

Utilization of Fly Ash Amended Sewage Sludge as Sustainable Building Material

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Abstract : Disposal of Sewage Sludge (SS) is a big issue especially in developing nation like India, where there is no control in the dynamicity of SS produced. The present research work demonstrates the potential application of SS amended with varying percentage (0-100%) of Fly Ash (FA) for brick manufacturing as an alternative of SS management. SS samples were collected from Jaspur sewage treatment plant (Ahmedabad, India) and subjected to different preconditioning treatments: (i) atmospheric drying (ii) pulverization (iii) heat treatment in oven (110°C, moisture removal) and muffle furnace (440°C, organic content removal). Geotechnical parameters of the SS were obtained as liquid limit (52%), plastic limit (24%), shrinkage limit (10%), plasticity index (28%), differential free swell index (DFSI, 47%), silt (68%), clay (27%), organic content (5%), optimum moisture content (OMC, 20%), maximum dry density (MDD, 1.55gm/cc), specific gravity (2.66), swell pressure (57kPa) and unconfined compressive strength (UCS, 207kPa). For FA liquid limit, plastic limit and specific gravity was 44%, 0% and 2.2 respectively. Initially, for brick casting pulverized SS sample was heat treated in a muffle furnace around 440°C (5 hours) for removal of organic matter. Later, mixing of SS, FA and water by weight ratio was done at OMC. 7*7*7 cm³ sample mold was used for casting bricks at MDD. Brick samples were then first dried in room temperature for 24 hours, then in oven at 100°C (24 hours) and finally firing in muffle furnace for 1000°C (10 hours). The fired brick samples were then cured for 3 days according to Indian Standards (IS) common burnt clay building bricks- specification (5th revision). The Compressive strength of brick samples (0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%) of FA were 0.45, 0.76, 1.89, 1.83, 4.02, 3.74, 3.42, 3.19, 2.87, 0.78 and 4.95MPa when evaluated through compressive testing machine (CTM) for a stress rate of 14MPa/min. The highest strength was obtained at 40% FA mixture i.e. 4.02MPa which is much higher than the pure SS brick sample. According to IS 1077: 1992 this combination gives strength more than 3.5 MPa and can be utilized as common building bricks. The loss in weight after firing was much higher than the oven treatment, this might be due to degradation temperature higher than 100°C. The thermal conductivity of the fired brick was obtained as 0.44Wm-1K-1, indicating better insulation properties than other reported studies. TCLP (Toxicity characteristic leaching procedure) test of Cr, Cu, Co, Fe and Ni in raw SS was found as 69, 70, 21, 39502 and 47 mg/kg. The study positively concludes that SS and FA at optimum ratio can be utilized as common building bricks such as partitioning wall and other small strength requirement works. The uniqueness of the work is it emphasizes on utilization of FA for stabilizing SS as construction material as a replacement of natural clay as reported in existing studies.

Keywords : Compressive strength, Curing, Fly Ash, Sewage Sludge.

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