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Partial Replacement Of Fine Aggregate With Fly Ash And It's Compressive Strength

Junaid Ul Islam[1] and Zulfuqar Bin Rashid[2]
1. M. Tech CTM Student, Chandigarh University, Punjab
2. Assistant Professor, Chandigarh University, Punjab

Abstract - Extreme utilization of river fine sand as fine aggregates in building construction aggravates environmental degradation and urges the need for alternate source in the context of sustainable construction. This paper explores the feasibility of fly ash as fine aggregate replacement in the manufacture of concrete building blocks. An experimental analysis was carried out to evaluate the characteristics of concrete building blocks by changing fine aggregate (river sand) with fly ash. A great effort is made for assessment of compressive durability of concrete on exchanging fine aggregate with fly ash. Concrete mixes M25 and M30 are designed in accordance with the Indian standard code (IS-10262-82) by adding varying mixtures of fly ash. Concrete cube of size 150mm X 150mm X 150mm casted and analyzed for compressive strength at 7 days and 28 days curing for all mixes and the results are compared with those of conventional concrete.

Keywords – Fly Ash, Building blocks, Sustainable construction, Compressive Strength, and M25 & M30 mix.

INTRODUCTION

At this time India is witnessing a new phase in development with rapid economic growth and high rate of urbanization. Construction provides the direct means for the development, expansion, improvement and maintenance of human settlements is particular and economic growth in general. Construction activity accounts for more than 50% of the development outlays in India. Building construction costs are increasing at rates which are So per cent over inflation. This is primarily due to the increase in the cost of basic building materials like burnt brick, steel, cement, timber, etc. As a result, Construction costs for normal housing have escalated to all new high levels.

Construction costs of this order are beyond the affordable capacity of the economically Weaker Section and Low Income Group and a large cross section of the Middle Income Groups, whose income levels have not increased commensurately. This has become all the more relevant in the macro context due to the large volume of housing to be done in both rural and urban areas and the limited resource of building materials and finance available.

However, it also needs to be recognized that construction also adversely affects the environment, through physical disruption. The depletion of key renewable resources like fertile top soil, forest cover and excessive consumption of energy. Therefore, there is a strong need to adopt cost-effective, environmentally appropriate technologies by upgradation of the traditional technologies and also using local materials as well as using appropriate and intermediate technologies using modem construction materials with efficient, effective technology inputs. Building materials is an area where enormous amount of innovation for cost reduction, can be achieved. May bricks being the most important area for innovation as the total demand of clay bricks, as a challenged walling material in India, is estimated at 180 billion per annum causing the depletion 540.000 metric tons of fertile soil.

In the above background, Fly ash basically a waste material has a dear edge over the construction material as it can be converted to a resource with a minimum amount of investment. Further, it can help to increase the speed and quality of construction and thereby helping in enhancing the efficiency of housing delivery mechanism.

Fly-Ash- The Environmentally Friendly Material

Fly-ash is the constituent of Silica, Alumina, Ferrous Oxides, Lime, Cadmium, Copper and some elements of Magnesium. It is technically produced from the combustion of coal, composed of fine material being driven as the waste product throughout the process. These particles solidify as microscopic, glassy spheres that are collected from the power plant's exhaust before they can "fly" away — hence the product's name: Fly Ash

The rapid increase in the annual consumption of natural aggregates due to the expansion of the construction industry worldwide means that aggregate reserves are being depleted rapidly, particularly in Kenya where the construction industry is at an all-time high. It has been reported that, if alternative aggregates are not utilized in the near future, the concrete industry will globally consume 8-12 billion tons of natural aggregates annually. Such large consumption of natural aggregates will cause destruction of the environment. Therefore, it is imperative that alternative substitutes for natural aggregates be found. One possibility is the utilization of 3 industrial by-products and waste materials in making concrete, which will lead to a sustainable concrete design and a greener environment

The damping of industrial wastes such as fly ash at waste management dumpsites causes a major problem to our environment by destroying soils and release of toxic fumes to the atmosphere. Hence, the utilization of fly ash, which constitutes industrial wastes, can provide solutions to the environmental degradation challenge posed by dumping of industrial wastes such as fly ash since these wastes are non- biodegradable. In order to curb this, there is need to provide an alternative use of fly ash by substituting them as partial replacements to natural fine aggregates.

Literature Review

A variety of reports for use of Fly Ash in concrete as a replacement of sand have been written and reported in literature. A brief survey of the research work done in this area is discussed below.

1. Shashidhara and Vyas., (2010) reported the results of replacing sand in cement concrete using imperial smelting furnace Fly Ash in Indian Concrete Journal. The fine aggregate fraction so produced conformed to the grading requirements of both fine aggregate and all in aggregate. The workability of concrete improved as the replacement level increased, though the packing 7 density of the dry all-in aggregate reduced. Replacing sand with fly ash did not affect the compressive strength, but in a leaching test, complete replacement resulted in Lead (Pb) setting leached above the permissible level.

