Introduction to hard rock drilling

Mechanical rock penetration

Drilling: Definition

Rock drilling:

- Mechanical rock penetration
- Process of cutting or boring rock

[Hartman, 1989].

Energy must be applied to the rock by direct or indirect means to fragment the rock

[Krech, SME, Mining Engineering Handbook].

- Energy is generated by rock drills

Rock Drills

A rock drill is a drilling device designed specifically for penetrating rock.

A drill is a tool fitted with a cutting tool, usually a drill bit.

There are many types of rock drills including:

- Electrical machines (electric drills)
- Pneumatic drills (Compressed air machines)
- Hydraulic drills

Rock drills can be hand-held or attached to drill rigs

Hand-held drills are manually controlled by an operator

Hand- held rock Drills

DTH Hydraulic Crawler Drill and Held-held Drill

Purpose of Drilling

The general purpose of holes drilled include:

- Prospecting
- Exploration
  - Core drilling
- Anchorage, and
- Blast holes

Core Drilling

Core Drilling: Exploration

Purpose of Drilling

For mining geologists, drill holes are specifically intended for:

- Geological information
- Establishment of stratigraphic column
- Determination of presence of ore
- Evaluation of ore and country rock
- Estimation of tonnage and grade

Purpose of Drilling

For mining engineers, drill holes are intended for:

- Anchorage or support systems
- Drainage, and
- Blast holes
  - The main purpose

Blast-holes

The principle and economics of rock blasting in mining depends on the type and characteristics of drill-holes.

Explosives are loaded in the drill-holes and blasting techniques depends on:

- Size of the blast-holes,
- Depth, and
- Spacing of drill-holes.

Blast-holes

The choice of explosives and the size of the most economics drill-hole size and drilling depth is dictated by the cost of drilling.

The cost of drilling depends on penetration and wear characteristics of the rock.

Drill Holes Characteristics

Drill holes are characterised by four factors:

1. Diameter
2. Length
3. Straightness
4. Stability

Classification of drilling according to energy used:

Drilling is mainly done by mechanical attack, other methods of cutting holes according to energy used include:

- Thermal hydraulic
- Electric and Electromagnetic
- Sonic high frequency vibration
- Light-laser system

Classification of Drilling

Classification according to principles of drilling:

