BLASTING IN QUARRIES

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Agenda

Typical Quarry Operation

Industry Terminologies

Blasting Operations

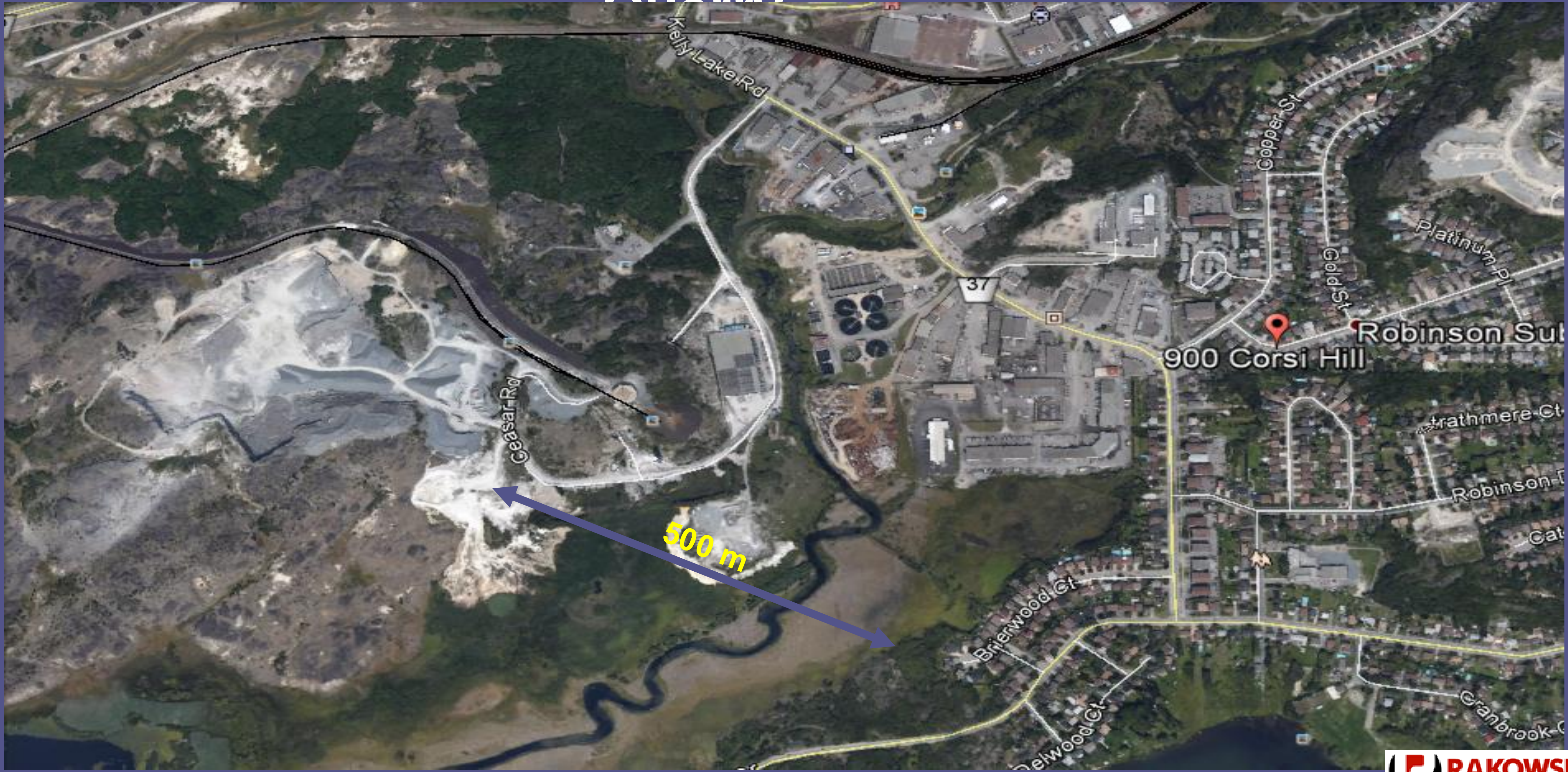
Design Parameters

Controlling Measures

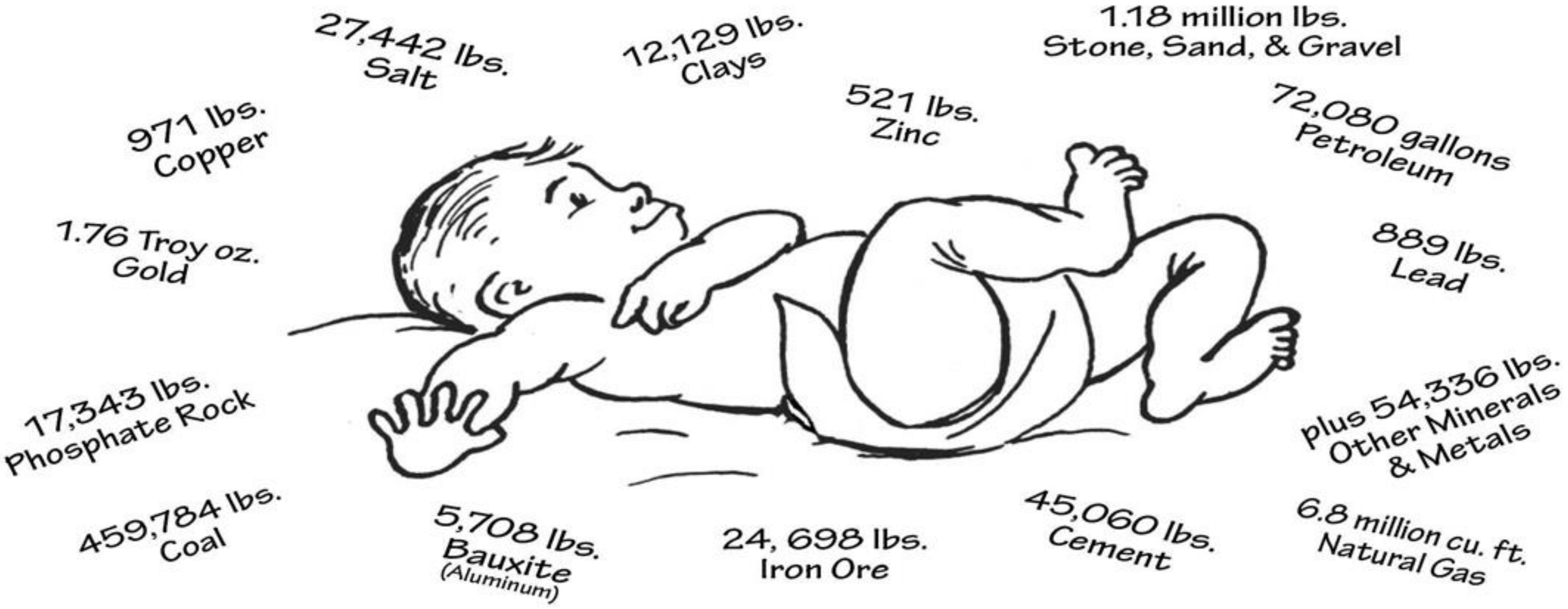
- Vibration and Overpressure
- Flyrock
- Discussion Period

Open Discussion

Typical Quarry