2. Hooper, R. et al., (2002) focused on setting characteristics of Fly Ash, the effect of fly ash in minimizing retardation of set as well as the European policies for reuse of secondary materials. According to them, the UK Ten Year Transport Plan, including the development of the highway infrastructure, offers opportunities to demonstrate successfully the consumption of small volume streams of secondary materials, including Fly Ash, within the local area. Pavement construction offers several opportunities for consumption, the most credible of these being the replacement of the sand fractions by the slag in bound mixtures, cement and bituminous. The paper focused upon cementitious mixtures alone. The presence of zinc and lead ions in the fly ash were proven to have an impact on the setting characteristics of concrete mixtures, although there is little difference in the compressive strengths after 28 days. The leaching, characteristics of the slag suggested that the retardation is not linearly related to the quantities of zinc or lead leached. Additionally, leaching tests in combination with pulverized fuel ash (fly ash) and ground granulated blast furnace slag indicated that it might be possible to minimize retardation of set in by including these materials in the concrete mixture.

3. Tripathi, B. et al., (2012) assessed the strength and abrasion characteristics of Fly Ash Concrete. In their report, they assessed the potential of Fly Ash as sand in concrete, considering the presence of toxic elements (lead and zinc) and their detrimental effects on the early hydration of cement. Equivalent volume of sand was replaced by FLY ASH in different percentages. Concrete specimens were prepared at different water to cement ratios. Compressive, flexural, and pull off strength, along with abrasion resistance, were examined.

Results were encouraging because sign of delay in setting was not observed. Improvement in compressive and pull off strength; comparable flexural strength and abrasion resistance; and, leaching of toxic elements within safe limits assured the potential of future use of the Fly Ash as sand in concrete.

4. Morrison and Richardson., (2004) stated in their study of Re-use of zinc smelting furnace fly ash in concrete, studied environmental concerns associated with the reuse of slag in concrete due to the presence of heavy metals like Zinc and Lead. They concluded that the fly ash is physically suitable for use as an aggregate, although there are several barriers that must be overcome before it can be used in concrete. The study also reported that the glassy nature of the slag initially raised concerns regarding the potential for alkali–silica reaction (ASR) to occur in concrete. However, after a comprehensive series of accelerated ASR tests indicated that the material was not susceptible to this type of deleterious reaction.

5. Kumar Mehta., (2010) referred to the work of Malhotra V.M and his colleagues according to which fly ash used in large volume imparts excellent workability to concrete at a water content 10 to 20% lower than that for concrete without the fly ash and further reductions in water content can be achieved with better aggregate grading and with the help of super plasticizing admixtures.

MATERIAL DESCRIPTION

1. **Aggregates -** For each and every aggregate are the necessary constituents in concrete. They provide body to the concrete, reduce shrinkage and impact economy. The mere proven fact that the aggregates occupy 70-80 per cent of the amount of concrete, their impact on varied characteristics and properties of concrete is without doubt considerable.
2. **Cement -** Cement is a binder material that sets and hardens independently, and can bind different materials along. Cement is formed from four main compounds (3CaO SiO_2), (2CaO SiO_2), (3CaO Al_2O_3), and (4Caco Al_2O_3 Fe_2O_3). Small amounts of un- compounded lime and magnesium oxide are also present, together with alkalis and minor amounts of alternative components.
3. **Fly ash -** Fly ash may be a by-product from coal-fired electricity generating power plants. The coal utilized in these power plants is especially composed of flammable parts like carbon, hydrogen and oxygen (nitrogen and sulphur being minor elements), and non flammable impurities (10 to 40%) typically present within the type of clay, shale, quartz, feldspar and sedimentary rock. the size of ash ranges from 1.0 to one hundred micron and the typical size is around 20 microns. it is found that particle size below ten microns contributes towards early Development of strength (7& 28 days).
4. **Water -** The pH value of water should be in between 6.0 and 8.0 as per IS 456-2000.

METHODOLOGY

The properties of material used, that is, fineness modulus and specific gravity using pycnometer, of sand, fly ash as well as the sieve analysis of fine and coarse aggregates will be carried out, and the results determined in the laboratory. Grading curves as well as the underlying zones for the fine aggregate and slag will also be determined in the laboratory according to IS codes of practice.

Essential Requirements of Aggregates

1. Durability.
2. Cleanliness.

3. Size of the Aggregates.
4. Grading of the Aggregates.
5. Sampling of Aggregates.

Conclusion

The following conclusions are derived from the results:

- Utilization of fly ash, an abundantly available waste material from thermal power plants as a constituent material in concrete building blocks replacing river sand certainly improves the sustainability of construction.
- Results of investigation reveal that it is feasible to replace natural sand by fly ash to achieve strength.
- The results of this investigation suggest that the fly ash could be very conveniently used as a partial replacement of natural sand in structural concrete.
- From the results of the investigation the maximum compressive strength was observed for 20% replacement level.

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