicates that load distribution along the pillar-wrapping cablebolts can vary substantially during the early stages of installation. As shown in Figure 12, drawbell blasts can trigger a redistribution of load along the cable free length when the loads retained in the cable slings are still relatively low. In some cases, the cable slings exhibited the desired convergent loading response following the drawbell blast, which is beneficial for long-term performance. However, cablebolts that displayed a divergent loading response are a concern, as this behaviour can concentrate load over a short segment and increase the potential for premature, localised failure.

Divergent loading can be partially attributed to pinching or shear loading at the guide washer plates, adhesion between the cable and the shotcrete cover spray, and irregular excavation surface profiles. These conditions can promote load concentration and inhibit efficient load transfer along the cablebolt free length, thereby limiting the development of a more uniform load distribution. Overall, these observations underscore the need for strict installation quality control to facilitate effective load transfer and achieve consistent cablebolt performance.

Recommendations for pillar wrapping

The comprehensive instrumentation programme complemented the routine field observations at the B3 extraction level and identified early stages of installation factors that can influence the long-term performance of pillar wrapping cable slings. A review of instrumentation data during the early caving process facilitated the development of practical design and implementation recommendations.

Cable sling design

Bond stiffness at the grouted tail end is critical to the long-term performance of pillar-wrapping cable slings. Insufficient shear stiffness at the tail can lead to premature failure under blast-induced loading. Performance can be improved through the following measures:

- ➤ **Use modified-geometry cables:** Modified-geometry strands can achieve higher bond capacity than plain strand cables, reducing sensitivity to grout quality and improving load transfer.
- ➤ **Increase embedment length:** Greater embedment improves confinement and bond performance, helping to ensure anchorage within the confined pillar core. Extensometer data can be used to estimate the depth of rock-mass fracturing so that embedment extends beyond the disturbed zone.
- ➤ **Avoid mechanical anchors unless necessary:** Expansion shells (e.g., CL65) can provide mechanical anchorage but are costly and tend to perform poorly in weak or deteriorated ground. Modified geometry cables are typically more practical and cost-effective.
- ➤ **Maintain rigorous quality control**: This includes confirming borehole length and inclination to achieve the specified embedment, visually inspecting cables to ensure they are free of contaminants (rust, grease, dust, paint), and sampling grout to verify strength and water-to-cement ratio meet specification.

By improving cable geometry, ensuring adequate embedment, and enforcing strong quality control, cable slings are more likely to withstand blast impacts and provide reliable long-term performance, reducing reliance on contingency installations intended to compensate for early-life failures.

Shotcrete spray and tensioning cable slings

Instrumentation data indicate that load transfer along the cable slings is initially limited but improves as loading increases. Early-stage load-transfer efficiency can be reduced by irregular excavation wall profiles, suboptimal guide washer design, interaction with adjacent support elements, and adhesion between the cable and shotcrete.

Table 2

Standard of quality for installing cable slings for pillar wrapping

Quality/design requirements	Example quality control measures	Consequence of Not Correcting Defective Work
Cable are tails installed to the design embedment length.	Routine checks of drilled borehole length.	Insufficient bond strength or anchorage into pillar core may cause premature failure of cable sling at the cable-grout interface.
Drill angle at 45° to 60°	Routine checks of drilled borehole angle.	Unintended shear loading of cable sling at the borehole collar. Shear loading can reduce the overall capacity of the cable.
Bolts with custom guide washer plates are installed along the design row and ring spacing.	Check mark up of bolt location and after it has been drilled.	Unintended shear loading on cable sling along the free length by guide washer plates if the bolt deviates from row spacing. Widely spaced bolts may cause cable slings to not be pinned tightly to wall once tensioned.
Grout strength meets minimum target (e.g., 40 MPa) and mixed at specified water to cement ratio.	Sample grout mixtures for density and strength testing. Job task observation with the grouting crew.	Insufficient bond strength or anchorage into pillar core may cause premature failure of cable sling at the cable-grout interface.
No binding or pinching of cable slings under the guide washer plates.	Visual inspection of the cable sling along the free length. Job task observation with the tensioning crew.	Load transfer efficiency is diminished along the free length of the cable.
Excavation surface is devoid of sharp corners; ensure regular profile.	Visual inspection of the excavation surface before drilling.	Unintended point loading on the cable sling, can diminish load transfer efficiency and/or reduce the overall capacity of the cable.
Cable surface is clean before installation into boreholes.	Routine checks of cable surface in storage and during install.	Insufficient bond strength. Less sensitive if bulbs are on the cable tail end.
Cable slings are tensioned to design jack load.	Routine check of slack on cable slings. Job task observation with the tensioning crew.	Cable slings act as passive support systems. Pillar movement is required for the cable slings to commence work.
No rotation in the connector block once the cable slings are tensioned.	Visual observation of the connector block. Job task observation with the tensioning crew.	Some of the cable slings that are part of the same system may have become unloaded during the tensioning of one of the other cable slings.
Connector blocks are positioned to a location least impacted by equipment damage.	Visual observation of the connector block. Job task observation with the tensioning crew.	Equipment damage to the connector block may cause sudden loss of tension on the cable slings as the cable slips through the wedge.
Secondary shotcrete spray provides full coverage over cable slings.	Visual observation of the shotcrete cover.	Equipment damage to exposed cable slings may cause irreparable damage.