Every American Born Will Need...



3.03 million pounds of minerals, metals, and fuels in their lifetime

Learn more at www.MineralsEducationCoalition.org

International Society of Explosives Engineers

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Blasting Operations In Quarries

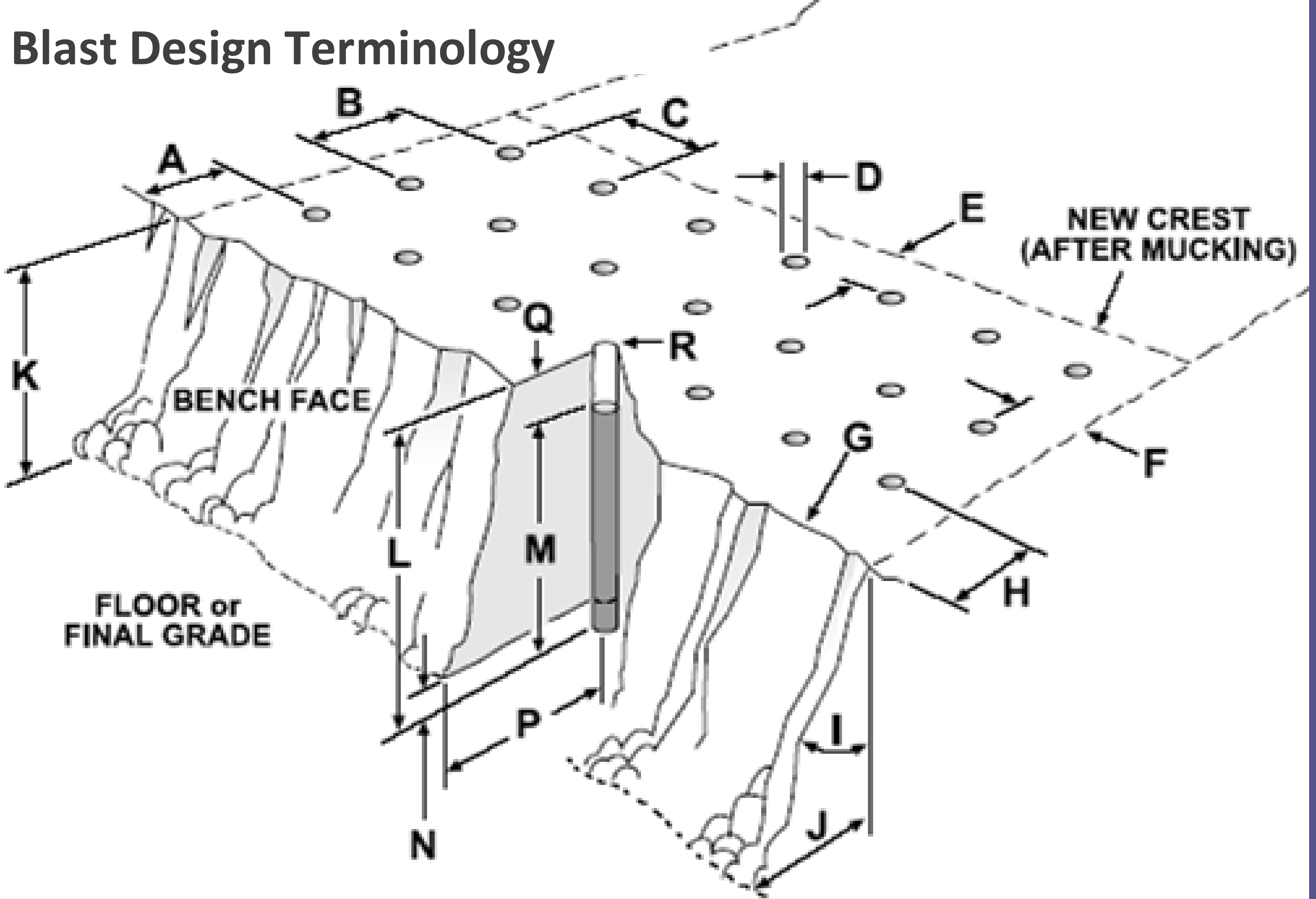
Any blasting operations inherently produces the following:

