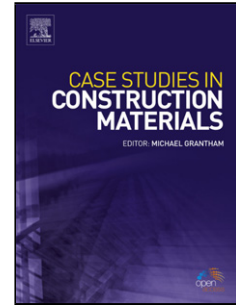


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Case Studies in Construction Materials



Case study

Geopolymerized Self-Compacting Mud concrete masonry units

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ABSTRACT

This study was conducted to develop an alternative method of utilizing fly ash as an alternative stabilizer to build affordable earth masonry units named “mud concrete blocks”. Mud concrete masonry block is a novel invention in which the mud helps to self-compact the mixture to reduce the production of energy content. This study uses fly ash from electric power generating plant with an alkaline solution made of Sodium hydroxide and Sodium chloride. Different combinations of mixtures (fly ash, sodium chloride, sodium hydroxide and soil) were taken into consideration to study a suitable mix design. And compressive strength was tested to understand each mix suitability.

Results of this study have manifested that suitable mix is to use Fly Ash 20% of the dry weight of soil, Sodium hydroxide 5% and Sodium Chloride 2% of the total dry weight. The suitable water ratio is 15%-20% of the dry weight. And then the suitable soil mix proportion was developed. It was found that the soil mix proportion of Gravel 10 - 20% (sieve size 4.25mm \leq gravel \leq 20mm) range of (35%-45%), the Sand 70 - 80% (sieve size 0.425mm \leq sand \leq 4.25 mm) proportion of (60%-70%) and Fine \leq 10% (\leq sieve size 0.425mm) content of 5% makes the best mix to develop. Scanning electron microscope images were taken to understand the geopolymerized fly ash bond result on the total strength of the soil mixture.

1 Introduction

Employing industrial waste as stabilizer or filler material can reduce the environmental contamination [1][2]. And they are economically beneficial as construction materials because they are less expensive[3]. Finally, the waste shall become a shelter for an affordable dwelling which serves the entire humanity. Mud concrete is a novel walling material[4]. A masonry unit made of mud and cement mixture[5]. In Mud-Concrete, the designated parts of sand and metal of concrete are replaced by a fraction of soil. The precise gravel percentage governs the strength of Mud-Concrete. In this research fraction of soil has been classified as follows; 35% Gravel (sieve size 4.25mm \leq gravel \leq 20mm), 65% Sand (sieve size 0.425mm \leq and \leq 4.25 mm) 5% Fine (silt and clay) (\leq sieve size 4.25 mm)[4][6][7][8] [9]. The cement in this concrete is also used as a stabilizer in very low quantities. The most popular cementitious materials are the Portland cement and lime. However, both of them have problems including heavy embodied energy and carbon foot print[10][11][12][13]. Therefore, a brand new study was conducted to investigate an alternative stabilizer for mud concrete masonry units.

Fly Ash, as an alternative stabilizer got the attention due to many reasons. Fly ash has some cementitious properties including its chemical composition shown in Figure 1. Cement chemical composition is Calcium oxide (lime), Silicon dioxide (silica), Aluminum oxide (alumina), Iron oxide and Sulphur[14]. Similarly, Fly Ash also has a similar chemical composition such as Silicon dioxide (silica), Aluminum oxide (alumina) shown in the Figure 1. And also the prevalent mineral in the clay/mud is Kaolinite[15]. Kaolinite has very high water absorptive capacity[16][17]. It's an engineering problem which could be resolved by adding fly ash[18]. In addition fly, ash increases the plasticity index. Because fly ash has a shape of a bubble and does not mix with water[19][20]. The high carbon in fly ash help to reduce the linear shrinkage limit in mud based masonry units[21]. But this is not a similar condition to all the soil types. Clay soil oil with high finer percentage doesn't work with fly ash either[22][23].

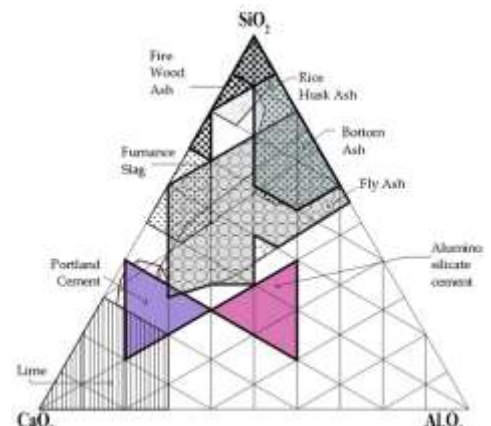


Figure 1: Comrades of cement

1.1 Geopolymer: A Literature review

This study was extended to ameliorate the cementitious property of fly ash. The literature review showed that alkali activation of fly ash can improve the strength of rammed earth[24][25][26]. Prof. Joseph Davidovits is the first person who introduced the concept of geopolymer in 1975[27]. The use of fly ash to stable soil was then developed by him[28]. The term “geopolymer” to classify the fresh ascertained geosynthesis of soil into soil blocks by using alkaline activator. Richard Heitzmann is the first to discover to use fly ash into geopolymer[27]. Several studies were done in

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