COMPRESSIVE STRENGTH OF CEMENT SAND BRICKS WITH COAL ASH CEMENT REPLACEMENT

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Abstract

In this study, industrial waste in the form of coal ash was used to replace certain percentages of cement in cement-sand bricks production. Two percentages of 15% and 30% of coal ash cement replacement were applied in this study, with the cement-sand ratio and water cement ratio of 1:5 and 0.5, respectively. All specimens were tested for compressive strength at 28 days. The findings show that 15% of coal ash replacement provides the highest compressive strength which able to increase up to 84.6% compared to the control specimens.

Keyword: Coal ash, compressive strength, cements replacement.

1.0 Introduction

During the last five years, concrete bricks incorrectly known as cement-sand bricks have been gaining rapid and increase demand in the construction materials market. As a masonry unit, clay has always been favored above concrete. However, new designs and colour ranges, higher standards, consumer mindset change, an increase in concrete brick specifications by architects and the relative ease and exactness of producing these bricks have resulted in a concrete brick boom (Abdullah, 2005).

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 μm to 100μm. They consist mostly of silicon dioxide (SiO_2), which is present in two forms: amorphous, which is rounded and smooth, and crystalline, which is sharp, pointed and hazardous; aluminium oxide (Al_2O_3) and iron oxide (Fe_2O_3). Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash (ASTM C618, 1994). This fly ash is pozzolanic in nature, and contains less than 10% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Meanwhile, Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes (ASTM C618, 1994).

2.0 Materials and Method

Brick samples were prepared in 15% and 30% coal ash replacement of cement as comparison to control specimens by using high density brick maker located in the Material Engineering Laboratory, UTHM. Mix proportions of coal ash by weight are shown in Table 2.1.

Table 2.1: Mix Proportion of Coal Ash by Weight

Materials	0%	15%	30%
Cement	1.00	0.85	0.70
Coal Ash (CA)	-	0.15	0.30
Sand	5.00	5.00	5.00
Water	0.50	0.50	0.50
Water/ (Cement +CA)	0.50	0.50	0.50

Specimens were then tested to determine the physical properties through dimension test and shrinkage test. As for mechanical properties, compression test and prism were conducted. The results were analyzed and compared with control specimen. Conclusions were drawn based on the test results analyzed.

3.0 Results and Discussions

3.1 Dimension Test

All cement-sand brick specimens were tested by arranging 24 cement bricks continuously in width, length and height directions. From the dimension test, the entire specimen dimensions were in range with standard range introduced by BS 3921:1985.

Table 3.1: 0% Percentage of Coal Ash Cement Replacement (Control Specimen)

Dimension	Max.	Min.	Total for 24 samples of brick (mm)	Average for 1 unit brick (mm)
Length (mm)	5235	5085	5092	212.2
Width (mm)	2505	2415	2490	103.75
Height (mm)	1605	1515	1565	65.2

Table 3.2: 15% Percentage of Coal Ash Cement Replacement

Dimension	Max.	Min.	Total for 24 sample of bricks (mm)	Average for 1 unit brick (mm)
Length (mm)	5235	5085	5142	214.3
Width (mm)	2505	2415	2505	104.4
Height (mm)	1605	1515	1515	63.1

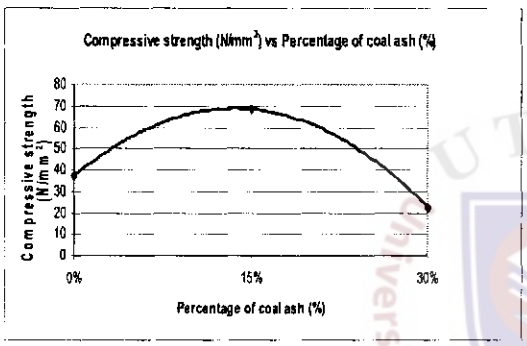
Table 3.3: 30% Percentage of Coal Ash Cement Replacement

Dimension	Max.	Min.	Total for 24 sample of bricks (mm)	Average for 1 unit brick (mm)
Length (mm)	5235	5085	5094	212.25
Width (mm)	2505	2415	2456	102.33
Height (mm)	1605	1515	1590	66.25

3.2 Compressive Strength

Coal ash replacement to cement has increased compressive strength of brick provided the optimum percentage is used. From compression test, 15% coal ash has increased the compressive by 84.61%. However, compressive strength for 30% coal ash reduced by 39.0% when 30% coal ash was used to replace cement.

Figure 3.4: Compressive Strength vs Percentage of Coal Ash



4.0 Conclusions and Recommendation

From the results, 15 % coal ash cement replacement gave the optimum value in term of mechanical properties. The compressive strength with 15% coal ash increased by 84.6% compared to control specimen. In terms of physical properties, all the bricks dimensions are in the range suggested by BS 3921:1985. In order to enhance this research, there are several recommendations that could be suggested. Since coal improved the mechanical strength of bricks, other properties such as service properties can be studied in the future. Various percentages between 0% to 30 % such as 10%, 20% and 25% of coal ash can provide more accurate finding of the effect of coal ash as cement replacement in cement-sand bricks properties.

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