GOLDER

Golder Associates Presentation

Community Relations Committee Meeting

FEBRUARY 6, 2018

Golder Associates

- Golder monitors the impact of quarry blasting and compliance with regulatory limits for quarries throughout Southern Ontario

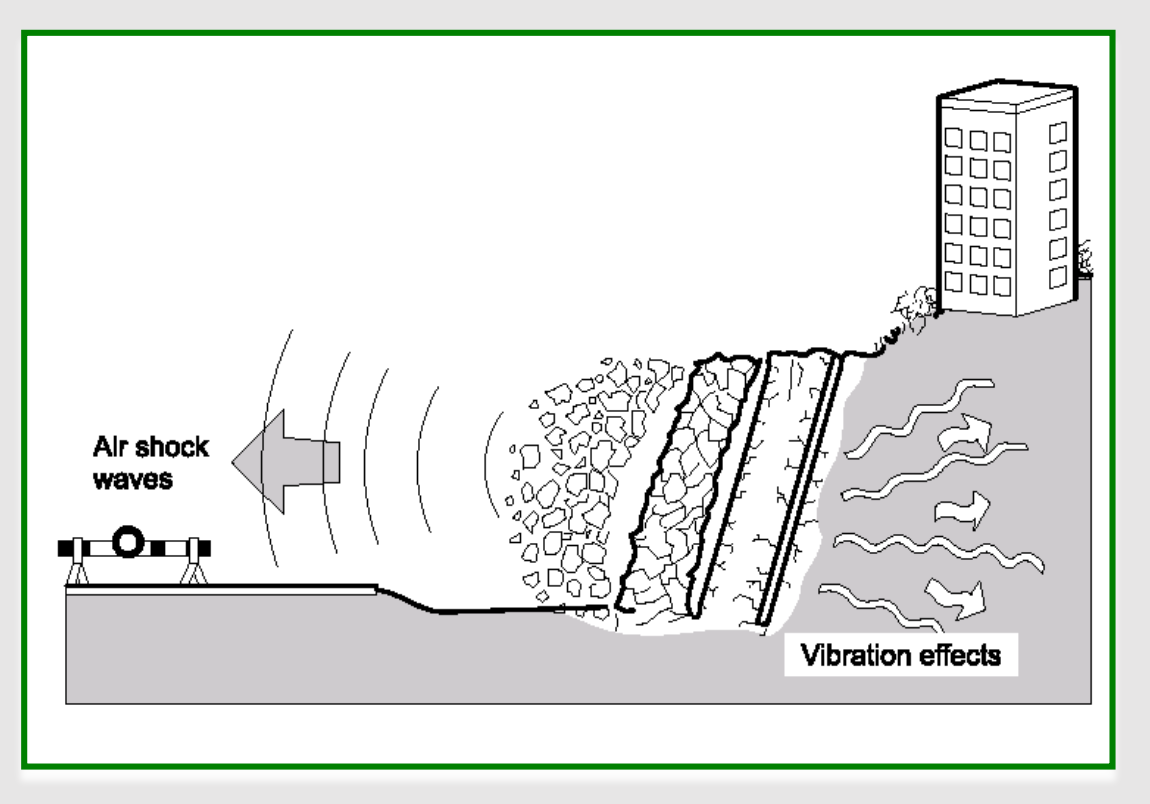
- **Daniel Corkery,** Associate & Senior Blasting Specialist
  - 32+ years professional experience
  - 28+ years of blasting experience including work in quarry, open pit, underground, construction, demolition and marine blasting.
  - Currently submits a monthly summary of the blasting vibrations recorded at the Bowmanville quarry

Drilling and Loading Blastholes

TYPICAL PHOTOS OF DRILLING BLASTHOLES AND LOADING WITH BULK EXPLOSIVES

Regulatory Requirements

Generation of Ground Vibrations & Air Concussion



Blast Vibrations and Overpressure Limits

ONTARIO QUARRIES

- The Ministry of the Environment and Climate Change (MOECC) guidelines for blasting in quarries are amongst the most stringent in North America.

- Studies by the U.S. Bureau of Mines (USBM) have shown that normal temperature and humidity changes, can have more of an impact to residences than blast vibrations and overpressure in the range permitted by the MOECC.

