

Coal Fly Ash as an Alternative Substrate to Replace River Sand in Cement Mortar Mixture

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Abstract

Coal is the most extensively used primary source of energy that accounts globally for 25% of total energy consumption. The global generation of coal fly ash (CFA) is estimated to be above 6×10^8 Mg per annum and its recycling rate is rather low (15%). Sri Lanka is also facing major economic and environmental problems of disposing CFA from Norochcholai thermal power plant and part of CFA disposal is being used as a raw material for cement production. However, CFA with high loss on ignition (LOI) values cannot be used for blending with cement and this study was designed to investigate the potential utilization of high LOI-CFA as an alternative substrate to river sand in cement mortar preparation. Compressive Strength (CS), water demand (WD), moisture content (MC), initial setting time (IST), and final setting time (FST) were examined to select the most suitable mixing ratio of CFA and river sand.

Treatments were prepared in accordance with SLS ISO 1253-107: part 2-2008, with 30 replicates for LOI and MC. Treatments were defined as the percentage of added CFA into sand as $T_1=0$ (control), $T_2=5\%$, $T_3=10\%$, $T_4=12\%$, $T_5=15\%$, $T_6=18\%$, $T_7=20\%$, and $T_8=25\%$. Four replicates per each treatment in different three ages (one day-1D, seven days-7D, and twenty-eight days-28D) were tested for CS of mortar in accordance with SLS ISO 679:2008. Initial and final setting time of cement CFA mixture was determined in accordance with SLS ISO 9597:2008(E) with 8 treatments.

Results have proven that high LOI-CFA can be used as an alternative substrate to sand up to 20%. The average CS for 1D, 7D, and 28D of control treatment were 16.8 MPa, 41.3 MPa, and 51.3 MPa respectively. The highest CS for 1D (21.9 MPa) and 28D (71.1 MPa) were given by 10% CFA treatment, but the highest seven-day CS results (50.1 MPa) was given by 12% CFA treatment. Each treatment was significantly different from other treatments. Means for CS of T_2 , T_3 , T_4 , T_5 , T_6 and T_7 were not significantly different from the mean of control treatment, while T_8 (25% CFA and 75% sand) was significantly different from the control. R^2 between WD and CFA percentage obtained by regression analysis was 93.2%, which showed a strong relationship between them. R^2 of IST versus WD, and FST versus WD were 97.7 % and 94.8 % respectively, which showed strong relationships with WD. Hence, it can be concluded that increasing CFA percentage up to 20, gave increased WD, IST, and FST.

Keywords: *Cement mortar, Coal fly ash, Compressive strength*