Underground Mining of Metalliferous Deposits
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Lecture – 48
Cable Bolting

CABLE BOLTING

- A conventional cablebolt is a flexible tendon consisting of a number of steel wires, wound into strand, which is grouted into a borehole.
- Cablebolts are normally installed in regularly spaced boreholes to provide reinforcement and support for the walls, roof and floor of underground or surface openings.
- The capacity of the steel cablebolt element is transferred to the rockmass through grout. Grout used in cablebolting applications is usually composed of Portland cement and water.

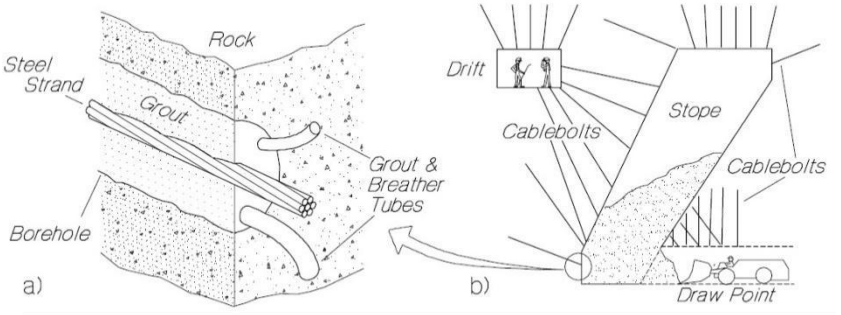

Figure 1. Cable bolt element and array

Cable bolts are used in underground hard rock mines to:

- Provide a safe working environment,
- Increase rock mass stability, and
- Control dilution of waste rock from the stope boundaries.
- For larger spans in major intersections, large underground chambers or in active mining stopes, cable bolts become an attractive support system due to the increased load capacity and the potential for increased bolt length.

Cable bolts can reach far into the rock mass and reinforce large volumes of rock to prevent separation along planes of weakness such as joints. By maintaining a continuum nature within the rock mass, the cable bolts help to mobilize the inherent strength of the rock mass, thereby improving overall stability. In addition, by supporting blocks of rock at the excavation surface, the remaining rock mass is prevented from loosening and weakening. Cable bolts thus restrict the dangerous and costly effects of progressive instability and failure.

CABLEBOLT APPLICATIONS

- Cable bolts can be used to support, reinforce or retain the rock mass around most excavations found at an underground mine, including:

  Drifts and intersections.

  Open stope backs.

  Open stope walls.

  Cut and fill stopes.

  Draw points.

  Permanent openings.

THE CABLEBOLT TOOLBOX

- The cable bolt toolbox includes a wide variety of items that allow the user to design a truly effective cable bolt element for most potential rock mass failure conditions.
- The toolbox includes a number of different cablebolt strand configurations and different grouting materials.
- Additional items in the cable bolt toolbox include surface restraint elements such as plates and straps.
- In the last 20 years, a number of different types of modified cable bolt strand have been developed in response to problems encountered with poor performance of plain strand cable bolts at mine sites. Some of these modified geometry cable bolt strands are shown in Table.

Table 1.5.1: The cablebolt toolbox (after Windsor, 1992). Detail in Section 2.9.

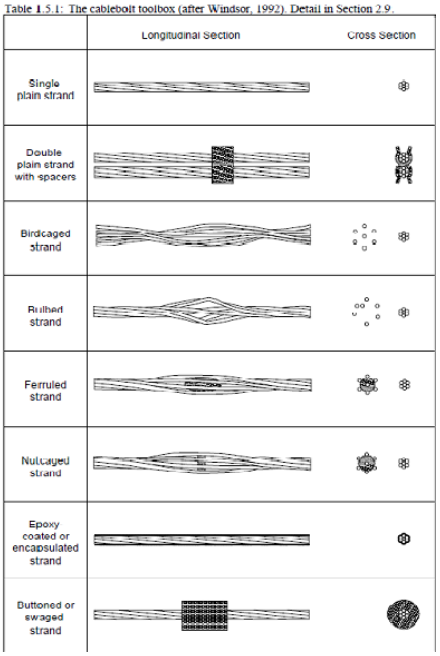

Figure 2. Cablebolt toolbox

FUNCTION

- Cablebolt support performs a combination of *reinforcement* and *holding* functions.
- If the inherent strength of the rockmass is not enough to resist the effect of induced stresses or if discontinuities are unfavorably oriented resulting in free and removable blocks, cablebolts can be effective *holding* elements, keeping the failed rock or free rock blocks in place**.**