- **Vibrations**
- **Overpressure (Air blast)**
- **Flyrock**
- **Dust**

The impact of these undesirable byproducts CAN be minimized by changes within the blast design

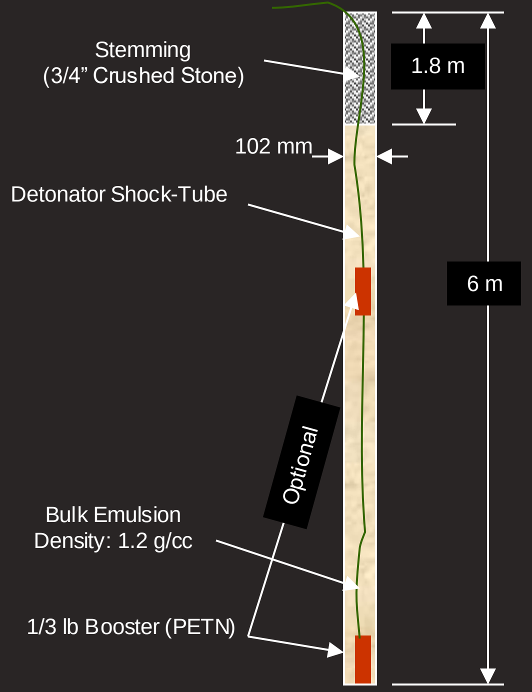
Let Us Walk Through A Typical Blast

Blast Design Terminology

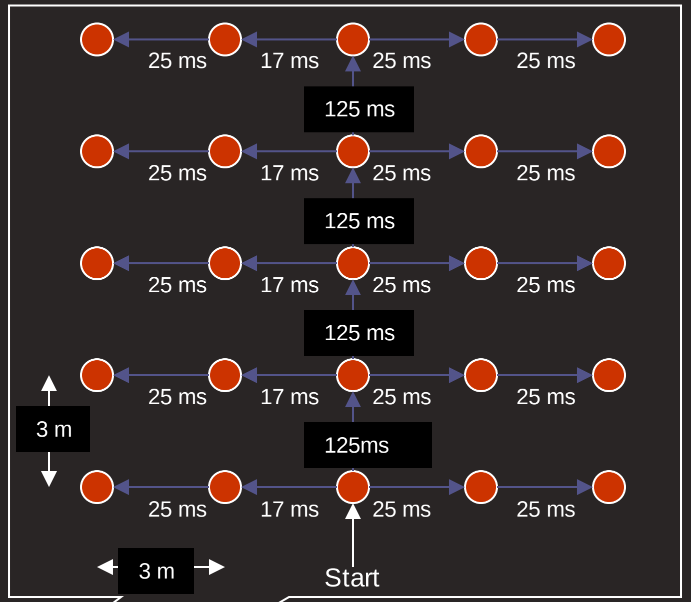


A	Hole-to-Crust	G	Crest	M	Explosive Column Height
B	Apparent Burden*	H	Crest Burden	N	Subdrilling
S	Apparent Spacing*	I	Bank Angle	P	Toe Burden
D	Hole Diameter	J	Toe	Q	Stemming Height
E	Back Break	K	Bench Height	R	Collar
F	Side Break	L	Hole Depth		

