Dynamic Testing: Determining the residual capacity of an axially strained tendon

G Knox & A Berghorst: GS2019
To quantify the potential risk of failure both the potential demand and residual capacity of the support system needs to be quantified.

01 DEMAND?

02 TOTAL CAPACITY?

03 RESIDUAL CAPACITY?
Concept of Degradation

![Graph depicting the concept of degradation over time and performance level.](https://via.placeholder.com/150)

Hadjigeorgiou, J 2016
Sources of Degradation

- Bolt Design / System interaction
- Installation Practices
- Material Handling
- Corrosion
- Ground Movement
Laboratory Testing

"the main advantage of the drop test approach lies in the capacity to perform a relatively large number of tests at a reasonable cost without interfering with mining operations." (Hadjigeorgiou & Potvin, 2011)
Objective

Determine the residual capacity of a pre-strained tendon to a dynamic impact
Loading Cycle

\[ E_{QS}(40) \]

\[ E_{DYKN}(40) \]
Effect of Input Energy

“the cumulative energy absorption is inversely proportional to the impact energy”

Berghorst et.al (2018)
## Testing Conditions

<table>
<thead>
<tr>
<th>Elongation</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 mm</td>
<td>3</td>
</tr>
<tr>
<td>40 mm</td>
<td>3</td>
</tr>
<tr>
<td>70 mm</td>
<td>3</td>
</tr>
<tr>
<td>100 mm</td>
<td>2</td>
</tr>
</tbody>
</table>
Elastic Displacement
Host Tube Design

Overcome elastic component of the deformation
Prevent damage to the resin as a result of welding
Quasi-Static Loading
Loading Configuration

- Impact Plate Welded to Sample Tube
- Impact Load Cell
- Nut
- Plate Load Cell
Loading Configuration
Dynamic Impulse Parameters

- $m_{\text{trolley}} = 3175$ kg
- $h = 1.8$ m
- $v = 5.8$ m/s
- Input Energy = 56 kJ
Results

Pre-Elongated Dynamic Average Load Time Curves
Input Energy: 55.6 kJ; Impact Velocity: 5.9 m/s
Results
Results

Total Energy Contribution

- Quasi-static Energy \([E_{qs}]\)
- Dynamic Energy \([E_{dy}]\)

![Bar chart showing total energy contribution for different samples with a split between quasi-static and dynamic energy categories.](chart.png)
Conclusion

Summary of Dynamic Testing of Strained PAR1 Resin Bolts
Input Energy: 55.6 kJ; Impact Velocity: 5.9 m/s

- Quasi-static
- 0_mm Avg.
- 40_mm Avg.
- 70_mm Avg.
- 100_mm Avg.

Trend in Ultimate Load
Dynamic load trendline
Shift in Displacement

$$E_{QS}(40)$$  $$E_{DYN}(40)$$
Future Work

- Instrumentation of the load frame
- Vary loading cycle
- Larger sample sets
- Further interrogation of the result
- Change the loading cases (shear/bending)
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