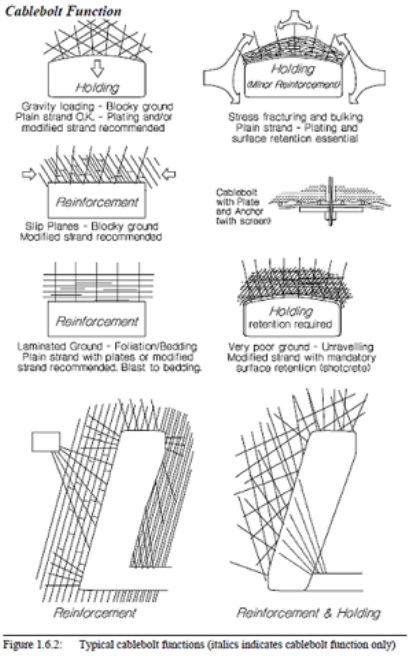

Figure 3. Cablebolt functions

EQUIPMENT

- There are a number of different cablebolt installation operations that require specialized materials and equipment.
- In addition to the cablebolt materials including strand, grout, plates and anchors, tubing and attachments, the cablebolting equipment list could include:

  Stationary cablebolt reel or revolving dispenser for dispensing the cablebolt.

  Hydraulic cutter, air powered grinder, oxy-acetylene torch, or explosives for cutting the cablebolt.

  Custom built cablebolt pushers.

  Paddle, drum or colloidal grout mixers.

  Piston or progressing cavity grout pumps.

  Tension jack for tensioning the cablebolt during surface element (plate, strap) installation.

  Cablebolting truck equipped with all of the items listed above, and any tools required by the crew.

INSTALLATION METHODS

- The selection of the best method depends upon the orientation of the borehole, the type of cablebolt, the grout flow characteristics and the grouting equipment available.
- The cablebolt installation methods most commonly used are:

I. Breather tube method (w/c ratio > 0.4) and
II. Grout tube method (0.3 to 0.35 w/c ratio)

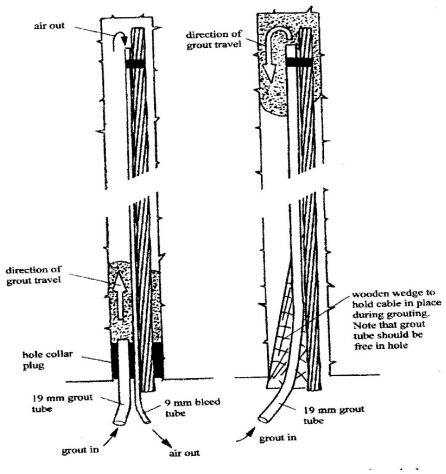

Figure 4. Breather tube and grout tube methods

1. **The Breather Tube Installation Method**

- In this method, the breather tube extends to the toe of the hole, while only a short length of grout tube is used at the collar of the hole. A cablebolt hanger and borehole collar plug are required.
- Grout of 0.4 water:cement ratio is optimum for this method.
- The grout is pumped through the short grout tube into the borehole. The grout flows upward against gravity in the hole. Air and then grout are expelled from the hole through the breather tube. Return of good quality grout through the breather tube is essential to indicate that the borehole is full of grout.
- A piston pump or progressing cavity pump can be used.
- Problems encountered with this method include: leaking or blown out collar plugs, caused by poorly plugged collars or undersized breather tubes, grout much wetter than design consistency; and no grout flow from the breather tube due to loss of grout into a badly fractured rockmass, an undersized breather tube for the design grout consistency, or inadequate pumping time.

2. **The Grout Tube Installation Method**

- The grout tube extends to the toe of the hole. A cablebolt hanger at the toe and/or a wooden wedge inserted at the collar secure the bolt in upholes.
- Grout of ≤ 0.37 water:cement ratio should be used for upholes.
- In upholes, the grout is pumped to the toe of the hole through the grout tube. The grout then flows downward with gravity inside the borehole.
- The grout must be thick enough so that at the instant the pump is stopped, the position of the grout flow front will freeze in the hole.

- A thick consistency "donut" of grout appearing at the collar indicates complete grouting of the hole.
- A continuous stream of grout is required, so a progressing cavity pump is usually used.
- Voids can easily be created in upholes: too thin grout will slump or spiral down the hole, and thick grout may hang up in the hole preventing complete grouting.