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"LITERATURE REVIEW FOR HIGH VOLUME FLY ASH CONCRETE BUILDING BLOCKS (SOLID AND HOLLOW) AND MASONRY"

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Abstract
In present project work an attempt has been made to develop mix proportion for M7.5 grade concrete using high volumes of fly ash. Two trial mixes were used for the conventional concrete and in each trial mix cement replacement levels of 50%, 60% and 70% with fly ash were used. A total number of 64 cubes of size 150x150x150mm and 40 prism of size 75x100x500mm were cast to study the compressive strength and flexural strength characteristics respectively. From the study of compressive strength characteristics, a concrete mix using 50% cement replacement with fly ash and a cement content of 90kg/m^3 was used for casting the solid and hollow concrete blocks to be used for masonry. A total 48 solid blocks and 48 hollow blocks of size 300x150x150mm were cast. Three wallettes each of size 0.6x1.0x1.5m were constructed using solid blocks and similar number of wallettes were constructed using hollow blocks.

Keywords:
Fly ash, Prism, Hallow blocks, Portland cement.

I- INTRODUCTION:

In recent times, there is a demand for making concrete construction industry sustainable due to depletion of virgin materials. High volume of fly ash, a waste product of thermal power plant, satisfies the requirement of sustainable concrete.

Many sectors of the building and research industry are investigating increased volume of fly ash as a replacement for cement in concrete. This is primarily driven by the realization that worldwide production of cement accounts for approximately 7% of the total world CO_2 emission. It not only reduces the amount of green house gas emission but also results in utilization of an otherwise unwanted byproduct.

For a variety of reasons, the concrete construction industry is not sustainable. First, it consumes huge quantities of virgin materials. Second, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change. Third, many concrete structures suffer from lack of durability which has an adverse effect on the resource productivity of the industry. Because the high-volume fly ash concrete system addresses all three sustainability issues, its adoption will enable the concrete construction industry to become more sustainable.

Fly ash is available in large quantities in the country, as a waste product, from a number of thermal power stations and industrial plants using pulverized coal as fuel for boilers. Its availability is likely to increase with the increased industrialization in the country[2].

Coal based thermal power stations in India contribute about 65% of the total installed capacity for electricity generation. In order to meet the growing energy demand of the country, coal based thermal power generation is expected to last for more than 100 years. A coal with an ash content of around 40% is predominantly used in India for thermal power generation. As a consequence, a huge amount of Fly ash is generated in thermal power plants causing several disposal related problems, in spite of initiatives taken by the Government, several Non-Government organizations and research and development organization for fly ash utilization are developed.

The level of fly ash utilization in the country was only 42% by year 2009 against the target fixed by MOEF/GOI (Ministry of Environment and Forests Govt. of India) as 100% by the year 2014. The problems associated with the low level of fly ash utilization include inconsistency in the quality of fly ash produced, cost involved in the transportation of fly ash and the consumer preference for products made for fresh materials rather than the recycled wastes.

In India the problem is further compounded by use of fly ash collection system by large number of power plants which results in degradation of pozzolanic characteristics of Fly ash.

Also unavailability of appropriate cost effective technologies for Fly ash has also led to low levels of its utilization in India.

Hence for adoption of safe and economically viable alternatives of Fly ash utilization options are properly assessed and evaluated to enable formulations and implementation of a proper plan of action and also there is a need to develop confidence among the user agencies in India to use High volume Fly ash concrete (HVFAC) in the concrete construction industries.

Fly Ash:

Fly ash is a finely divided residue resulting from the combustion of pulverized coal and transported by the flue gases of boilers fired by pulverized coal.

Fly ash resulting from the combustion of pulverized coal in boiler of thermal plant is grey in colour and alkaline in nature. The particle size may correspond to that of silty sand to silty clay i.e. between 5-120 microns. The fly ash also contains heavy metals depending upon the coal burnt. This is prevented from polluting atmosphere by extracting it from the flue gases by ESP’s (Electro- static-precipitators). At thermal plants at Raichur, Roper, Bathinda and Lehra Mohabat, the fly ash collected in the ash hopper is removed from boilers house by wet as well as dry system. In the dry system the ash is collected in silos where from it is available for various uses. In the wet system, fly ash is mixed with water in a mixing sump to form ash slurry and is pumped into ash ponds.

