Review Paper (T-2)

HIGH VOLUME FLY ASH CONCRETE : A GREEN CONCRETE

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ABSTRACT

Infrastructural Development is at its peak all over the world and is a symbol of growth for any country. But, as every coin has two faces - Concrete is no exception. The negativity attached to construction industry is that concrete, the most popular construction material, involves use of cement which is responsible for 7% of total world's carbon dioxide emissions. Carbon dioxide is the main threat in causing global warming of the environment. Though attempts have been made to reduce CO_2 emissions in environment by all possible means, but cement has not found a suitable replacement for it till date. High Volume Fly ash Concrete (HVFC) is an effort in reducing cement content of construction. The paper aims at discussing the use of HVFC in construction as a solution to address two environmental problems - one, disposal of huge amounts of fly ash, a byproduct of thermal power plants, causing environmental degradation through large areas of landfills and two, high percentage of carbon dioxide emissions in atmosphere from cement industry.

Key Words : Cement, fly ash, Concrete, High performance concrete, High volume fly ash concrete, Environment.

INTRODUCTION

In the present era of growth and development, progress is taking place in all the fields. But, in the light of progress, man is ignoring nature and harming it. Construction area, with the use of virgin materials like cement, is also posing the threat of global warming and environmental degradation. The challenge in front of civil engineering community is to provide sufficient, economical and comfortable infrastructure without causing any hardship for environment. Taking sustainable development in view, an attempt has been made to reduce the use of cement in concrete by replacing it with otherwise waste materials such as fly ash, slag, silica fume and rice husk[1]. A major breakthrough in using fly ash in concrete was provided by first comprehensive study in 1969[2].The use of fly ash in concrete has been encouraged all over the world[3].Though this has been tried at some places in India but the percentages replacements of cement by fly ash are very small and only less than 25% of total fly ash produced is being utilized[4]. A confidence is required to be built up in developing countries like India to make use of high volume fly ash concrete in various fields of construction.

AIMS AND OBJECTIVES

Cement concrete, the most popular construction material, has its own problems. Firstly, cement production is highly energy intensive. It consumes approximately 4 GJ of energy per ton of cement production. Secondly, the cement production process results into emission of large amount of CO_2, a green house gas. It is worth mentioning, here, that for every ton of Portland cement produced, 0.9 tonne of CO_2 is released in the atmosphere. The ensuing research focused its attention on finding some solution to reduce the consumption of cement by replacing a percentage of it by fly ash, an

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otherwise waste byproduct from thermal power plants.

MATERIAL AND METHODS

Cement

The most popular construction material till date is cement in the form of concrete. The use of cement in construction is as old as Greek civilization. Cement has proved its efficiency in terms of its sufficient strength, economic cost, less time of construction and finally good durability. Moreover, the growth of a country is adjudged through its infrastructural facilities. Hence, construction industry has always been in boom and has seen rapid development in recent past. Cement Concrete with large volumes of fly ash needs to be used in construction activities for the benefits discussed later in this paper.

Fly ash

Fly ash is the fine residue produced from the combustion of pulverized coal in electric and steam generating plants. In India, thermal power plants are the main source for producing electricity. Though attempts are being made to find solutions for cleaner production of electricity, but still there is a long way to go and we may depend on traditional coal burning thermal power plants for quite some more time (50-100 years). As a rough estimate, approximately 115 million tones of fly ash are being produced annually from thermal power plants in India. However, only 40 million tones of fly ash are used annually in various engineering applications. The use of small percentages of fly ash in a variety of civil engineering works is being carried out mainly for economical reasons. Fly ash, being available, at negligible or no cost is taking place of cement, a costly construction raw material with the aim - one, to solve the problem of disposal of fly ash in environment and two, to get some financial benefit. However, researchers abroad, especially in developed countries, have proved that fly ash in high volumes can safely be used in concrete and results in better pump ability[5] and long term durability. The use of fly ash in concrete has increased in last 20 years considerably[6].

High volume fly ash concrete

A concrete with high volumes i.e. 25% to 60% of fly ash in it is called high volume fly ash concrete[7, 8]. The concept of high volume fly ash concrete in construction is a solution to environmental degradation being caused by cement industry and thermal power plants. As mentioned earlier, cement industry alone is producing $1/15^{th}$ of total worlds' carbon dioxide which is a green house gas causing global warming of the environment[9]. On the other hand, fly ash is produced as a waste material in bulks from thermal power plants and its proper disposal is a serious problem in itself. If left indisposed, laying on the ground, it causes air and soil pollution and if tried to be disposed off, it requires huge land areas for land filling. Using fly ash in concrete will address the problem of green house gases emissions and save a lot of land areas for some other useful purposes than land filling. The replacement of small percentages of cement by fly ash results in economic benefits but the misconception that its high strength will lead to high durability has probably resulted in cracking and premature deterioration of some structures[10]. The high volume replacement of cement by fly ash gives not only significant economic benefit but also improves long term durability of structure. A comparison in properties of concrete with varying properties of fly ash has been made in developed countries[11].Though the use of fly ash in construction has been tried for long and sufficient literature and test results are available on its usage[12] but very little research has been carried out in India on this front. The development of high performance concrete with fly ash in India for infrastructure and water resources projects has been studied very recently[13]. Secondly, the mind set of people in India has a fear on the performance of high volume fly ash concrete, especially regarding its strength criteria. Some more research and education on the topic can take out this fear and make use of high volume fly ash concrete more popular in all types of concrete construction.

Environmental benefits

High volume fly ash utilization, especially in

concrete, has significant environmental benefits including:

- Increasing the life of concrete structures by improving concrete durability, besides exhibiting good workability and better strength[14].
- Net reduction in energy use and green house gas emissions through cement industry.
- Reduction in amount of coal combustion byproducts that must be disposed in landfills.
- Conservation of natural resources and materials.
- More sustainable concrete industry.

RESULTS AND DISCUSSION

The test results conducted in laboratory on compressive strength, flexural strength and durability of high volume fly ash concrete showed encouraging results. All the concretes with fly ash more than 30% replacement level for cement showed an increase in strength at 365 days, though there was a decrease in strength at early ages up to 56 days. Also, it was observed that the optimum level of replacement of cement in concrete by fly ash was definitely more than 15%-20% for achieving better properties of concrete in terms of workability, strength and durability. Hence, it is suggested that the focus for partial replacement of cement in concrete by fly ash should be shifted from economical reasons to technical reasons.

CONCLUSION

For reducing the adverse environmental impact of concrete industry, the first step can be cement conservation with the aim to check energy consumption and reduce green house gas emissions[15]. It is worth mentioning here that though the technology has advanced in all fields including infrastructural one, concrete construction industry is not sustainable. For the benefit of our future generations, we need to make serious efforts to make it more sustainable. Certain recent investigations have been made with the aim to reduce environmental degradation by disposal of high volumes of fly ash in landfills[16]. Use of high volume fly ash concrete in construction is one big step in natural resource conservation and it needs to be promoted all over the world. In fact, it will not be wrong if we call high volume fly ash concrete as a green concrete, since it can protect the environment from global warming to a large extent. There may be some negativity attached to the use of high volume fly ash concrete like slower construction rates as it gains strength slowly and gives lower early strengths. But, the same can be ignored as the later strengths (90 days or more) and durability of high volume fly ash concrete is much better than plain concrete. Moreover, we can not forget our responsibility towards nature/ environment and shall sacrifice at least time in safeguarding it from global warming and help it be more sustainable.

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