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Sugarcane Bagasse Ash Geopolymer Mixtures: A Step Towards Sustainable Materials

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Abstract : Millions of tons of sugarcane bagasse ash (SBA) are produced as a byproduct by burning sugarcane bagasse in powerplants to run the steam engines for sugar production. This bagasse ash is disposed into landfills effecting their overall capacity. SBA contains very fine particles that can easily become airborne, causing serious respiratory health risks when inhaled. This research study evaluated the utilization of high dosage of SBA for developing geopolymer based “Green” construction materials. An experimental design matrix was developed with varying dosages of SBA (0, 20%, 60%, and 80%) and Na_2SiO3/NaOH ratio (0, 0.5, 1, 1.5, 2) based on the response surface methodology. Precursor (consisting of SBA and fly ash) to aggregate ration was kept constant at 30:70 and the alkali to binder ratio was maintained at 0.45 for all the mixtures. Geopolymer samples of size 50.8 x 50.8 mm (2” X 2”) were casted and cured at 65oC for 48 hours in a water bath followed by curing at room temperature for 24 hours. The samples were then tested for compressive strength as per ASTM C39. The results revealed that based on varying SBA dosage the compressive strengths ranged from 6.78 MPa to 22.63 MPa. Moreover, the effect of SiO2, Na_2O and Fe_2O_3 on the compressive strength of these mixtures was also evaluated. The results depicted that the compressive strength increased with increasing Na_2O and Fe_2O_3 concentration in the binder. It was also observed that the compressive strength of SBA based geopolymer mixtures improved as the SiO_2 content increased, reaching an optimum at 42%. However, further increase in SiO_2 reduced the strength of the mixtures. The resulting geopolymer mixtures possess compressive strengths according to the requirements set by ASTM standard. Such mixtures can be used as a structural and non-structural element as strong road bases, sidewalks, curbs, bricks for buildings and highway infrastructure. Using industrial SBA in geopolymer based construction materials can address the carbon emissions related to cement production, reduce landfill burden from SBA storage, and mitigate health risks associated with high content of silica in SBA.

Keywords : compressive strength, geopolymer concrete, green materials, sugarcane bagasse ash
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