Blast Vibrations and Overpressure Limits

ONTARIO QUARRIES (NPC 119)

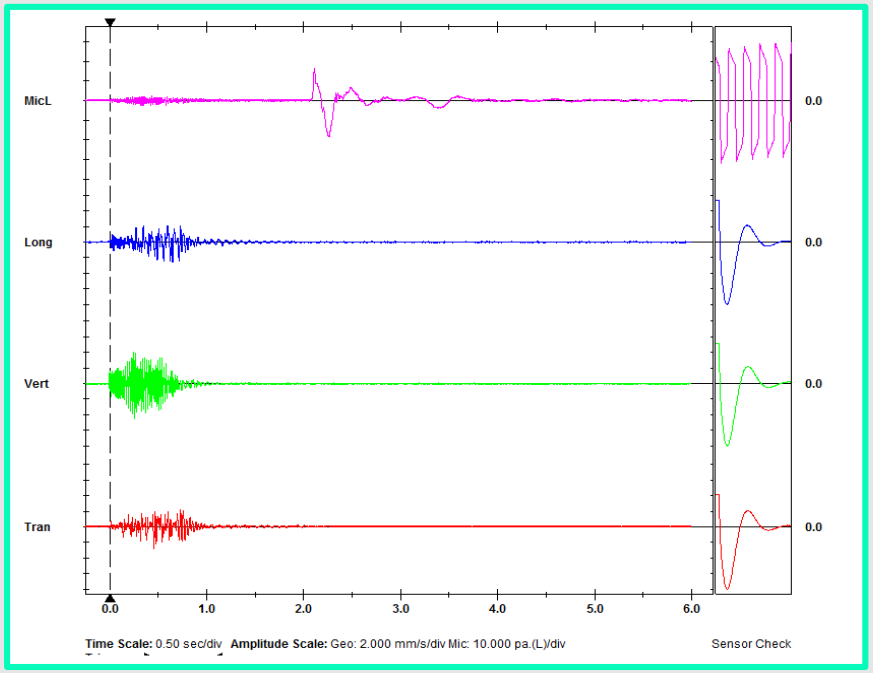
Parameters	Maximum	Monitoring Frequency	Monitoring Station
Concussion (Airblast)	128 dBL (50 pa)	Every Blast	Within 7 m of the nearest structure not located on the Site
Ground Vibration	12.5 mm/s (0.5 in/s)	Every Blast	Below grade or less than 1 m above grade in any part of the nearest structure not located on the Site

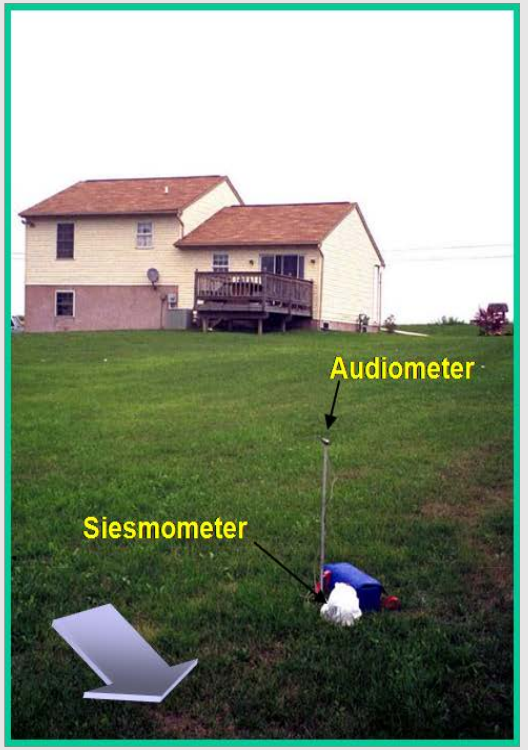
Monitoring of Ground Vibrations and Air Concussion

PHOTO OF VIBRATION MONITORING EQUIPMENT

Monitoring Vibrations Typical Setup

GRAPHICS OF VIBRATION MONITORING EQUIPMENT AND PLOTTED VIBRATION WAVEFORMS





Impact of Blast Design

- The principal influences determining peak ground vibrations and air concussion at a receptor are:
  - Distance between the blast and the seismograph (residence)
  - Maximum explosive weight per delay period (each blasthole is detonated at a separate time)
- Flyrock is controlled by the blast design - the blasts are designed to minimize flyrock range.

