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RESEARCH ARTICLE

STUDIES ON STABILISED COMPRESSED EARTH BLOCKS

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ABSTRACT

The development of many alternative building materials as possible will be of immense benefit to minimize the impact on the environment. Earth can be used for construction of walls in many ways. However, there are few undesirable properties such as loss of strength when saturated with water, erosion due to wind or driving rain and poor dimensional stability. Hence a study was conducted to determine the characteristics of stabilized compressed earth blocks (CEB). The new technology focuses on stabilized earth masonry brick development incorporating an industrial by-product material, which is vital for the future of construction. The stabilized earth masonry brick technology relies on the use of an activated industrial by-product (like fly ash) and natural earth. Due to the use of a by-product material in the formulation, it is anticipated that the final pricing of the stabilized earth masonry building brick will be reduced. The added environmental advantage of utilizing industrial by-products available in the country will further improve the sustainability profile of masonry brick production. Properties of compressed stabilized earth blocks like Clay brick water absorption and durability, Clay brick density; Compressive strength and thermal properties versus other walling materials were measured. Based on the results it was found the performance of the stabilized compressed earth blocks was comparable with others in terms of their strength characteristics. Meanwhile the reduction of transportation time, cost and attendant pollution can also make CEB more environmentally friendly than other materials.

INTRODUCTION

Filler materials are generally the inert materials which are used in composite materials to reduce material costs, to improve mechanical properties to some extent and in some cases to improve processability. Need for environmental building materials is growing at an alarming rate and in order to meet the demand for new buildings, new ways and techniques must be evolved. Manufacturing of building materials like bricks/blocks, cement, steel, aggregates, etc. consumed in bulk quantities, puts great pressure on natural resources (raw materials) and energy requirements. The use of alternative materials for bricks should be encouraged in order to preserve precious fertile top soil. The energy derived from coal in India is about twice that of energy derived from oil, as against the world, where energy derived from coal is about 30 % lower than energy derived from oil. Nearly 73 % of the country's total installed power generation capacity is thermal of which coal-based generation is 90 %. High ash content (30 % - 50 %) coal contributes to these large volumes of fly ash (Sahu *et al.,* 1991). The country's dependence on coal for power generation has unchanged. Thus fly ash management is a cause of concern for the future. According to ASTM C-618, two major classes of fly ash are identified. These two classes are related to the type of coal burnt and are designated as Class F and Class C. Class F fly ash is normally produced by burning anthracite or bituminous coal while Class C fly ash is generally obtained by burning sub-bituminous or lignite coal. At present, no appreciable amount of anthracite coal is used for power generation. Hence, all the Class F fly ashes presently available are derived from bituminous coal. Class F fly ashes have less than 6 % calcium oxide (CaO), designated as low calcium ashes and are not self hardening but generally exhibit pozzolanic properties. Class C fly ashes, containing usually more than 15 % CaO and also called high calcium ashes, Class C fly ashes are not only pozzolanic in nature but are invariably self cementations (McLaren and Digioia, 1987). Low calcium Class F fly ash normally acts as a fine aggregate of spherical form in early stages of hydration whereas high calcium Class C fly ash may contribute to the earlybinding reactions in addition to its presence as fine particulate in the mix. Up to 35 % of suitable fly ash can directly be substituted for cement as blending material keeping the structural considerations. Addition of fly ash significantly improves the quality & durability characteristics of the resulting concrete. Use of blended cement has now become quite popular world over, from durability and environmental benefits point of view. The advantages achieved with the use of blended cement in concrete are quite well documented: Reduced heat of hydration, improved workability & ease of pumping, superior microstructure leading to lower permeability, higher long term strength, better performance in

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aggressive environment Sulphates, Chlorides etc.), reduced risk of alkali silica reaction and higher electrical resistance leading to lesser chances of reinforcement corrosion are some of the benefits of pozzolona material blends. While portland pozzolona cement saves energy by 20 %, lime pozzolona mixture shows up to 70 % savings in energy.

In addition to the above mentioned advantages, use of fly ash provides more durability, saves on clinker cost, conserves mineral resources, provides good compaction, avoids breaking of large lumps, is light in weight, has no subsequent settlement, has no royalty to be paid as excavation of soil is eliminated, normally reduces transportation cost, easy and faster construction leads to overall reduction in construction cost; and supports additional agriculture produce from the land, which would otherwise be excavated for getting soil. The new technology focuses on stabilized earth masonry brick development incorporating an industrial by-product material, which is vital for the future of construction. The stabilized earth masonry brick technology relies on the use of an industrial by-product (Fly ash) and natural earth. Due to the use of a by-product material in the formulation, it is anticipated that the final pricing of the stabilized earth masonry building brick will be reduced. The added environmental advantage of utilizing industrial by-products available in the country will further improve the sustainability profile of masonry brick production.

The properties of fly ash based bricks depend on the following

- Fly ash type (classification, particle size distribution, etc.)
- Fly ash chemistry (pH, cat ion exchange capacity, etc.)
- Types of stabilization agent/agents
- Packing tool / method
- Sample size (mold size)
- Curing time

Literature review on stabilized earth masonry bricks/blocks revealed that there is a growing interest in stabilized earth building materials development with respect to an energy conscious and ecological design, which fulfils all strength and serviceability requirements for thermal transmittance. There are previous researches studies reported on compressive strength and erosion characteristics of earth blocks/ rammed earth wall (Jayasinghe and Kamaladasa, 2007). Reddy *et al.* (2007) reported on enhancing bond strength and characteristics of soil-cement block masonry. This resur-gence of renewed research interest in recent years in stabilized earth building bricks may be partially due to its potential as a commercial construction material. The fact that, a single element can fulfill several functions including structural integrity, thermal transmittance and durability in service makes the material an excellent walling material when compared to the fired earth bricks used in mainstream construction of today. Strength charecteristics of flyash incorporated stabilised blocks in comparison with compressed stabilised earth blocks (Adam, 2001) are presented below.

Properties	Compressed stabilised blocks	Stabilised blocks with flyash
Wet compressive strength (MN/m^2)	1-40	30-50
Moisture Movement (%)	0.02 - 0.2	0.03-0.1
Density(kg/m^3)	1700 - 2200	1600-1800
Thermal Conductivity W/m^oC	0.81 - 1.04	0.9-1.43

Advantage of compressed earth blocks (CEB) with fly ash are

(i) Cheap and affordable
(iii) Easy to use
(iv) Suitable as a construction material for most parts of the building.
(v) Availability of flyash in abundance

CONCLUSION

The following conclusions can be drawn:

I. Major usage in the world for construction is clay bricks; many researchers are presently looking for newer options because they need low cost materials, which are also environmentally friendly.
II. Stabilized compressed earth blocks include;uniform, sized building components which can result in less waste, faster construction and the possibility of using other pre-made components or modular manufactured building elements.
III. The use of natural, locally-available material like flyash makes good housing available to more people, and keeps money in the local economy rather than spending it on imported materials, fuel and replacement parts.
IV. The reduction of transportation time, cost and attendant pollution can also make fly ash incorporated more environmentally friendly than other materials.

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