Use of Bagasse Ash as a Concrete Additive for Road Pavement Applications

Investigates use of sugarcane bagasse ash to reduce the cost and carbon footprint of concrete materials for road pavement construction and maintenance

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Existing literature and preliminary research results indicate that ground bagasse ash with low Loss on Ignition (LOI) can be a suitable substitute to fly ash as a partial replacement of cement in concrete mixes. However, bagasse ash is currently not used in road construction or repair in the US. This research focuses in developing the much-needed engineering knowledge to promote the use of bagasse ash in concrete mixes for concrete road pavement construction and repair. This use will decrease the cost of concrete mixes and help reducing the backlog of existing road construction projects. It will also provide concrete with better long-term compressive strength and durability characteristics, as well as help preserve the environment by reducing the carbon footprint of concrete construction.

Background

Bagasse is the fibrous by-product of sugarcane stalks after they are crushed to extract their juice. In 2016, the sugar production industry in Louisiana harvested 12,822,249 tons of sugarcane, which yielded 1,614,116 tons of sugar and almost 2,400,000 tons of bagasse. Bagasse is used as a primary fuel source for sugar mills by burning the fibrous material into bagasse ash. Based on the combustion procedure, the total production of bagasse ash is between 3% and 9% of the total dry fibrous bagasse production. In the US, bagasse ash is currently considered an agricultural waste of no economic value that constitutes a fire hazard, with associated containment and disposal costs, and potentially negative environmental impact. Thus, the Louisiana sugar industry has a significant interest in finding a useful application of bagasse ash to minimize these disposal costs and reduce the fire hazard posed by fibrous bagasse.

At the same time, the consumption of concrete in the US and particularly in Louisiana is steadily increasing; e.g., the consumption of cement went from 1.8M tons in 2002 to 2.2M tons in 2015. This consumption increase produces a significant need of new affordable and sustainable materials to be used as SCMs in concrete mixes. Bagasse ash could provide one alternative to reduce cement consumption and/or to substitute fine aggregates and/or fly ash. High-quality fly ash that satisfy ASTM C618-15 requirements for use in concrete is relatively expensive and produced at a lower level than the amount needed to keep up with the increase in concrete consumption in Louisiana and the US. The use of pozzolanic additives as bagasse ash presents several benefits: (1) lower cost and lower carbon footprint of the concrete, (2) higher long-term compressive strength (e.g., at 90 days or more) at the expense of a small reduction of the 28-day compressive strength, and (3) better durability.

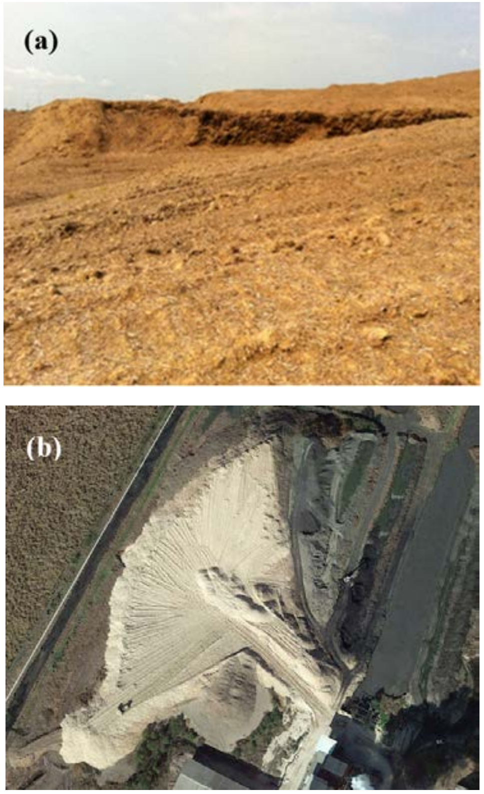

Figure 1. (a) Close view of fibrous bagasse mound (b) aerial view of fibrous bagasse (light color) and bagasse ash (dark color).

