Contents

• Introduction
• Types of dynamic testing
• Laboratory testing of rockbolts
• Interpreting results
• Using the data
Introduction

- Good understanding of static loading requirements for ground support
- Support performance under static / quasi-static loading easier to test
Introduction

- Dynamic demand for rock support more difficult to quantify
- Performance of support under dynamic loading more difficult to test
Introduction

Static support performance ≠ dynamic support performance

Different Energy Capacity
Introduction

• Uncertainty in the dynamic demand placed on ground support
• Limitations in our understanding of ground support’s dynamic performance

Yet

• Increasing mining depths changing ground conditions
  (deepest mine heading to depth of 4km)
• Mining increasingly difficult orebodies

Introduction
Types of Dynamic Testing

• Observation

• Blasting / Explosive Methods

• Underground testing of support and reinforcement elements

• Laboratory testing of support systems

• Laboratory testing of individual support elements
Laboratory Testing of Rockbolts

• Facilities
  – WASM, Curtin University
  – Momentum Transfer loading
  – Tests tendons and systems

“Dynamic testing of rock reinforcement using the momentum transfer concept”
Player, J.R.; Villaescusa, E; Tompson, A.G., 2004
Laboratory Testing of Rockbolts

• Facilities
  – CanmetMining, Canada
  – Impact loading mechanism
  – Tests individual tendons
  – 62 kJ max, 6.5 m/s max

“Rock bolts testing under dynamic conditions at Canmet-MMSL”
Plouffe, M; Anderson, T; Judge, K
Laboratory Testing of Rockbolts

- Facilities
  - Dynamic Impact Tester, NCM
  - Impact loading mechanism
  - Max. Impulse: 65 kJ
    - Max. Impact Velocity: 6.42 m/s
    - Max. Sample Length: 3.5 m
    - Height of Structure: 8.2 m
Laboratory Testing of Rockbolts

- HD slow motion analysis

Energy absorbed 55 kJ
Impact velocity 5.4 m/s
Interpreting results

- Test configuration

Continuous Tube Test

Split Tube Test
Interpreting results

- Impact velocity and input energy
Interpreting results

• What’s been recorded and presented

Typical Load and Displacement Curves over the period of a single drop

Impact Load (kN)  Plate Load (kN)  Toe Displacement (mm)  Plate Displacement (mm)

Period of First Impulse  Period of a single Drop

Plate Displacement  Trolley at Rest

Multiple Dampened Bounces  Toe Displacement
Interpreting results

• Load and Displacement vs Time

Ø25mm Par1 Resin
V = 5.4 m/s, E = 17.4kJ
Interpreting results

- Load and Cumulative Energy vs Displacement

Ø25mm Par1 Resin
V = 5.4 m/s, E = 17.4kJ

Unloading of intact bolt

New Concept Mining
Innovative Performance
© NCM 2018
Interpreting results

- Compounding of multiple dynamic events

Ø25mm Par1 Resin
V = 5.4 m/s, E = 6 x 17.4kJ
Interpreting results

- Repeatability

4 x Ø20mm MP1
V = 5.4 m/s, 4 x 17.4kJ
Interpreting results

- Energy Absorption vs deformation
Using the data

- Energy Absorption
Choosing a bolt

Using the data
Using the data

- Validating support design

Magnitude 1.4 event
Using the data

- Validating support design
Using the data

- Validating support design

<table>
<thead>
<tr>
<th>Bolt</th>
<th>Displacement (mm)</th>
<th>Predicted Energy (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulcan Ø20mm</td>
<td>0.0</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>11.5</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>18.3</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>20.6</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>22.9</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>34.4</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>38.9</td>
</tr>
<tr>
<td></td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

© NCM 2018
Conclusion

- Increasing understanding of dynamic performance
- Improved analysis of support performance underground
- Better informed selection of dynamic support
Questions?

brendanc@newconceptmining.com