Use of Rice Husk Ash (RHA) in Flowable Fill Concrete Material

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Assessing the viability of locally produced rice husk ash (RHA) in preparing flowable fill concrete (FFC)

Flowable fill concrete (FCC) is a self-compacting material, which has been recently developed and utilized. It is a relatively new construction technology for use where rapid construction is needed, such as for: backfilling walls, sewer trenches, bridge abutments, and conduit trenches. The objective of this study is to evaluate the usage of ruce husk ash (RHA) in producing FFC. Two different RHA samples (RHA-1: 600 µm and RHA-2: 150 µm) in three different percentages (40%, 60%, and 80% by the weight) of ordinary Portland cement (OPC) have been used to prepare FFC mixtures. Evaluation of these FFC mixtures includes: determination of strength, setting time, flowability, unit weight, and air content in the laboratory. Furthermore, two field demonstration projects have been planned to evaluate their workability, placement, and in-service performance.

Background

Rice hull is one of the main agricultural residues obtained from the outer covering of rice grains during the milling process. RH constitutes 20% of about 700 million tons of paddy produced in the world. When burnt, 20% of RH is transformed into rice husk ash (RHA). Riceland Foods Inc., a family owned business in Arkansas, is the largest rice miller in the U.S. with an annual production of about 100 million bushels. A significant portion of RHA generated by Riceland Foods Inc. is being treated as waste. RHA is a cementitious material, contains roughly 75% silica in an amorphous form, and has an extremely high surface area.

Based on preliminary research, locally produced RHA is not capable of producing "regular" concrete of compressive strength of greater than 3,000 psi. Rather, low strength concrete such as FFC can be produced using RHA "as is".

Project Summary

The main objective of this study is to assess the feasibility of using local RHA in producing FFC. Specific objectives are to: (i) prepare FFC and determine their workability and flow behavior, (ii) evaluate the effect of curing time and environmental conditions on strength properties and durability of RHA-modified FFC, and (iii) evaluate the optimum dosages of RHA as pozzolan in preparing FFC. These objectives will be accomplished by testing RHA-modified FFC samples in the laboratory and through two field demonstration projects. Flow behavior and strength properties (compressive, tensile, elastic modulus, etc.) and alkali silica reactivity (ASR) properties of RHA-modified concrete at different curing time will be evaluated.

Status Update

Chemical properties of RHAs used in this study have been compared using AASHTO M 321-04. It appears that neither RHA-1 nor RHA-2 satisfies the moisture content and the loss on ignition specifications. As per ASTM D6103, the typical flow of flowable fill mixtures needs to be 20 to 30 cm (8 to 12 in). From trial mixes, it was found that 2.5 w/c was needed to have a preferable consistency of flowable fill mix (Figure1).

Figure 1. Trial mix of FFC with different w/c ratios (from left: 2.0 w/c, 2.5 w/c, 2.7 w/c, respectively).

With the help of Arkansas Ready Mix Concrete Association (ARMCA), the research team has conducted a lunch and learn workshop, which included a field demonstration on the application of RHA in FFC in Jonesboro, Arkansas (Figure 2).

Figure 2. Field demonstration on RHA modified flowable fill concrete.

Impacts

The main benefits of this study are: (a) reuse of RHA in transportation construction projects, (b) enhance training opportunity for students in the region, (c) help local farmers and asphalt industries to be more economically sustainable, and (d) enform a more prepared workforce. The expected deliverables of this project are: (1) a technical report containing performance data and guidelines of RHA-modified FFC and (2) showcase the findings of the study at the annual Technical Research Committee (TRC) meeting at Arkansas DOT and at the Tran-SET Conference.

The outcome of this study is expected to be important in setting the direction of the sustainable use of RHA in producing FFC – and lead to significant cost saving for transportation agencies and construction industries. This study will also help local farmers to be economically sustainable as they are striving to find new markets for RHA.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

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