Project Summary

This study will develop new uses for bagasse ash as an additive for concrete. In particular, the use of bagasse ash as a partial substitute for cement and fly ash will be investigated to develop an efficient production method to maximize the pozzolanic activity of bagasse ash, identify optimal amounts of bagasse ash to obtain desired concrete properties, and verify the economic feasibility of bagasse ash use as a concrete additive through a preliminary life-cycle cost analysis.

Status Update

To date, the effect of different processing methodologies on the pozzolanic properties of sugarcane bagasse ash (SCBA) have been studied. The evaluated processing methodologies produce the following three materials: (1) raw SCBA (i.e., SCBA obtained directly from the mill and produced under uncontrolled burning conditions); (2) controlled SCBA (i.e., virgin SBF processed under controlled burning conditions); and (3) post-processed SCBA (i.e., raw SCBA from the mill post-processed to enhance its pozzolanic activity through controlled burning). The microstructure (Figure 2) and chemical composition of the different SCBAs produced were characterized utilizing SEM-EDS, XRD and XRF. Furthermore, the moisture content, Loss on Ignition (LOI), and Strength Activity Index (SAI) were evaluated. Currently, the mechanical and physical properties of concrete with SCBA are being evaluated. Furthermore, a preliminary Life-Cycle Cost Assessment of Concrete Mixes with different types of SCBAs is being performed.

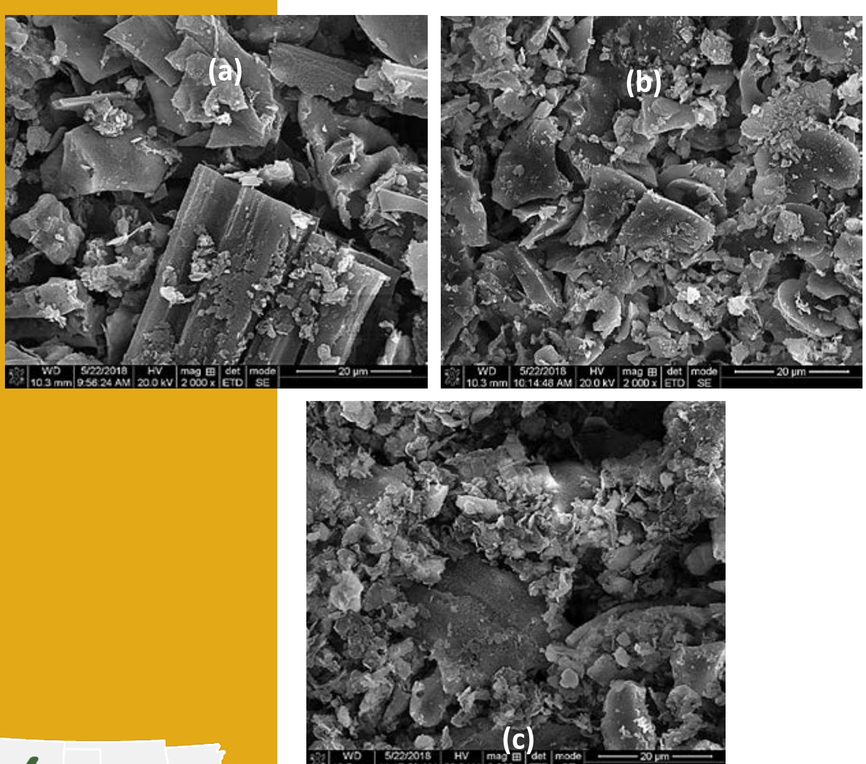

Figure 2. Microstructure of: (a) raw SCBA, (b) controlled SCBA at 550^{0}C, (c) post-processed SCBA at 600^{0}C.

Impacts

This research has the potential to: (1) improve the sustainability of Louisiana's construction industry by reducing its carbon footprint and material costs, (2) resolve issues related to the environmental disposal of an abundant agricultural by-product, and (3) significantly increase the value of an underutilized Louisiana resource.

Tran-SET

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