GROUND VIBRATIONS

Ground Vibration Characteristics

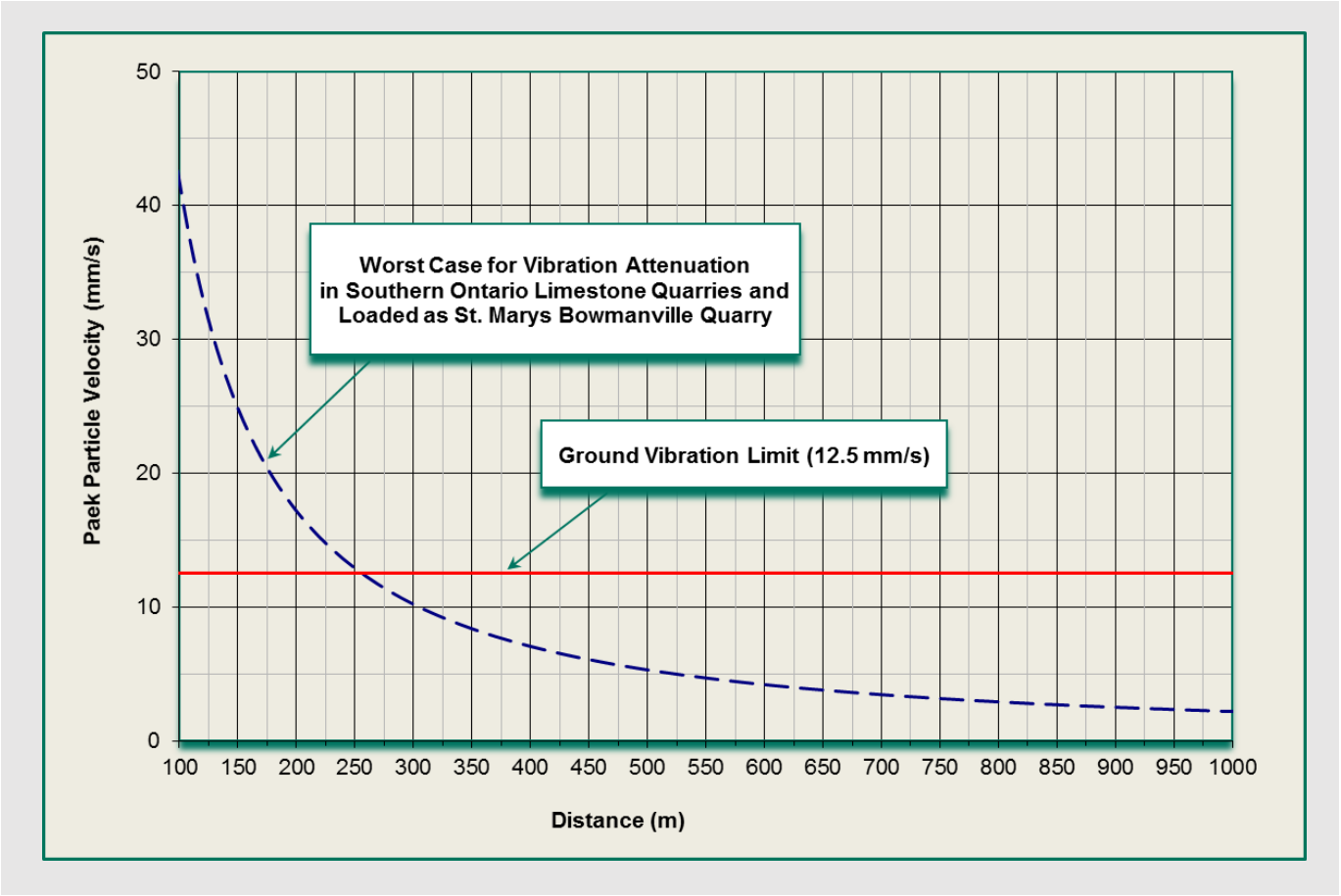
- Peak Particle Velocity (PPV) - This is the level of excitation of the particles in the ground usually measured in mm/sec

