**The Use of Recycled Concrete Aggregate for Rigid Pavements**

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**Research Objective**

To investigate mechanical properties of recycled and virgin concrete aggregates for use in rigid pavements.

Secondary objectives are to investigate the:
- Effect of recycled coarse aggregate on concrete fracture and drying shrinkage properties
- Effect of synthetic fibers on recycled concrete aggregate concrete

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**Background**

Recycling concrete is a viable option to decrease the use of natural resources and a way to limit the amount of construction waste disposal. Recycled materials such as concrete are typically used as unbound material layers in the base or subbase. However, there is no technical reason why recycled concrete cannot be used to construct concrete pavements. In fact, the state of Illinois has previously used recycled concrete in transportation projects. In 1986, the Illinois Department of Transportation (IDOT) used recycled concrete on two interstate construction projects. The first project was completed on a 4 mile stretch of I-57 near Effingham, Illinois. A 10-inch continuously reinforced concrete inlay with a widen lane was constructed. Approximately 80 percent of the aggregates used in the concrete surface were from recycled concrete. A second project also on I-57, south of Ullin, Illinois, used recycled concrete aggregates (RCA) for an asphalt concrete pavement inlay.

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**RCA Technical Issues**

- Decrease in strength and modulus
  - Contributing factors:
    - Concrete mixture, blending percentage, water-cement ratio, RCA gradation
- Greater moisture shrinkage potential (drying and autogeneous)
- Shrinkage may be same or reduced if RCA is presoaked to provide internal curing
- Higher absorption capacity
  - RCA 3% - 9%
  - Virgin 1% - 2%
- Lower bulk specific gravity
- Workability can be reduced due to the greater absorption capacity

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**Virgin & Recycled Concrete Aggregate**

This figure shows virgin aggregate (left) and RCA (right)

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**Methodology**

The recycled concrete aggregate was sieved and meet IDOT CA-7 specifications.

The Bulk Specific Gravity and absorption capacity were determined for RCA.

Four different concrete mixtures were used. The first and second used virgin coarse aggregate with the addition of synthetic fibers to the second mix. The third and fourth used recycled concrete aggregate with the addition of fibers in the fourth mix.

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**Results and Discussion**

**Drying Shrinkage**

<table>
<thead>
<tr>
<th>Material</th>
<th>Virgin Concrete</th>
<th>RCA</th>
<th>RCA FRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.023</td>
<td>3.13</td>
<td>3.94</td>
<td>4.95</td>
</tr>
<tr>
<td>28.2</td>
<td>Lb/C</td>
<td>Lb/C</td>
<td>Lb/C</td>
</tr>
</tbody>
</table>

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**Experimental Procedure**

The compression and tensile split samples measured 8 inches in height and 4 inches in radius. The compression and split tension samples were tested in accordance to ASTM C39 and ASTM 496, respectively. ASTM 107-99 was used to test the drying shrinkage samples.

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**Conclusions**

- RCAC has slightly lower strength and 40% less fracture energy
- Shrinkage of RCAC is greater at 28-days
- No mix design adjustments
- Addition of FIBERS result in similar fracture behavior of RCAC and PCC

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**Virgin & Recycled Concrete Aggregate**

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**Experimental Procedure**

The compression and split tensile cylinders, drying shrinkage and three point bending samples were cast.

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**Fiber Reinforced Concrete**

CMOD vs Load Curve Comparison

<table>
<thead>
<tr>
<th>RCA</th>
<th>Virgin FRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRC</td>
<td>No FRC</td>
</tr>
</tbody>
</table>

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**Similar peak load**

Virgin aggregate concrete fracture energy (Gr) is 1.5 times larger than Gr for RCA.

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