Bond Characterization of FRP Laminates to Steel

Investigators: Anja Frauenberger (Graduate Student)
P.F. Silva (Faculty)
Sponsored by: FRA – Federal Railway Administration

June 5th-6th 2003

Background
Section loss due to corrosion and an increase of the load on steel structures require efficient strengthening. The use of FRP appears to be an alternative to conventional strengthening methods, but has to be further investigated.

Objectives
1. Characterize the bond behavior of pre-cured FRP laminates to steel.
2. Develop design approach for the application of pre-cured FRP laminates to steel.

Test Matrix
Adhesive Type:

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnForce CFL</td>
<td>1</td>
</tr>
<tr>
<td>Sikadur 30</td>
<td>3</td>
</tr>
<tr>
<td>Sikadur 31</td>
<td>3</td>
</tr>
<tr>
<td>Tyfo MB I</td>
<td>3</td>
</tr>
<tr>
<td>S&amp;P Resin 220</td>
<td>3</td>
</tr>
</tbody>
</table>

Conclusions
1. Two different strain distributions were observed as a result of using different adhesives: brittle and ductile.
2. Different design approaches are necessary depending upon the strain behavior.

Observed Strain Distributions

Brittle
- EnForce CFL
- Sikadur 30 & 31
- S&P Resin 220

Ductile
- Tyfo MB I

Strain Profiles

Bond Stress Profiles

Bond Stress Distribution (max values)

Suggested Design Approach

\[ f_{\text{lim,frp}} = \alpha \cdot \mu_{\text{max}} \cdot \frac{I_d}{2 \cdot t_{\text{frp}}} \]
\[ I_b = \alpha \cdot 2 \cdot t_{\text{frp}} \cdot \frac{f_{\text{uu,frp}}}{\mu_{\text{max}}} \]

\( f_{\text{lim,frp}} \) ... factor of safety
\( I_d \) ... FRP laminate thickness
\( I_b \) ... stress in the FRP laminate

All specimens were fabricated with the CFRP laminate 200/2000, had a bonded length of 9in and an adhesive thickness of 80mils.