



Optimized Aggregate Gradations for Concrete Mixture Designs

Problem Description

Tennessee is part of the performance-engineered concrete mixtures initiative, led by the FHWA, aiming to improve the durability, economy, and sustainability of the concrete infrastructure using both prescriptive and performance specification provisions and emerging technologies. The Performance Engineered Mixtures (PEM) addresses concrete pavements durability and performance issues rather than designing and accepting concrete primarily on strength. Tennessee does not currently have procedures and/or specification requirements that fully support the use of optimized gradations in concrete. The current prescriptive specifications adapted by TDOT and many DOTs and agencies may preclude the acceptance of mixtures that have superior economy, durability, sustainability, and satisfactory mechanical performance. Thus, it is urgent to create new procedures to allow producers creating more durable and equal and/or higher strength concrete mixtures through optimizing aggregate gradation.

PROJECT NUMBER:

RES2023-16

PRINCIPAL INVESTIGATOR:

Dr. Z. John Ma

University of TN Knoxville

TDOT LEAD STAFF:

Tyler Lacy

Materials & Tests

PROJECT SCHEDULE:

August 2022 to July 2024

Research Objectives

This research aims at developing new procedures to allow producers to create more durable and equal and/or higher strength concrete mixtures while reducing cost and environmental impacts through optimizing aggregate gradation. The technical objectives of the proposed research include the following:

- Collect data regarding the available aggregates to Tennessee concrete producers.
- Determine/Analyze the effects of adjusting the target mixture gradations in relation to the paste content and the overall strength of each mixture.
- Observe the performance of TDOT concrete mixtures with and without an optimized gradation.
- Determine necessary changes needed to the 2021 TDOT Standard specifications, supplemental specifications, and/or Standard Operating Procedure.

Potential Implementation and Expected Benefits

This study will provide TDOT with several benefits including an overall reduction in the cost of concrete structures, an environmental benefit of less cement use (reduction in CO2 Emissions), and reduce the potential for shrinkage cracking, which potentially reduces long term maintenance and replacement costs. This will facilitate an efficient and quick implementing of optimized gradation for TDOT concrete mixtures. This research will help keep TDOT at the forefront of implementation of the PEM initiative to improve the durability, economy, and sustainability of the concrete infrastructure. Implementation of optimized aggregate grading will provide concrete with low permeability and reduced cementitious content and thus better resistance against Alkali-Silica Reaction, which has been identified as a high-risk for concrete and pavement in Tennessee.