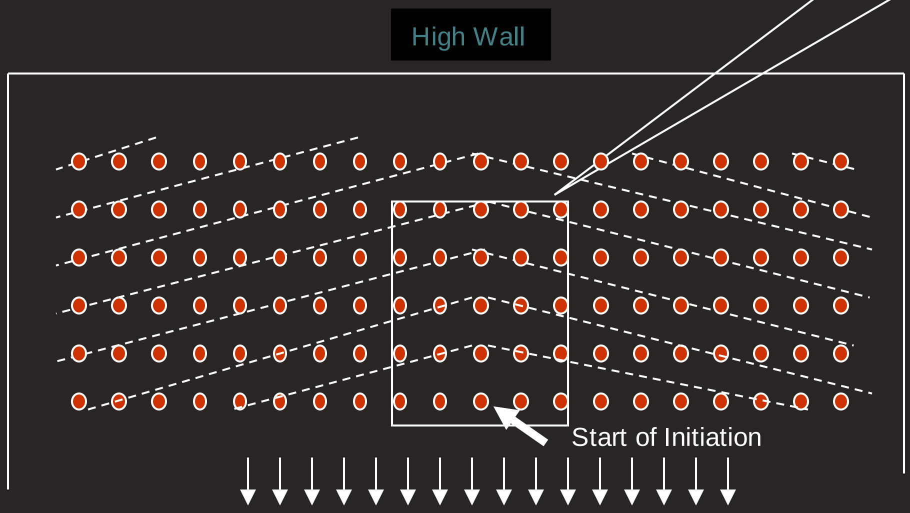
Typical Blasting Plan



Typical Loaded Hole



Sample Detonator/Sequencing Layout



Blast Design Parameter Details

- Pattern: 3 m Burden X 3 m Spacing
- Hole Diameter: 102 mm
- Explosive: Bulk emulsion, d=1.20g/cc
- Detonators: Non-electric Dual Dets 25 ms/500 ms
- Surface Connectors: 17 ms, 125 ms
- Delay Between Holes: 25 ms
- Delay Between Rows: 125ms
- Max. Hole Depth: 6 m Incl. Sub-drill
- Collar: Min. 1.8 m
- Explosive Wt./Delay: 41 kg
- Primer: 1/3 lb   Booster (PETN)
- No. of Holes: 120 (Typical)
- Direction of Throw: TBD
- Weather Condition: …………….
- Wind: ……………….
- Blaster-In-Charge: ……………….

NOT TO SCALE

VIBRATIONS

Peak Particle Velocity (PPV): The rate of change of amplitude, usually measured in mm/sec. or in/sec. This is the excitation of the particles in the ground resulting from vibratory motion.

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Blast Induced vibration limits are governed by the Ministry of the Environment Conservation and Parks (MECP). The upper limit for vibrations is 12.5 *mm/s*

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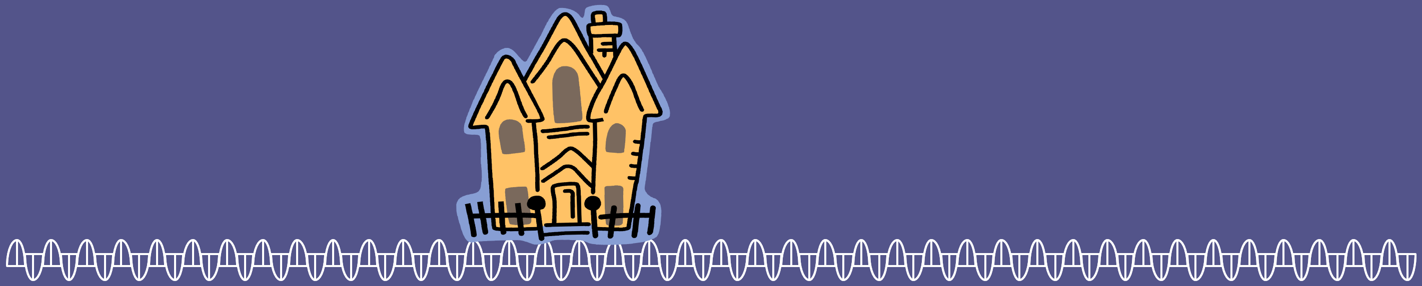
Low Frequency Wave



High Frequency Wave

Vibrations induced by blasting are of high frequency

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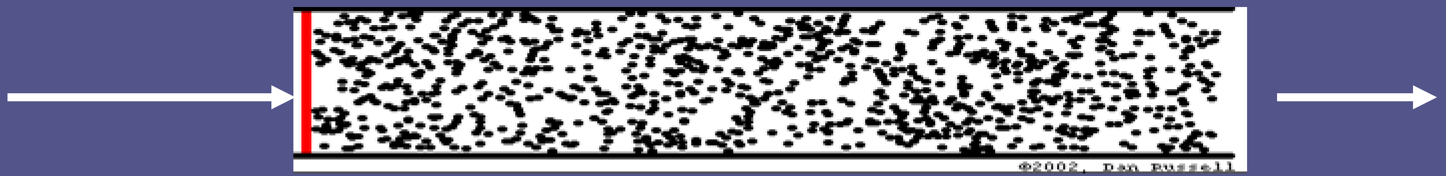
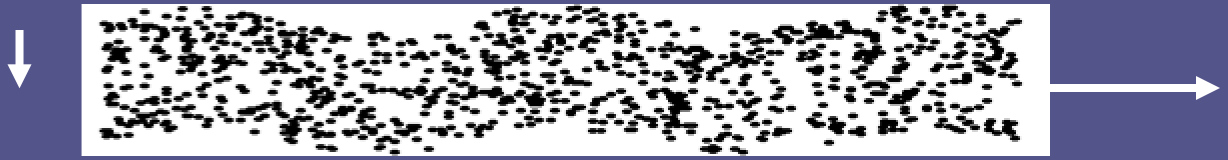
Vibration Type

