<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Load tests on arches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors(s)</strong></td>
<td>Fanning, Paul</td>
</tr>
<tr>
<td><strong>Publication date</strong></td>
<td>2018-06-08</td>
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<tr>
<td><strong>Conference details</strong></td>
<td>1st UIC Workshop on Masonry Arch Bridges, Madrid, Spain, 7 - 8 June 2018</td>
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<tr>
<td><strong>Item record/more information</strong></td>
<td><a href="http://hdl.handle.net/10197/10465">http://hdl.handle.net/10197/10465</a></td>
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</table>
Load Testing

- Expensive, disruptive, time consuming
- Why?
  - Improved understanding of structural response of bridge
  - Verify serviceability load capacity in conjunction with an assessment tool
  - Validate numerical models
  - Complex irregular geometries
  - ........
- Rich source of data & understanding
Load Testing

- Appendix F provides guidance on:
  - Test planning
  - Loads
  - Judging results
  - Limits of applicability

- Static, Quasi-static or Dynamic
  - What to measure?
  - Deflection, strain, crack opening, acceleration, etc.

- Interpreting results
  - consistent with expectation
  - Repeatability? Linearity? Predictability?
Load Testing

Stone Arch Bridge Research at UCD

- **Testing**, Modeling, Assessment

- 1999 – 2014

- National Roads Authority (Ireland)
- ICE (UK)
- EU FP5 Marie Curie Host Fellowship Scheme
- Dublin County Council
- UIC
Context: “Stone Arch Bridges”....
..particularly those characteristic of Irish bridge population.

16,000 arch bridges, 80% total

Very few brick arches!

..predominantly single span short bridges of sub-standard width!
..tested 8 bridges...one to very high load levels...

Griffith Bridge
Dublin, 1792
9.5m span

Killeen Road Bridge
Dublin
9.3m span, 2.65m rise
Span/rise = 3.5
Rq/rc = 0.88

Cabra Road Bridge, N3 Dublin - Blanchardstown
Square span 8.9m, skew span 10.42m, rise 2.65m
Span/rise ratio = 3.9, 3.3
Rq/rc = 0.83

Eldon Bridge, NB1, Wicklow
8.4 span, 2.02m rise (x2): span/rise ratio = 4.2, rq/rc = 0.78
10.6m span, 2.31m rise (x1): span/rise ratio = 4.6, rq/rc = 0.78

Sarah Bridge, Dublin, 1793
31.8m span, 6.58m rise
Span/rise ratio = 4.8
Rq/rc = 0.8

Paul Fanning
<table>
<thead>
<tr>
<th>Condition</th>
<th>Front Axle (tonnes)</th>
<th>Axle 2 (tonnes)</th>
<th>Axle 3 (tonnes)</th>
<th>Total (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty</td>
<td>12.7</td>
<td>4.90</td>
<td>4.90</td>
<td>22.6</td>
</tr>
<tr>
<td>Half-Full</td>
<td>13.6</td>
<td>11.7</td>
<td>11.7</td>
<td>37.0</td>
</tr>
<tr>
<td>Full</td>
<td>14.1</td>
<td>15.7</td>
<td>15.7</td>
<td>45.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Weight Rear Axles</th>
<th>Peak Deflections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty : Full</td>
<td>0.31</td>
<td>0.33</td>
</tr>
<tr>
<td>Empty : Half-Full</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>Half-Full : Full</td>
<td>0.75</td>
<td>0.77</td>
</tr>
</tbody>
</table>
Griffith Bridge

<table>
<thead>
<tr>
<th>Griffith Bridge</th>
<th>Rear Axles (tonnes)</th>
<th>$\delta_{\text{max}}$ (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Truck</td>
<td>10.3</td>
<td>0.41</td>
</tr>
<tr>
<td>Empty Truck</td>
<td>6.2</td>
<td>0.26</td>
</tr>
</tbody>
</table>

$(0.41/10.3) \times 6.2 = 0.25 \text{ vs. } 0.26$
Modified MEXE (BA16/97)

MAL = Fsr Fp Fm Fj Fc (PAL)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisional axle load</td>
<td>16.86 T</td>
</tr>
<tr>
<td>Condition factor</td>
<td>0.9</td>
</tr>
<tr>
<td>Modified Axle Load</td>
<td>7.4 T</td>
</tr>
<tr>
<td>Allowable, single axle</td>
<td>11.7 T</td>
</tr>
<tr>
<td>Allowable, double axle</td>
<td>7.4 T</td>
</tr>
<tr>
<td>Allowable, triple axle</td>
<td>6.4 T</td>
</tr>
</tbody>
</table>

But....

......Test Truck : 2 rear axles each 10.3T !!

......measurements = linear, elastic, repeatable
Three Dimensional Response!
Peak abutment deflection of similar magnitude to crown deflection!
Load Testing

- Linearity of response within load range tested
- Repeatability of response
- Significance of abutment deflections
- Three dimensional nature of response