DURABILITY STUDIES ON GFRP REINFORCING BARS IN CONCRETE STRUCTURES CONDUCTED AT THE UNIVERSITY OF SHERBROOKE

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OBJECTIVES

To determine the effect of ageing in the field on GFRP materials used as main reinforcement in five concrete bridges in Canada.

1. Joffre Bridge, QC (ribbed-deformed C-BAR, 2 types);
2. Crowchild Bridge, AB (ribbed-deformed C-BAR);
3. Hall’s Harbour, NS (sand-coated ISOROD bar);
4. Waterloo Creek, BC (NEFMAC grid);
5. Chatham, ON (NEFMAC grid).

SPECIFIC: Microscopic and physico-chemical analysis on core samples.
## TECHNIQUES

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>TECHNIQUE</th>
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<tbody>
<tr>
<td></td>
<td>OM</td>
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<tr>
<td>GFRP/Concrete Interface</td>
<td>✓</td>
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<tr>
<td>Micro-cracking and Physical Degradation of Fibres, Resin and Glass Fibres/Resin Interface</td>
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<tr>
<td>Degradation and Thermal Properties of Resin Matrix</td>
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<td>Chemical Degradation of Resin</td>
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<td>Concrete Structure</td>
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**OM**: Optical Microscopy; **SEM**: Scanning Electronic Microscopy; **DSC**: Differential Scanning Calorimetry; **FTIR**: Fourier Transform Infrared Spectroscopy.
RESULTS

Optical Microscopy:

- Joffre Bridge X8
- Crowchild Bridge X40
- Hall’s Harbour Bridge X40

Interface concrete/ GFRP:

- Intimate
- No debonding
- No microcracking
- No void
Scanning Electronic Microscopy:

- No resin microcracking
- No glass fibre degradation
- No significant delamination/debonding
RESULTS (Cont…)

Differential Scanning Calorimetry:

Thermogramm of 9mm GFRP bar from Joffre Bridge
(left: in service and right: reference)

- No glass transition (Tg) decrease
- No sign of chemical degradation of the resin
## RESULTS (Cont…)  

Calorimetry Results for GFRP Materials: Glass Transition Temperatures \( (T_g) \)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tg (1st run) ( (^\circ C) )</th>
<th>Tg (2\textsuperscript{nd} run) ( (^\circ C) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>JBB (Ref.) (15 mm)</td>
<td>107</td>
<td>108</td>
</tr>
<tr>
<td>JBB (15 mm)</td>
<td>107</td>
<td>108</td>
</tr>
<tr>
<td>JBS (Ref.) (9 mm)</td>
<td>123</td>
<td>126</td>
</tr>
<tr>
<td>JBS (9 mm)</td>
<td>127</td>
<td>128</td>
</tr>
<tr>
<td>CB</td>
<td>126</td>
<td>129</td>
</tr>
<tr>
<td>HH (Ref.)</td>
<td>105</td>
<td>125</td>
</tr>
<tr>
<td>HH</td>
<td>123</td>
<td>125</td>
</tr>
<tr>
<td>WC</td>
<td>78</td>
<td>117</td>
</tr>
<tr>
<td>CHB</td>
<td>98</td>
<td>116</td>
</tr>
</tbody>
</table>
RESULTS (Cont…)

Infrared (FTIR):

FTIR spectra of Joffre Bridge GFRP (C-BAR 9 mm) (left: reference; right: core sample)

- No chemical degradation (hydrolysis)
RESULTS (Cont…)

X-Ray Diffraction:

X-Ray diffratogramm of Crowchild Bridge Concrete Samples

- Concrete not affected
CONCLUSIONS

- The adhesion of concrete to GFRP reinforcement has not been affected with time under field conditions.
- The different components of the reinforcement did not show any significant changes due to the service.
- The resin matrix and glass fibres were not affected by chemical degradation.
- The concrete embedding the different GFRP materials was not affected.
- The different microstructural analyses performed demonstrate that the GFRP bars have not been affected by the service conditions.