Compressive Waves



Compressive waves are the fastest travelling waves and are also known as primary, compressional or “P” waves

Shear Waves

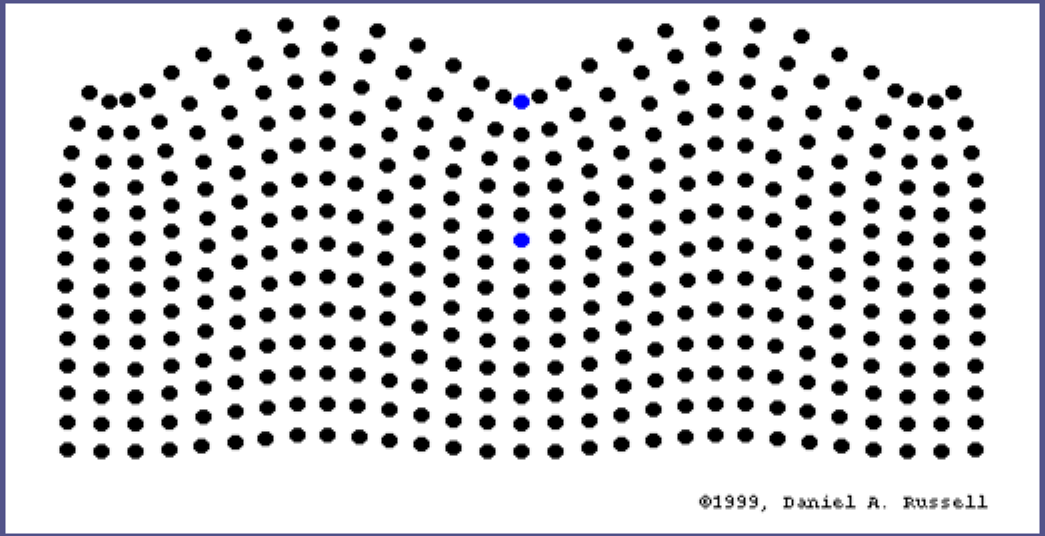


Shear waves travel at speeds lower than “P” waves and are also known as secondary, or simply “S” waves

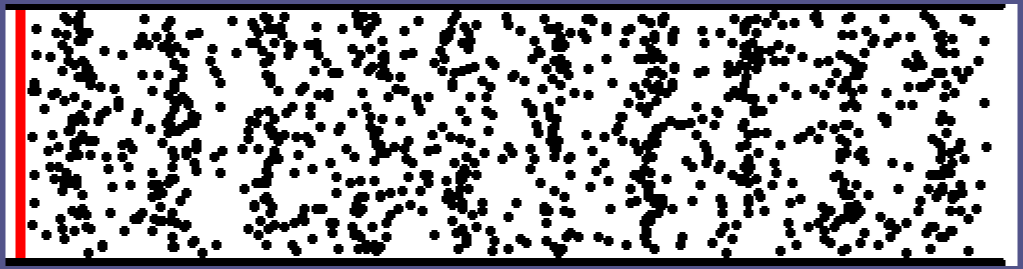
Travels through solids only

Surface Waves

Rayleigh waves



- Love Waves



Vibration Control

- $PPV = k \{ d/(w)^{1/2} \}^{-m}$ cylindrical charge
- $PPV = k \{ d/(w)^{1/3} \}^{-m}$ spherical charge

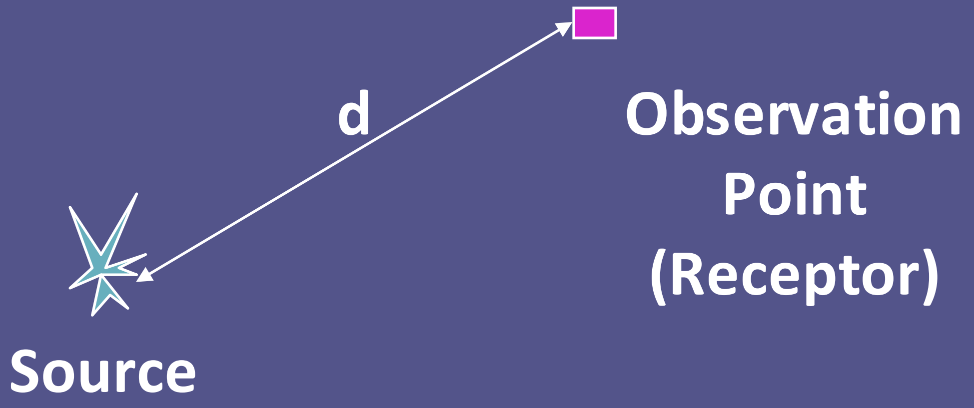
PPV = peak particle velocity (mm/s)