- Particle velocity is the single best ground motion descriptor and the most practical method for regulating damage potential for a class of structures

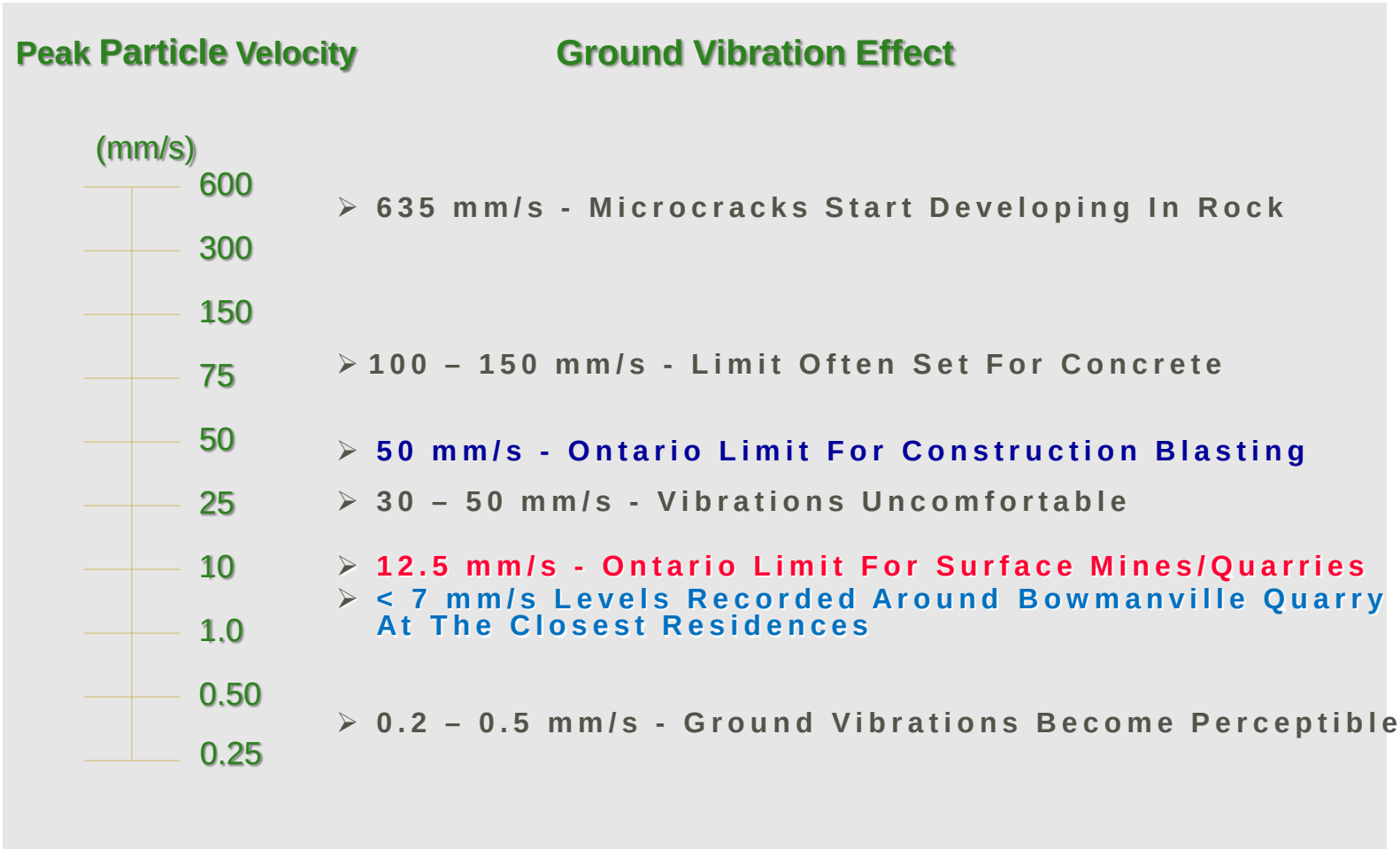
- Damage potentials for low-frequency blasts (<40 Hz.) are considerably higher than those for high frequency blasts (>40 Hz.)