Classification of Fly Ash:

ASTM – C 618-93 [1] categorizes fly ashes into the following three categories:

1. Class N Fly ash: Raw or calcined natural pozzolans such as some diatomaceous earths, opaline chert and shale, stuffs, volcanic ashes and pumice come in this category. Calcined kaolin clay and laterite shale also fall in this category of pozzolans.
2. Class F Fly ash: Fly ash normally produced from burning anthracite or bituminous coal falls in this category. This class of fly ash exhibits Pozzolanic property but rarely if any, self-hardening property.
3. Class C Fly ash: Fly ash normally produced from lignite or sub- bituminous coal is the only material included in this category. This class of fly ash has both pozzolanic and varying degree of self-cementitious properties. (Most class C fly ashes contain more than 15 % CaO. But some class C fly ashes may contain as little as 10 % CaO.

HIGH-VOLUME FLY ASH CONCRETE:

“The concrete which contains minimum 50% of Fly Ash by mass of cementitious material, is known as High Volume Fly Ash Concrete (HVFAC)”

The use of HVFAC fits in very well for sustainable development. High volume Fly ash concrete mixtures contain lower quantities of cement and higher volume of fly ash. The use of fly ash in concrete at proportions ranging from 20 to 50% of total cementitious binder has been studied extensively over the last twenty years and the properties of blended concrete are well documented. The replacement of Fly ash as a cementitious compound in concrete depends upon several factors such as design strength and workability of concrete, water demand and relative cost of fly ash compared to cement. The use of fly ash in concrete at proportions higher than 50% of total cement content is of recent origin.

The incorporation of high volume of fly ash in concrete reduces the water demand, improves the workability, minimizes cracking due to thermal and drying shrinkage, and enhances durability to reinforcement corrosion, sulfate attack, and alkali-silica expansion. It also supplements Portland cement in concrete production, where it can bring both technological and economic benefits. The replacement of Portland cement with fly ash also reduces the greenhouse gas foot print of concrete.

Concrete Block Technology:

Concrete block technology is based on the principle of densification of a lean concrete mix. To make a regular shaped, uniform, high performance masonry unit. Concrete block technology can be easily adapted to suit special needs of users by modifying design parameters such as mix proportion, W/C ratio and type of production system. It is an effective means of utilizing wastes generated by stone crushers, quarrying and stone processing units. The technology has high potential in areas where raw materials are easily available. The concrete block technology package is a highly profitable business for micro and small-scale building material producers and construction companies. Concrete blocks can be surfaced engineered by using pieces of stone or ceramic waste on their face. Another common type is hollow concrete blocks. They are made with a richer mix, but offer a number of advantages, such as light weight, easier handling and facility for conducting or reinforcement though the hollows.

Concrete blocks are masonry units which can be used to build foundations, walls, arches and corbel, etc. A typical concrete block is equivalent to 4.5 bricks; thus, construction is faster than with other masonry units. The mortar used is also less which results in cost saving. Concrete blocks have been extensively used in combination with conventional roofing system like RCC, RBC, GI sheets, ACC sheets etc. They are also compatible with other materials like fired bricks, dressed stone and compressed earth blocks for composite wall construction. Thus, concrete block technology offers a speedier, cost effective, and environmentally sound alternative to conventional walling materials.

In the present project proposal, it is aimed to establish mix proportions for M7.5 grade concrete by replacing 50 to 70% of cement by fly ash. It is also aimed to study strength properties such as compressive strength and static flexural strength characteristic.

After the development of mix proportion for concrete using the high-volume fly ash concrete building blocks [300x150x150 mm], solid as well as hollow were cast. Compressive strength characteristic and flexural strength properties of these blocks was studied. Also, masonry construction of size [0.6x0.15x1m] was done using these blocks which was tested under compression and flexure.

II-LITERATURE REVIEW:

John Albinger et al [2], The reasons for this were lack of availability of high-quality consistent material, lack of adequate technology, and sales programs based on cutting edge technology.

