FLEXURAL AND SHEAR REINFORCEMENT OF REINFORCED CONCRETE BEAMS USING FIBER REINFORCED POLYUREA COATINGS

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Challenges and Significance

The use of polyurea coatings as a blast damage mitigation barrier has been well-researched and supported, and the addition of chopped fibers has been shown to increase the coating strength (Carey and Myers, 2010), however, the application of strengthened polyurea systems to structures has not been documented. The development of strengthened polyurea coating systems could yield a multi-hazard retrofit material suitable for at-risk aging structures.

Test Details

1. Reinforced concrete beams were considered for flexural and shear type failures. Selected beams were coated on the bottom and sides (U-shape) with polyurea and fiber-reinforced polyurea and compared to non-coated control specimens. One beam was tested for each coating scheme shown.

<table>
<thead>
<tr>
<th>Coating Description</th>
<th>Code</th>
<th>Vf (%)</th>
<th>Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control – No Coating</td>
<td>F-C</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Polyurea A, No Fiber</td>
<td>F-P-A-0</td>
<td>0%</td>
<td>2147</td>
</tr>
<tr>
<td>Polyurea A, Lower Fiber Ratio</td>
<td>F-P-A-L</td>
<td>3.0%</td>
<td>1004</td>
</tr>
<tr>
<td>Polyurea B, Lower Fiber Ratio</td>
<td>F-P-B-L</td>
<td>7.2%</td>
<td>1403</td>
</tr>
<tr>
<td>Polyurea B, Higher Fiber Ratio</td>
<td>F-P-B-H</td>
<td>10.8%</td>
<td>1859</td>
</tr>
<tr>
<td>Control – No Coating</td>
<td>S-C</td>
<td>N/A</td>
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</tbody>
</table>

2. Flexural beams were tested in 4-point loading during which deflection and strain values in concrete and coating were monitored. Shear beams were tested in a similar setup utilizing different load spans in order to obtain two tests from each region and determine coating contribution to shear capacity.

Important Findings

1. The polyurea coating systems provided additional flexural reinforcement that resulted in ultimate capacities as much as 24% greater than the control case (non-coated beam).
2. The deflection of polyurea-coated beams as opposed to non-coated beams was up to 94% greater.
3. The ductility of the coated beams was substantially greater than that of the non-coated beams. Polyurea B with 7% fiber volume fraction developed an increase in ductility of 30% and overall ductility was increased by as high as 160% with various polyurea coating systems.
4. The shear capacity of the coating system was measured to be 2.3 k (10.2 kN) in the case of Polyurea A with low fiber volume fraction, and greater than 6.2 k (27.6 kN) in the case of Polyurea B with high fiber and larger coating thickness.

Research to Reality

1. Develop improved manufacturing processes yielding higher volume fractions of fiber with consistent fiber distribution for higher strengthening capabilities
2. Complete advanced blast testing and blast modeling, in addition to advanced modeling of flexural and shear reinforcement behaviors
3. Yield multi-hazard repair/reetrofit technique

State of the Art

• Investigated a new strengthening technique for multi-hazard mitigation

References


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