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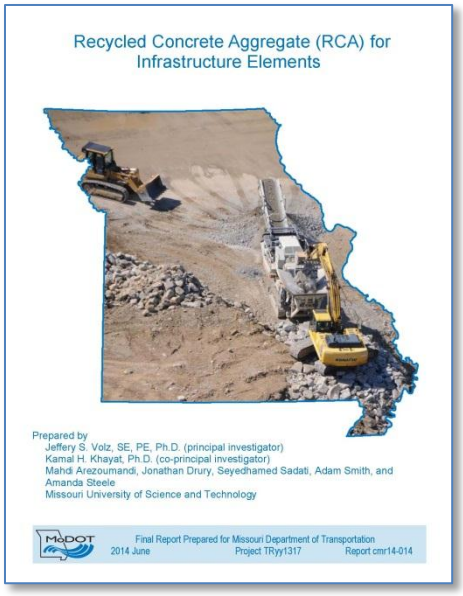
Research Summary

Recycled Concrete Aggregate (RCA) for Infrastructure Elements

Concrete recycling protects natural resources and eliminates the need for disposal by using readily available concrete as an aggregate source for new concrete, including in-place recycling. Recycled concrete can be less expensive than virgin aggregate sources, and its use would remove a sizeable amount of material from landfills, turning a waste product into a viable construction material. This value aligns with both MoDOT's Tangible Result of being environmentally and socially responsible and MoDOT's Research Need for strategies to reduce energy consumption.

The research work plan included nine tasks consisting of the following:

Task 1: Literature Review,
Task 2: RCA Characterization,
Task 3: Mix Development & Fresh Concrete Properties,
Task 4: Hardened Mechanical Properties,
Task 5: Durability Performance,
Task 6: Bond and Development Length,
Task 7: Full Scale Specimens,
Task 8: Recommendations & Specifications for Implementing RCA in Concrete, and
Task 9: Value to MoDOT and Stakeholders to Implementing RCA in Concrete.


Recycled Concrete Aggregate (RCA) for Infrastructure Elements

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A standard MoDOT Class B air-entrained mix served as the parent material for the RCA coarse aggregate. The research team cast 20 cubic yards of the MoDOT mix into concrete blocks for processing at a local quarry. The quarry then crushed, screened, and sieved the material to produce a MoDOT D Gradation similar to that of the Potosi limestone used in the parent material. The research team then evaluated the properties of the RCA necessary for developing the recycled aggregate concrete (RAC) mix designs.

The research team successfully developed recycled aggregate concrete (RAC) mixes containing 30%, 50%, 70%, and 100% RCA. The mixes met MoDOT requirements for slump and air content for an air-entrained Class B mix. Both fresh and hardened properties of the RCA concrete were examined.

In terms of compressive strength, there was not a significant decrease for the 70% and 100% RCA mixes compared to the baseline mix. However, the mixtures made with 30% and 50% RCA replacement had a higher air content which resulted in lower compressive strengths compared to the baseline and other RCA mixtures.

All concrete material properties were impacted with increasing replacement of coarse natural aggregates with RCA.

Splitting tensile strength: The splitting tensile strength decreased 12% and 29% for the RAC-50 and RAC-100 mixes, respectively.

Fracture energy: The fracture energy decreased 14% and 22% for the RAC-50 and RAC-100 mixes, respectively.

Shrinkage: The RCA mixes had comparable values to the baseline mix, which is contrary to most of the data available in the literature. This result may be traced to the internal curing effect of the highly absorptive RCA used in this research.

Deicing salt scaling: Mixtures containing up to 70% RCA performed at an acceptable level. However, the 100% RCA mix suffered serious scaling damage.

Freeze-thaw resistance: Mixtures containing up to 50% RCA performed at an acceptable level. However, the 70% and 100% RCA mixes had durability factors below acceptable levels.

Bond and shear strength: The bond and shear strength decreased 20% and 11%, respectively, for the RAC-100 mix but showed negligible decrease for the RAC-50 mix.

The Research Team recommends initially limiting the RCA replacement levels to 50% for structural members to prevent any decreased performance compared to conventional concrete. Higher replacement levels are possible but will depend on the specific application

Project Information

PROJECT NAME: Recycled Concrete Aggregate (RCA) for Infrastructure Elements

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LEAD CONTRACTOR: Missouri University of Science and Technology

PRINCIPAL INVESTIGATOR: Dr. Jeff Volz

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