

# Research Summary

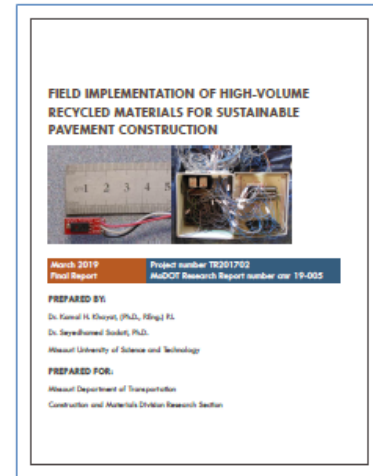
## Field Implementation of High-Volume Recycled Materials for Sustainable Pavement Construction

The objective of this study was to evaluate the feasibility of producing sustainable concrete materials for rigid pavement construction using high volumes of recycled materials. The goal was to replace 50% of all solid materials in the concrete with recycled materials and industrial by-products.

This included the replacement of cement with at least 50% supplementary cementitious materials (SCMs) and aggregate with 50% recycled concrete aggregate (RCA). Nine optimized mixtures from the first phase of the project that exhibited satisfactory performance were selected for the construction of single layer and two-lift rigid pavement systems.

Life cycle cost assessment indicated that sustainable concrete with optimal SCMs and RCA can lead to cost savings of 17.6% of agency costs, 12.1% of user cost, 12.1% of social cost, and 17.5% of total life cycle cost. The development of a database and analysis using artificial intelligence was performed to quantify the properties of concrete as a function of RCA characteristics.

Test results obtained through the case study indicated that the reduction in the modulus of elasticity (MOE) of pavement concrete can be limited to 10% when the coarse RCA has a water



absorption lower than 2.5%, Los Angeles (LA) abrasion less than 23%, or oven dry specific gravity higher than 156 lb/ft<sup>3</sup> (2500 kg/m<sup>3</sup>) for concrete made with 100% RCA replacement rate.

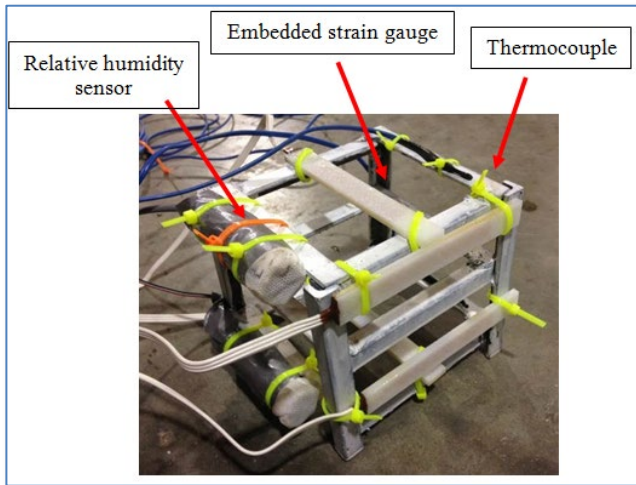
The use of 30% and 50% RCA can lead to a reduction of up to 20% and 30% in the MOE of pavement concrete, respectively, when a relatively low-quality RCA is selected that has an oven dry specific gravity of 131 lb/ft<sup>3</sup> (2100 kg/m<sup>3</sup>) and a water absorption as high as 8.5%.

The water absorption, specific gravity, and LA abrasion mass loss of RCA were found to categorize the RCA quality and resulting engineering properties of concrete made with RCA.

The selection of RCA with a lower water absorption and LA abrasion mass loss and a higher oven dry specific gravity corresponded to a higher quality of RCA that can produce concrete with greater mechanical properties.

*“The study demonstrated the feasibility of using RCA and high-volume SCMs for the production of sustainable concrete mixtures in transportation infrastructure.”*





Instrumentation layout B showing embedded strain gauges, thermocouples and RH sensors

This study is a follow-up to the earlier Phase I report [High-Volume Recycled Materials for Sustainable Pavement Construction](#) published in May 2017.

### ***Project Information***

**PROJECT NAME:** Field Implementation of Recycled Concrete

**PROJECT START/END DATE:** July 2016- July 2018

**PROJECT COST:** \$69,687

**LEAD CONTRACTOR:** Missouri University of Science and Technology

**PRINCIPAL INVESTIGATOR:** Dr. Kamal H. Khayat, Ph.D., P.Eng.

**REPORT NAME:** Field Implementation of High-Volume Recycled Materials for Sustainable Pavement Construction

**REPORT NUMBER:** cmr 19-005

**REPORT DATE:** March 2019

### ***Project Manager***



**BILL STONE (FORMER RESEARCH ADMINISTRATOR)**

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