



## Research Summary

# Use of Recycled Concrete Aggregate in Concrete Pavement Mixes



### ***WHAT WAS THE RESEARCH NEED?***

Concrete production continuously consumes natural virgin aggregate (NVA), which has gradually exhausted this natural resource especially near larger cities in the US. There are growing needs for replacing NVA with more sustainable materials. Recycled concrete aggregate (RCA) deserves serious considerations because it offers dual benefits of saving landfill spaces as well as creating a cheaper and more sustainable alternative. The use of RCAs in

structural concrete such as pavement slabs has been exceptionally limited mostly due to concerns over RCA quality and wide variations in its sources.

**Project Number:**  
RES2020-06

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**Project Term:**  
July 2019 to January 2022

### ***WHAT WERE THE RESEARCH OBJECTIVES?***

The objectives of the study were:

1. Evaluate and determine how RCAs influence the performance of TDOT paving concrete.
2. Determine how to improve the performance of RCA concrete through mix design and optimization.
3. Provide information that aids practitioners in developing methods and specifications for selecting adequate RCAs for future pavement construction.

### ***WHAT WAS THE RESEARCH APPROACH?***

In this project, eight RCAs from various sources such as pavement, buildings, and returned concrete were requested from local concrete recycling facilities across the state of Tennessee. Their basic properties were evaluated, including size and gradation, absorption, specific gravity, Los Angeles abrasion loss, adhered paste and air content,

and pH value. Then, these RCAs were used to replace NVAs in TDOT paving concrete, and the performance of RCA concretes was evaluated. After the successes and the problems were identified, various materials and methods were employed to improve the performance of RCA concretes.

### **WHAT WERE THE FINDINGS?**

Significant findings of this study include:

- Aggregate optimization helped to improve the workability of gap graded RCAs. Pre-mixing dry RCAs with 80% mixing water for 1 to 2 minutes made RCA's absorption equivalent to that of NVAs during mixing and placing, which controlled aggregate absorption-related problems such as rapid slump loss.
- RCAs reduced, or increased, or did not significantly affect the compressive strength of TDOT paving concrete depending on the quality of RCAs.
- RCAs significantly reduce or did not affect the freeze/thaw resistance of concrete depending on the aggregate origins and the quality of adhered paste of RCAs.
- RCAs increased the free shrinkage of concrete but delayed the restrained shrinkage cracking.
- RCAs affected the fresh air measurement. Pressure method measured the total air in both the new and the adhered pastes. Volumetric method determined the air content in the new paste.

### **IMPLEMENTATION AT TDOT**

The results of this study can aid TDOT engineers in developing specifications on the use of RCAs in TDOT new paving concrete. This new practice would save Tennessee's natural resources as well as landfill spaces. The continued recycling and unlimited reusing of concrete as aggregate in new concrete mixes would enable Tennessee transportation structures to be built and maintained more sustainably. Recommendations include:

- RCAs from reliable concrete origins such as pavements with good residual strength and air entrainment are highly recommended to TDOT RCA paving concrete as they will behave like NVAs.
- RCAs from unknown sources particularly with a high percentage of non-concrete materials and freshly crushed RCAs from uncarbonated concrete origins should be used with caution.
- RCAs with nondurable aggregate origins and RCAs with porous unsound adhered paste are not recommended for TDOT paving applications as they will significantly reduce the durability of concrete.
- Dry RCAs without pre-soaking can be directly used for proportioning TDOT paving concrete when adequate mixing water addition procedures are followed.

### **MORE INFORMATION**

Find the final report here: [https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2020-final-reports/RES2020-06\\_Final\\_Report\\_Approved.pdf](https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2020-final-reports/RES2020-06_Final_Report_Approved.pdf).