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Influence of sugar-cane bagasse ash and fly ash on the rheological behavior of cement pastes and mortars

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HIGHLIGHTS

- Rheology of pastes and mortars with untreated sugar-cane bagasse ash and fly ash was studied.
- Single, binary and ternary systems were evaluated for both pastes and mortars.
- The use of untreated sugar-cane bagasse ash increased the viscosity of pastes and mortars.
- Fly ash lowered the yield stresses in the binary systems with untreated sugar-cane bagasse ash.

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ABSTRACT

In the present study, the effects of a sieved sugar cane bagasse ash (SCBA) and fly ash (FA) on the rheological properties of pastes and mortars were investigated. Cement pastes and mortar mixtures were designed as single ingredient, binary and ternary systems. For the single ingredient system only cement was used. For the binary system, SCBA or FA was used to replace some of the cement. For the ternary systems, combinations of cement, SCBA and FA were used. The rheological tests were carried out with a stress controlled rheometer equipped with a ball measuring system. In addition, mini-slump cone and the flow/spread table tests were carried out to determine the feasibility of evaluating the rheological properties of pastes and mortars from empirical tests. The results indicate that for the binary pastes and mortars, there is an inverse relationship between the yield stress and FA concentration. On the other hand, the shape and size of the particles of the used SCBA produced more viscous and plastic binary pastes and mortars than mixes without the SCBA. When the SCBA concentration was increased, the yield stress linearly increased as well. In the ternary systems, the use of 20% of FA combined with 10% and 20% of SCBA was beneficial producing lower yield stresses than those presented in the binary system. The results obtained with the mini-slump cone and the flow/spread table tests showed a certain relationship with the rheological measurements, but this could not be completely identified.

1. Introduction

Fly ash (FA) is a mineral admixture that enhances flowability in the fresh state of concrete and is widely recommended as a partial replacement for cement [1]. Tattersall [2] showed that, in concrete mixtures, when FA is used as a partial replacement of cement, the yield stress decreases while plastic viscosity decreases. In mortar mixtures, Banfill [3] demonstrated that both yield stress and plastic viscosity decrease with the increase in FA content. Although the benefits of incorporating FA into cementitious materials are evident, FA is not readily available in Mexican markets and when it is available tends to be very expensive.

In recent years, the use of solid waste in developing cement pastes, mortars and concrete mixtures has been the focus of research, particularly solid wastes derived from agriculture and used as mineral admixtures. The research has centered primarily on the use of rice husk ash (RHA), sugar-cane bagasse ash (SCBA) and corn leaves ash (CLA) [4,5].

According to Akram et al. [6], Mexico is ranked fifth in the world production of sugar cane, and after processing produces approximately 11.7 million tons of bagasse per year. If a moisture content of the bagasse is considered to be less than 50%, then after processing 0.58–0.29 million tons of SCBA are produced every year and this amount is deposited mainly in open dumps, causing significant pollution and disposal problems [6].

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