V. M. Malhotra et al [3], Gives a review on the use of by-products in concrete. Since Portland cement is a highly energy-intensive product, to save energy and conserve resources, considerable efforts are being made to find substitute materials for the partial replacement of cement in concrete. Some of the most promising substitutes or supplementary cementing materials are high and low-calcium fly ashes, ferrous and nonferrous slags, condensed silica fume, and rice husk ash.

Jose A. Vargas et al [4], A primer on replacing a portion of the Portland cement with fly ash in a concrete mixture is provided to help engineers unfamiliar with its effects better understand how fly ash will change the properties of the mixture, Jose. A. Vargas described the effects on plastic and hardened properties at both typical and high-volume replacement levels. Obstacles to the increased use of fly ash were also presented.

Dr. R.L.Khitoliya, et al [5], has worked on compressive and flexural strength of high volume fly ash concrete with a replacement of 40%, 50% and 60% of Fly ash by cement. The conclusion of his work is, the flexural and compressive strength of mix containing 40% of Fly ash is more or comparable with conventional concrete after 28 days of curing. And he also stated that the fly ash concrete continues to gain strength after 28 days, the compressive strength after 56 and 90 days of curing are more appropriate to show the effect of Fly ash on the strength of concrete.

Seshasayi, et al [6], Deals with an experimental investigation carried out to assess the performance of three types of concrete: one with ordinary Portland cement, another with blended cement and a third with site mixed high volume fly ash (with cement replacement level of 50 %). All three were exposed to acidic environment. Concrete with high volume fly ash showed better resistance when exposed to acidic environment, though strength decreased marginally. Concrete with blended cement is found more impermeable than concrete with fly ash mixed at site. It was concluded that high volume fly ash concrete is more durable than ordinary concrete.

Gihad Mohmmad, et al [7], **is** on mechanics of hollow concrete block masonry under compression. The aim of this work is to critically asses the mechanical properties of hollow concrete masonry using experimental results from prism constructed with blocks of two different strength and four types of mortar. The porosity of the mortar and the state of stress that mortar undergoes in the process of compressive loading can be responsible for changes in the mechanical properties such as elasticity, modulus and poisons ratio.

Mohammad, Labeed Ahmed et al [8], University Malaysia studied the structural behavior of interlocking hollow block wall with subjected to axial and eccentric loads. This study presents experimental testing of interlocking hollow block walls having window opening under concentric and eccentric vertical compressive load. The experimental testing focused on the effect of different layout of the reinforce stiffener around the opening on the structural response of the wall and its failure mechanism. The specimens are differing in the layout of the stiffener around the opening. These walls are subjected to vertical load of 0mm, 40mm, and 50 mm. eccentricity. The response was investigated in terms of deformation characteristics, strain variation, failure load and failure mechanism.

Mr.K.Ramamurthy et al [9], The results of a systematic experimental investigation on 306 stretcher bonded concrete hollow block masonry prisms under axial compression for influences of block-mortar strength combinations, block geometry, height to thickness ratio (h/t) of block, morta bedding, and thickness of mortar joint. The stress results were then used to derive a prediction relation for a rational assessment of the compressive strength of masonry prisms.

Tariq S Cheema et al [10], Experimental tests on prisms and constituents' materials (mortar, grout, and hollow- core concrete blocks) were used to calibrate linearly elastic finite element models for hollow and grouted concrete masonry prisms. These finite element models were then used to develop simplified relationships which closely predict the compressive strength and failure modes of prisms.

Robert G. Drysdale et al [11], The results of 146 axial compression tests of concrete block masonry prisms were reported. The results show that the strengths of grouted prisms are not affected much by the mortar joint. The average compressive strength for grouted prisms was less than for similar ungrouted prisms indicating that the concept of superposition of the strengths of grout and the ungrouted prism is not valid. An explanation for this phenomenon is suggested which indicates that the incompatibility of the deformation characteristics for the grout and the block contributes to these results.

III- CONCLUSION:

1. Flexural strength of solid concrete block masonry was same as that of brick masonry.
2. Flexural strength of hollow block masonry was 87.5% higher than that of solid block masonry.
3. Use of high-volume fly ash concrete for concrete building blocks is economically viable and environmentally sustainable option.

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