K = site factor (1725)

d = distance from charge (m)

w = explosive wt./delay (Kg)

m = constant = 1.6



Overpressure (Noise)

Air overpressure is the low frequency component of the of airborne shock wave or acoustic transient generated by an explosion (blast)

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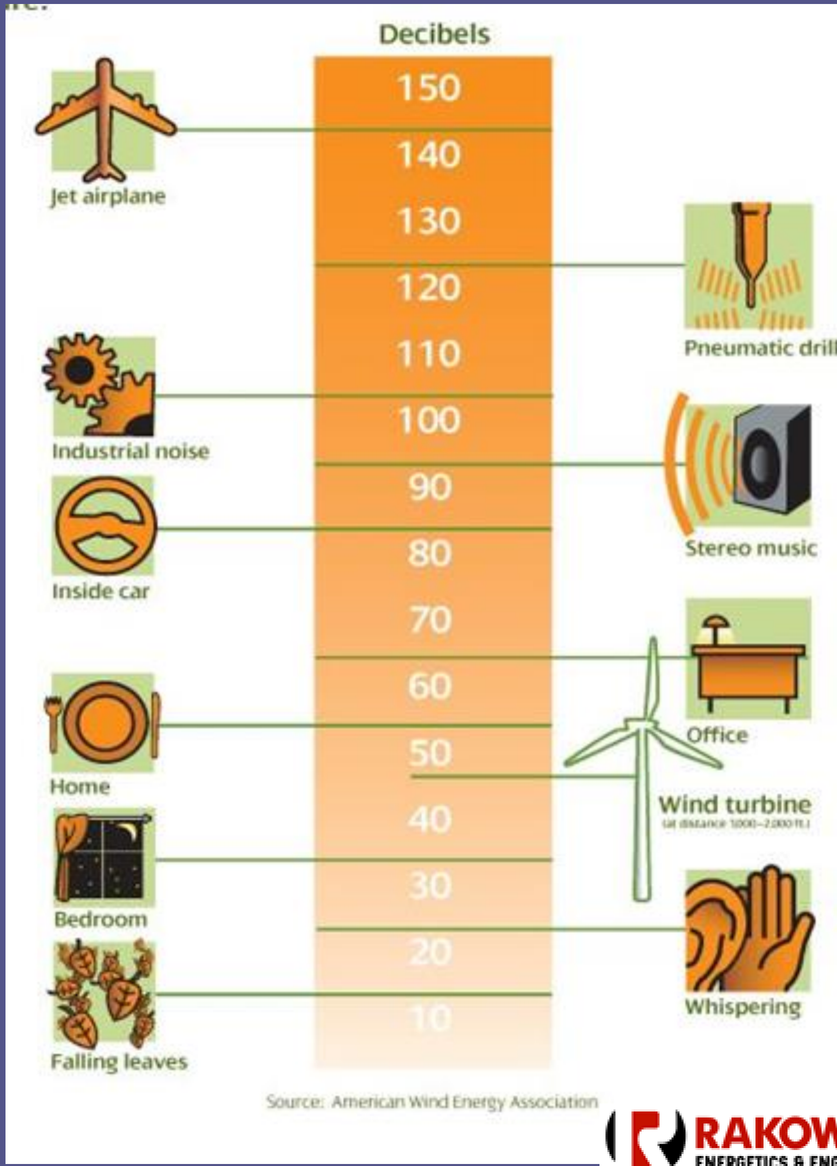
Overpressure limits are governed by the Ministry of the Environment Conservation and Parks (MECP). The upper limit for Peak Sound Pressure Level (PSPL) is 128 dB

Typical Noise Levels From Various Sources



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Flyrock Hazard

Flyrock is defined as rock fragment(s) propelled from a Blasting Site that travels beyond expected blasting area

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Flyrock Hazard

Aggregate Resources Act (ARA)
Ontario Regulation 244/97
Clause 0.13(1).28

A Licensee or permittee shall take all reasonable measures to prevent flyrock from leaving the site during blasting if a sensitive receptor is located within 500 meters of the boundary of the site.

