Grand Hornu (Mons) Coal mining complex
UNESCO 2012 / MAC
Damage progress assessment on textile reinforced cement retrofit patches attached to traditional masonry using acoustic emission

Eleni Tsangouri, David Martin Linn III, Dimitrios G. Aggelis
Textile reinforced cement (TRC) repair solution

TRC repair patch for the restoration of masonry heritage structures
TRC to masonry substrate bond

Complex testing procedure

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10.1617/s11527-018-1216-x
TRC-substrate samples preparation and casting

- **90° steel block**
- **Red brick**: CEM I 42.5 R
- **Bonded area**: 100x250 mm
- **TRC thickness**: 10 mm

Wall construction supported & leveled 28 days curing

Surface roughness:
- Rough (no preparation)
- Smooth (grinder used)

<table>
<thead>
<tr>
<th>Mesh (mm)</th>
<th>Tens. strength (Mpa)</th>
<th>Density (g/m²)</th>
<th>E (Gpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITGRID 200</td>
<td>17.5</td>
<td>526</td>
<td>653</td>
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<tr>
<td>SITGRID 017</td>
<td>13</td>
<td>814</td>
<td>578</td>
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<tr>
<td>SITGRID 701</td>
<td>22.5</td>
<td>496</td>
<td>308</td>
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</table>

Wood formwork
Textile clamped between formwork blocks

! Bricks irregularity
TRC-substrate samples test set-up, support setting and testing

RILEM TC 250-CSM
Grips to Instron: pair of aluminum plates + epoxy glue (100x60x2mm)

Instron5885 100kN load cell
Test rate: 0.2 mm/min

“Reacting Steel Frame”
Plaster at top/bottom + fastened steel plates

Unbonded length=400mm
## TRC-substrate bond tests results

<table>
<thead>
<tr>
<th>Textile Material</th>
<th>Surface Treatment</th>
<th>Support System</th>
<th>Fiber Volume Fraction</th>
<th>Specimen Number</th>
<th>Ultimate Load</th>
<th>Displacement at Ultimate Load</th>
<th>Load at 1st Masonry Debonding</th>
<th>Final Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>Rough</td>
<td>Free</td>
<td>Low Vol Frac</td>
<td>1</td>
<td>2.5 kN</td>
<td>8.8 mm</td>
<td>N/A</td>
<td>E1</td>
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<tr>
<td></td>
<td></td>
<td>Free</td>
<td>High Vol Frac</td>
<td>2</td>
<td>4.5 kN</td>
<td>7.0 mm</td>
<td>N/A</td>
<td>D</td>
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<tr>
<td></td>
<td>Smooth</td>
<td>Free</td>
<td>High Vol Frac</td>
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<td>4.1 kN</td>
<td>11.5 mm</td>
<td>N/A</td>
<td>D</td>
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<tr>
<td>Carbon</td>
<td>Rough</td>
<td>Free</td>
<td>High Vol Frac</td>
<td>1</td>
<td>9.0 kN</td>
<td>9.5 mm</td>
<td>7.2 kN</td>
<td>D/C</td>
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<td></td>
<td>Free</td>
<td>High Vol Frac</td>
<td>2</td>
<td>10.3 kN</td>
<td>16.2 mm</td>
<td>8.4 kN</td>
<td>C</td>
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<tr>
<td></td>
<td>Fixed</td>
<td>High Vol Frac</td>
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<td>13.5 kN</td>
<td>12.3 mm</td>
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<td>Carbon</td>
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<td>Free</td>
<td>High Vol Frac</td>
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<td>8.7 kN</td>
<td>11.3 mm</td>
<td>7.0 kN</td>
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<td>Fixed</td>
<td>High Vol Frac</td>
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<td>N/A</td>
<td>D/E1</td>
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<tr>
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<td></td>
<td>Free</td>
<td>High Vol Frac</td>
<td>3</td>
<td>13.8 kN</td>
<td>10.5 mm</td>
<td>12.5 kN</td>
<td>C</td>
</tr>
</tbody>
</table>
TRC-substrate bond tests results

Pictures taken after the test

- Masonry
- Masonry
- Masonry

Load (N) vs. Displacement (mm)

Failure
RILEM TC 212-ACD: acoustic emission and related NDE techniques for crack detection and damage evaluation in concrete

In-plane excitation on the side: beam & plate

Excitation on the surface: beam & plate

TRC-substrate bond tests results


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Dimension Effects on the Acoustic Behavior of TRC Plates

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TRC-substrate bond tests results – AE hits analysis
TRC-substrate bond tests results – AE hits analysis
Conclusions

✓ Complex damage progress revealed only by using RT-AF AE parameter trends

✓ Damage characterisation based on failure modes

✓ Elimination of interference with secondary effects and noise

✓ Still tests to be done in other TRC materials and under dynamic service loads (i.e. earthquake)

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