- Percussive action (hammer drills)
- Rotary
- Rotary-percussive

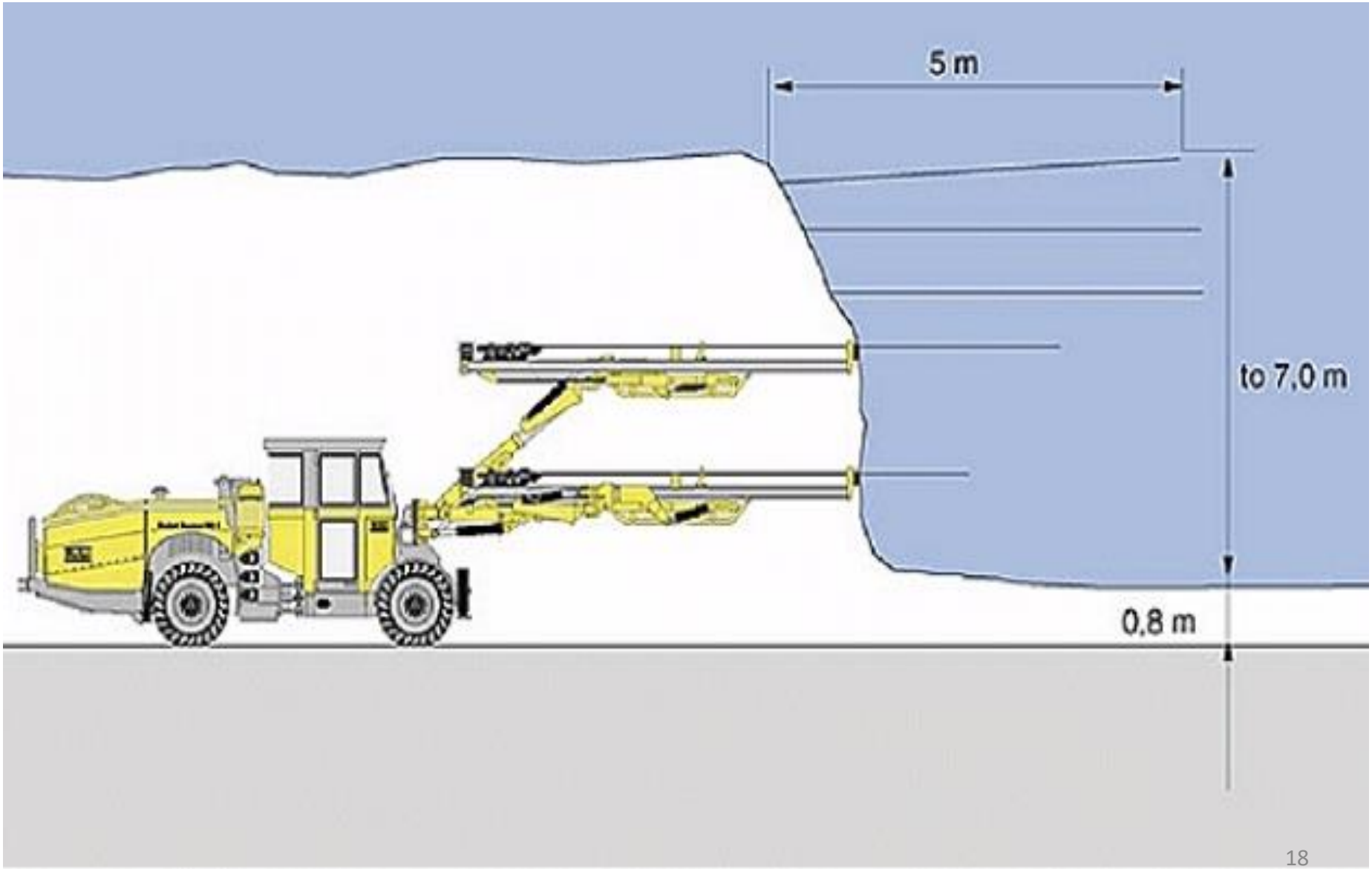
Trends in Drilling

Advanced Drilling Methods

- Better technology
  - Machine design
  - Machine efficiency
  - Less lose of energy
- Modern equipment
  - Automated
  - Safe
  - Environmental control

Automated Drilling rig

Drilling Rig



Trends in Drilling

Advanced Drilling Methods

- Higher productivity
  - Effective
  - Low manpower
  - High pay load
  - High yield
- Knowledge of mechanics of rock
  - More knowledge of rock properties
  - Properties affecting drilling

Trends in Drilling Equipment

- Hydraulic drilling equipment
- ITH high pressure drilling equipment
- Diesel powered drilling equipment
- Electro-hydraulic drilling equipment

Automation of Drilling Equipment

- Automated or computerized drilling
- Eliminates the human factor
  - Error in positioning and aligning
- Rig orientates itself on its axis
- Accurately collar and drill
- Controls drilling parameters
- Programmed coordinates, angles and depth
- Optimum drilling of pattern of holes

Factors Considered in Selection of Drilling Equipment

- Length of holes
- Diameter of holes
- Rock characteristics
- Drilling space
- Source of drilling energy
- Penetration rate
- Safety

Factors Affecting Drilling Performance

1. Operating variables (controllable factors)
   - Drill power
   - Speed
   - Thrust
   - Bit and rod design
   - Blow energy and frequency

2. Drill hole factors (dependent variables)
   - Hole size
   - Hole length
   - Inclination

Factors Affecting Drilling Performance

3. Rock factors (independent variables)
   - Properties of rock
   - Geologic conditions
   - State of stress acting on the drill-hole

4. Service factors (external variables)
   - Labour and supervision
   - Power supply
   - Job site

Performance Parameters

In selecting the optimal drilling system or evaluating drill performance, four parameters are measured or estimated:

1. Process energy
2. Penetration rate
3. Bit wear
4. Cost
   - Ownership + Operating = Overall Cost

Revision Questions

1. What are advantages and disadvantages of pneumatic and hydraulic drills?
2. Describe physical and mechanical properties which affect drilling performance
3. Describe how rock strength properties relate to energy required for mechanical rock penetration?