Flyrock Causes

- Geology and rock geometry
- Lack of care and attention to details
- Blast design deficiencies
- Lack of communication between drilling crew and blasting crew

All Flyrock Are Preventable

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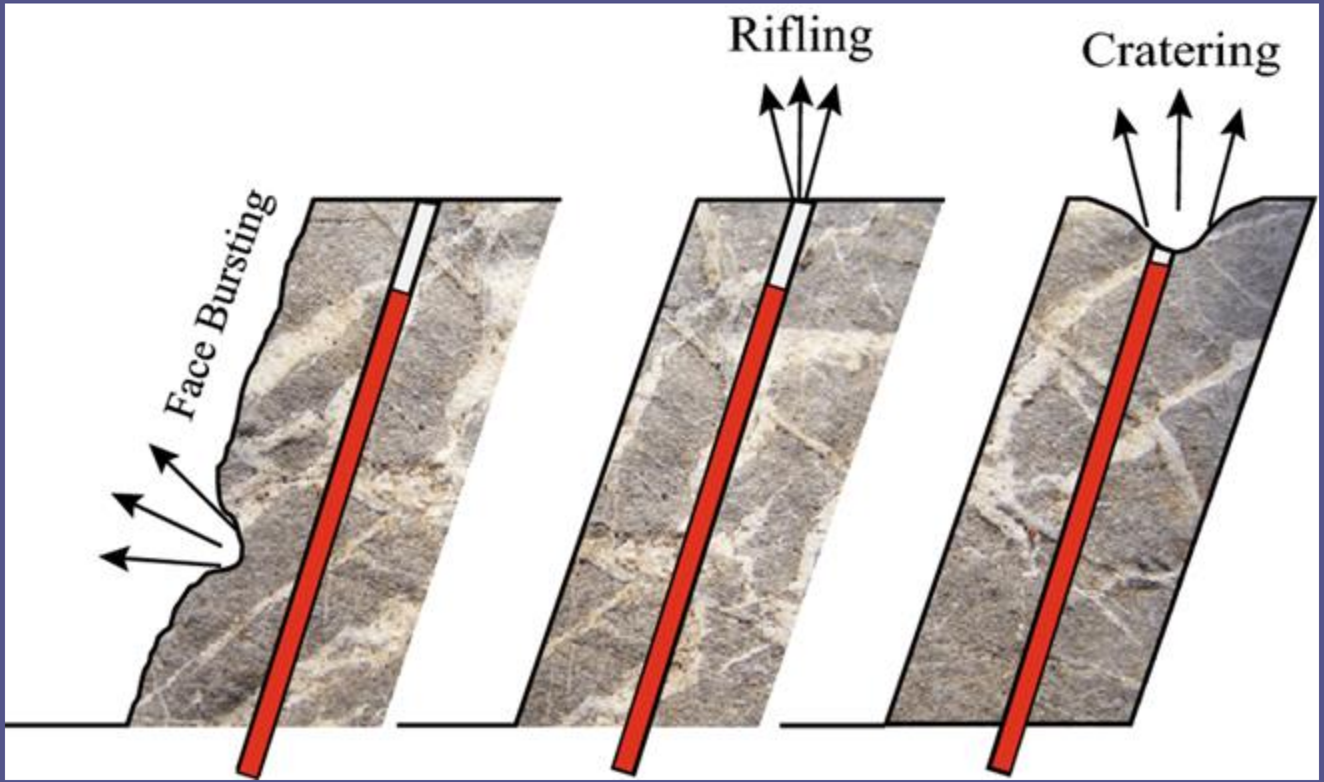
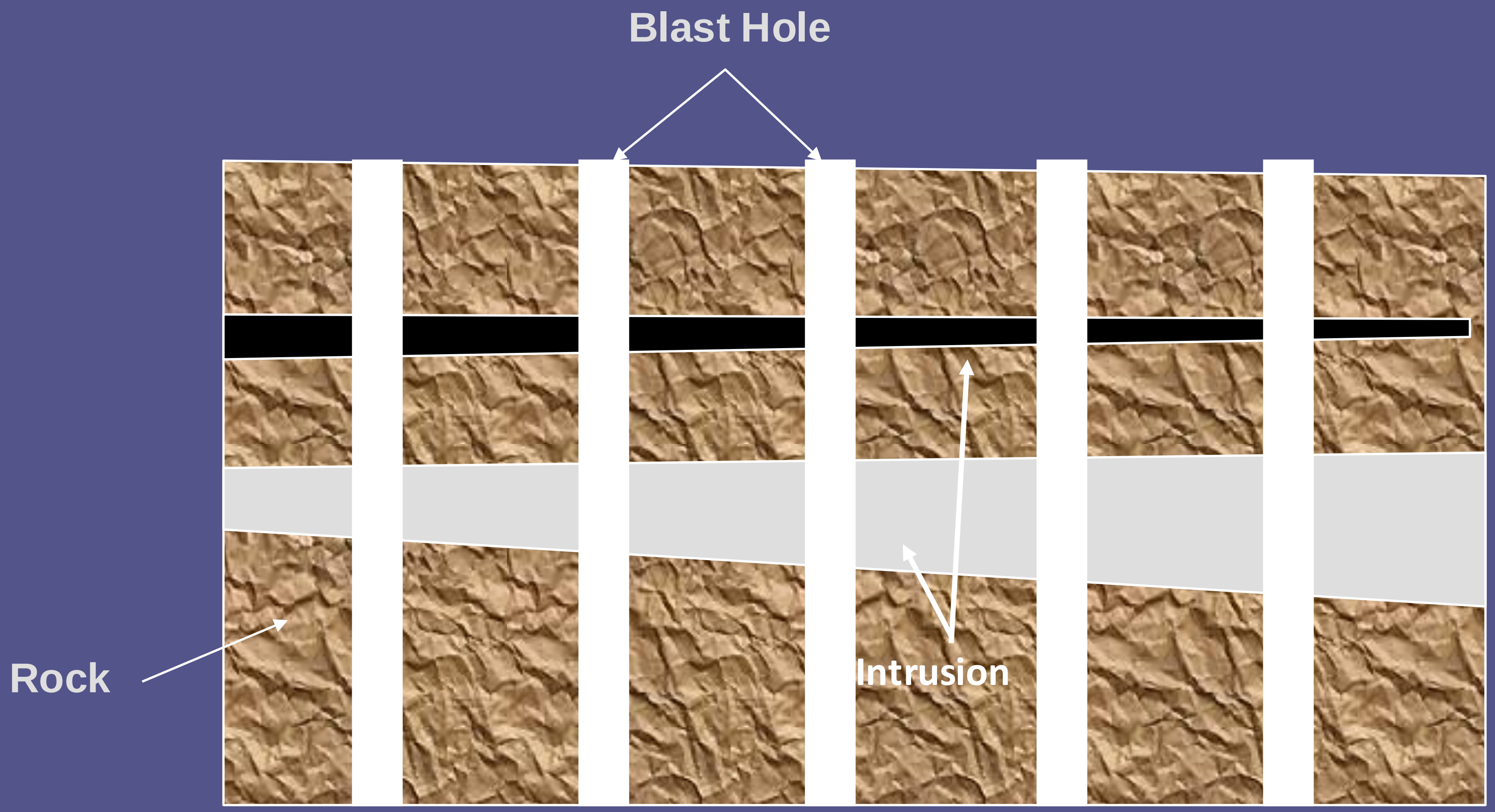
Flyrock Origin

