LOUISIANA TRANSPORTATION RESEARCH CENTER
LTRC

TECHSUMMARY December 2016

State Project No. 30001502 / LTRC Project No. 13-2C

Laboratory Evaluation of 100 Percent Fly Ash Cementitious Systems

INTRODUCTION

Long-lasting durable concrete is a must-have for departments of transportation (DOTs) in today's construction and economic climate. Many entities are turning to alternative concrete mixtures to ensure long-term durability such as ternary mixtures, lower w/cm ratios, lower cementitous materials contents, and alternative binders, such as Ekkomaxx. This project will evaluate concrete produced with 100 percent fly ash combined with an activator provided by Ceratech. The use of fly ash as a sole binder production of portland cement concrete can be difficult, and the aforementioned product allows the control of the set times to allow better usage of class C fly ash as the sole binder. This project will enable the owner (Ceratech) and the user (DOTD) to gain a more in-depth understanding of the interactions associated with the use of 100 percent class C fly ash systems produced with Ceratech' s activator.

OBJECTIVE

The objectives of this research were to characterize the concrete produced with Ekkomaxx and determine all effects with respect to the activator dosage rate, water to ash ratio, and ash content.

SCOPE

To meet the objectives of this project, a full factorial was developed with activator dosages ranging from 0.2 to 0.5 gallon/hundred weight (cwt), fly ash binder contents ranging from 600 to 800 pounds per cubic yard (pcy), and water to ash (w/a) ratio ranging from 0.2 to 0.4. The activator dosages were varied in increments of 0.1 gallon/cwt; the fly ash contents were varied in increments of 100 lbs, and the w/a was varied in increments of 0.1. In order to determine effects and repeatability, each mixture was duplicated.

Fresh concrete properties measured included air content, unit weight, and set time. Hardened concrete properties of compressive and flexural strength, free shrinkage, and surface resistivity were measured for each mixture. Samples were produced and cured in 100 percent relative humidity conditions. Compressive and flexural strength were measured at 7-, 28-, and 56-days of age. Surface resistivity was measured at 28-, 56-, and 90-days of age.

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SPR: TT-Fed/TT-Reg

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METHODOLOGY

The class C fly ash used in this study originated from the Big Cajun power plant located in New Roads, LA. Mixtures incorporated No. 67 limestone and a natural sand as the coarse and fine aggregate, respectively. The coarse to fine aggregate ratio was kept near 60:40. Fresh properties were measured with ASTM C138, ASTM C231, and ASTM C403. Hardened concrete properties were measured with ASTM C39, ASTM C78, ASTM C157, and DOTD TR 233.

RECOMMENDATIONS & CONCLUSIONS

The results of this study warrant the following conclusions. The slump results show that the w/a ratio affect the slump greater than the admixture dosage rate. Generally the slump increases as dosage rate increases, but the trend is difficult to follow as the w/a changes between the different admixture dosage rates.

The time between initial and final set was very short. This is of concern to the authors due to the fact that this is the period in which the concrete material has to be finished and textured. In a controlled laboratory environment, this can be completed rather easily. In an ambient environment, many effects come into play such as wind speed, temperature, and relative humidity. The short window may be a barrier to full-scale implementation. Overdosing the admixture has a negative effect of producing concrete that does not set within a 24-hour time period, and sometimes not even within 36 hours.

The hardened concrete properties show that many of the mixtures will meet or exceed DOTD requirements for compressive strength and surface resistivity. The results show that the overall strength is dependent upon admixture dosage rate, followed by the w/a ratio and ash content, respectively. Although these mixtures will meet or exceed requirements, care should be exercised when utilizing this material; a trial batch is recommended for all applications.

Louisiana Transportation Research Center sponsored jointly by the Louisiana Department of Transportation & Development and Louisiana State University