Ground Vibrations & Distance

VIBRATIONS TREND DOWNWARD WITH DISTANCE



Ground Vibration Levels



AIR CONCUSSION

Air Concussion Characteristics

- Energy is transmitted within the atmosphere in the form of pressure waves
- Air pressure rises very rapidly then falls more slowly then returns to a normal value after a number of oscillations.
- Spread over a large area
- Wave consists of audible sound (noise) and concussion measured in dBL, pa or psi (for pressure)

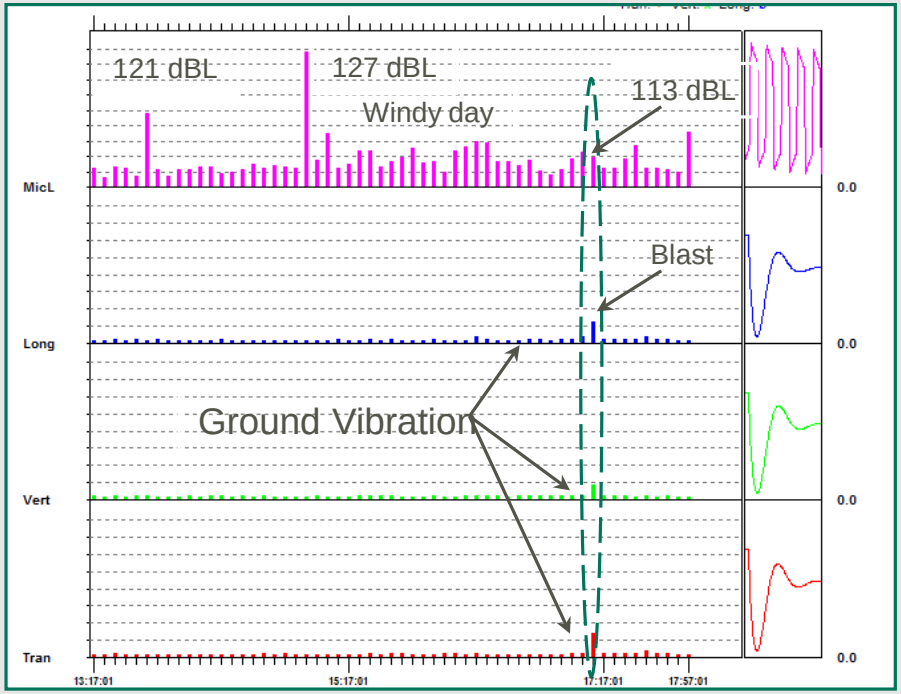
Air Concussion Levels

Overpressure (dBL)	Overpressure (psi)
181	3.00
171	1.00
161	0.30
151	0.10
141	0.03
131	0.01
121	0.003
111	0.001
101	0.0003
91	0.0001

Air Concussion Effect

- 181 dBL - Conventional structures can be severely damaged.
- 171 dBL - Most Windows break
- 151 dBL - Some windows break.
- 140 dBL - Some large, poorly set plate glass windows may break/crack (USBM reasonable threshold for glass & plaster.
- 129-134 dBL - USBM interim limit of allowable air blast (max. safe airblast levels).
- ***128 dBL – Ontario Quarry Limit (NPC 119)***
- 117 dBL - Dishes & windows may rattle
- 95 dBL – Nail-gun
- 65dBL – Ordinary conversation

Windy Day and Airblast (example)



Many wind peaks are above the blast overpressure

HUMAN RESPONSE & VIBRATIONS

Human Response to Vibration

- Human response to vibration is complex
- Dependent upon a range of factors
- Vibration magnitude is only one factor
- Human body is:
  - Very sensitive to the onset of vibration
  - Very poor at distinguishing relative magnitudes.
  - Perceive vibrations well below the onset of even cosmetic damage

Ground Vibration Perception

- Perception is dependent upon:
  - Magnitude
  - Dominant Frequencies
  - Duration

Human Perception to Air Concussion

- Human perception to airblast concussion is similar to ground vibrations
- Perception is stronger inside the house.
- Air pressure pulses from the airblast can create rattling and rumbling noises

Questions?

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Thank you for your attention.