Covering exposed cables with shotcrete is beneficial for protecting the slings from equipment damage; however, adhesion between shotcrete and the cable can inhibit cable movement and reduce load-transfer efficiency. Laubscher (2000) suggested using polypipes to prevent bonding, but this approach was found to be time-consuming and offered limited benefit. A more practical alternative is to apply a thick, inert grease to exposed cable sections prior to shotcrete spraying. At New Afton, this practice has improved load transfer, although additional testing is required to quantify the magnitude of the benefit.

Cable tensioning should also account for significant losses between the applied jack load and the residual load retained in the sling—often on the order of 30% to 90%—largely due to the jack configuration and installation setup. At New Afton, cables are tensioned using a hollow rod to avoid interference with wall-mounted equipment. To achieve target residual loads, it is therefore critical to quantify these losses as part of installation. While instrumented cablebolts provide detailed insight, a simpler field test using a load cell can be used to estimate jack-to-residual load losses and confirm that slack has been fully removed following tensioning.

Quality control

Given the number of steps involved in installing pillar-wrapping cable slings, rigorous quality control is essential to identify and correct defects early. The most effective approach is to develop a quality management plan and review it with the construction crew and key stakeholders prior to commencing work. Implementing the plan provides a structured framework for maintaining consistent quality throughout installation.

Table 2 summarises baseline quality standards to consider when establishing quality control measures for pillar-wrapping cable sling installation. Job task observations are a critical component, as they verify that operators are following standard procedures in the field. Any deficiencies or non-conformances identified should be documented and addressed promptly through corrective actions.

Operational factors

Preliminary trials and the full-scale trial reported in this paper indicate that ground support interaction during drilling is more common than anticipated. In block caving, pillar-wrapping cable slings frequently intersect previously installed cablebolts that are installed at systematic spacings. Because cable slings are not always drilled perpendicular to the excavation wall, the tail sections can intersect or interfere with existing reinforcement elements. If the installation sequence is not optimised to minimise drilling-related damage, the load-bearing capacity of the slings may be reduced. Unfortunately, drilling-related damage to reinforcement is often difficult to detect in the field.

Field inspections also indicated that repetitive impacts—particularly from LHDs constructing berms at drawpoints to manage mud rush and hang-ups—frequently damaged cable slings along the upper walls and shoulders. Applying a shotcrete cover in these areas is therefore essential to protect the cable slings from equipment-related damage.

Conclusions

Pillar wrapping using cable slings is a surface support system employed at block cave operations worldwide to reinforce drawpoint pillars on the extraction level. In poor-quality, highly fractured ground, overstressing of the extraction-level rock mass can drive significant deformation and convergence, increasing safety risk and potentially causing production delays and/or reserve losses.

Cable slings are designed to provide high yielding capacity, allowing them to accommodate large ground movements while continuing to confine the rock mass as it transitions into, and progresses through, post-peak behaviour. Despite their widespread application in cave mining, a technical review of pillar-wrapping cable slings identified a limited body of published information describing their design basis and field performance.

An instrumentation study conducted on New Afton's B3 extraction level was undertaken to quantify the performance of cable slings installed in drawpoint corners during the early stages of caving. The programme focused on the cave initiation and early propagation phases of the B3 cave life cycle, with particular emphasis on sling response to undercutting activities and drawbell blasting. Data from the instrumented cables provided valuable insight into load transfer and deformation behaviour, demonstrated the QVP of deploying pillar-wrapping cable slings at New Afton—by linking installation quality and system performance to tangible operational risk reduction—and informed practical recommendations to improve installation quality and maximise the performance benefits of cable slings in the field.

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