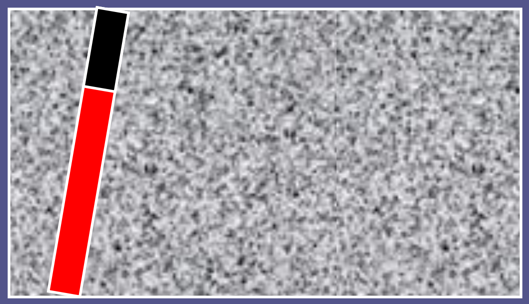


Flyrock ……Geology

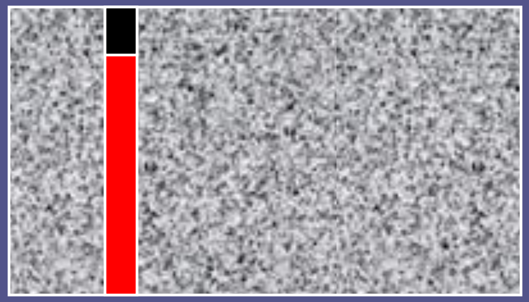


PROFILE

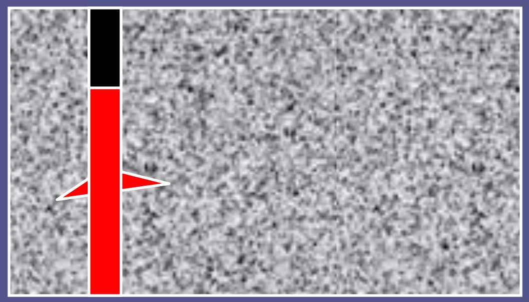
Flyrock……Other Causes



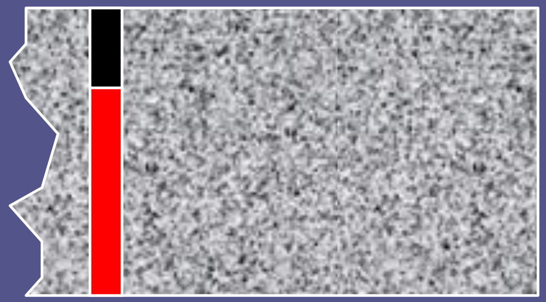
Angled Holes



Not Enough Collar



Ground Cavities



Uneven Face

Flyrock Hazard Mitigation

Flyrock can be mostly controlled by changes in controllable parameters in the blast design

- Drilling Pattern
  - Pattern too big
  - Pattern too small

- Charge Weight
  - Under loading
  - Over loading

- Initiation Sequence

- Type of Explosives

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Flyrock Hazard Mitigation

- Proper Planning
- Use of flyrock prediction models
- Communication between drillers and blasters
- Orientation of blast or direction of throw away from receptors

All blasts in a quarry must be designed so that the flyrock range does not exceed the licensed area.

OPEN FORUM (QUESTIONS)

Thank You

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