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Carbon Credit Gains Due To Reuse Of Fly Ash In Concrete Technology

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ABSTRACT

Carbon credit has emerged as on the newest and promising parameter for quantifying the pollution. Construction industry is the basic and largest capital investment industry of the world. The traditional construction materials create huge pollution during their synthesis. The major pollution is due to the reason that their synthesis process consumes large amount of energy. The energy is obtained from fossil fuel. Thus there is a large scale emission of green house gasses.

Fly ash is a large magnitude waste material generated by thermal power plants. Its magnitude is gigantic and pollution effects are multiple. However, its use in concrete has emerged up as a successful method of reuse and ultimate disposal. It enhances the concrete properties. Moreover it earns carbon credits too. The present paper describes the reuse of fly ahs in concrete and consequent gains in carbon credits.

Key words: *Carbon credits, fly ash concrete.*

INTRODUCTION:

Evolution is the law of nature. It is the well known theory of Charles Darwin that the species that can accommodate and adopt to the changing environment they only persist; else they get extinct however strong they may be. Vanishing of dinosaurs by the end of Mesozoic era and persistence of microorganisms are the examples. Mankind is the physically most fragile living creation. Man has its own supremacy due to its developed intellectual power. The intellectual power provides the means to protect itself under changing environmental conditions. Today's environment is rapidly degrading due to the improper use of man's intellectual creativity. It is due to the impact of development of science and technology, industrialization and rising population with their 'needs and greed'. Science has a deep impact on human lifestyle. It has indeed made the life more comfortable, more enjoyable, and more secured.

The pollution arising out of such luxury life may be considered as a darker side of scientific development. In fact science has also provided answers and means to cope with pollution. If these means and methods are employed properly the state of "development without destruction" can be achieved. The twentieth century has seen a rampant growth in industrialization using science and technology. Modern life has become more mechanized and energy intensive.

The per capita total energy demand has greatly increased, and also the global population too has increased many folds. Today world's 90% of the total energy is derived from fossil fuel [1]. In the past century, the atmospheric concentration of CO_2 has significantly increased resulting in absorption and accumulation of heat in atmosphere and consequent rise in the mean temperature thus global warming has also disturbed the climatic pattern. The rain cycle has shifted. Few places are prone to excessive rains and flooding, landslides while others are subjected to dry spell. This has affected crop yield. Scientists have estimated that by 2050, the climatic cycle will affect large scale agricultural practices [2]. The land submergence is at such a scale that according to an estimate, by 2020, one third land of Bangladesh will be drowned leading to mass migration [2].

In order to meet ever rising demand for electricity, installed power generation capacity of India has increased by 67 times between 1947 to 1998 [3]. In 1947, there was just 1331 MW of power generation and in 1998, it has reached about 89167 MW. Yet there is no respite. Demand continues to outstrip supply. Presently India largely depends on coal for its electricity generations The nation produces 65% of its electricity by thermal power plants [4]. Thermal power plants burn coal and produce fly ash as a by-product. In 2007_08 the fly ash generation rate in India stood at 130 million tone [3]. Government has set the coal based addition target of about 60000 MW in the 11th five year plan. It is estimated that with new power plants, fly ash production of the country will reach a high of 225 million tonne per annum by 2012 [5].

This shows that now the problem of fly ash is and will become gigantic and needs serious thoughts. The technology of reuse of fly ahs for varieties of applications has emerged up. One of the popular applications is in concrete. Addition of fly ash has been globally recognized to be beneficial for the concrete. In fact in the present scenario fly ash addition has been recommended by the IS codes and in market it is not possible to get fly ash free concrete without special request to the manufacturer.

The use of fly ash in concrete has several benefits. It solves the problem of fly ash disposal and consequent pollution. It enhances concrete performance. In fact IS Codes have recognized their significance and have incorporated them in themselves [6-10]. It reduces cement cost also. Over and above it earns carbon credit. The present paper investigates the various aspect and scope of fly ash reuse in concrete in India and subsequent gain in carbon credit.

CARBON CREDIT CONCEPT

In 1997, the Kyoto Protocol was prepared and many countries were signatories to it [11-12]. There was an agreement to reduce the CO_2 generation and other green house gasses gradually so that by 2012, it falls down to the level that of 1990. This requires adoption of new technology and optimum use of fuel and other renewable energy sources. Some industries can easily bring down their carbon emission while for others it may be cost intensive. The concept of carbon credit was evolved in the protocol [13]. According to this, in a region there are set mandatory norms for carbon emissions. The industries which have reduced their emissions below permissible limits are allowed to earn equivalent carbon credits. These credits are traded by industries which are unable to bring down emissions. Due to globalization, credits can be sold to other countries. This trading of carbon credit provides an opportunity to balance the environment globally.

CO_2 GENERATION DURING CEMENT MANUFACTURING

In the process of manufacturing of cement, CO_2 generation takes place in two ways. Firstly during burning of coal and secondly during cracking of lime. The quantitative estimations are done herein:

CO_2 GENERATION BY COAL BURNING

For manufacturing cement, ingredients are heated at around 1400^0C. At such a high temperature, the ingredients fuse together and combine chemically. This high temperature is obtained by burning coal. There are different estimates for carbon emission estimations by various researchers according to Yashpal Singh [14] one tonne of Portland production produces approximately 0.87 tonnes of CO_2 in the environment and Datta et al [15] has estimated that approximately 0.95 tonnes of CO_2 is released in the atmosphere during production of one tonne of cement. Further, in Japan every year barren land of approximately 1.5 times that of India is needed to be afforested to compensate for total global accumulation of CO_2 into the atmosphere by the cement industries [15].

According to Vimal Kumar [16], the current level of use of Fly ash of 80 million metric tonne per year conserves annually (i) 300 lakh tonnes of coal, (ii) 650 lakh tones of lime, (iii) 400 lakh tonnes of top soil which is equivalent to 3000 acres of land and (iv) 300 lakh tonnes of CO_2 generation. By replacing 40% cement we will be able to reduce CO_2 emission by 44 million tonnes per annum in India.

Quantitative estimation of CO_2 generation during cement manufacturing shows approximately 4.5 kg of coal is burnt for making 1 kg of cement [17]. Considering coal as pure carbon, CO_2 generation can be estimated as:

$$C + O_2 \rightarrow CO_2$$

12 32 44

Hence, 12 g carbon combining with 32 g of Oxygen, produces 44 g CO_2. Therefore it is estimated that 1 kg coal produces about 0.9 kg of CO_2 [5].

CO_2 GENERATION BY LIME CRACKING

Lime stone is used as raw material for manufacturing cement. Raw material of cement is a mixture of 60% lime (CaO) and 40% alumina. So, 1 kg of cement requires 600 g of CaO. The lime is obtained from lime stone ($CaCO_3$). From molecular weight considerations, 56 g CaO requires 100 g $CaCO_3$. Hence, 1 kg cement requires 1071 g $CaCO_3$. When $CaCO_3$ is cracked by burning, CO_2 is liberated.

$$CaCO_3 \rightarrow CaO + CO_2$$
$$100 \quad 56 \quad 44$$

100 g $CaCO_3$ produces = 44 g CO_2.

56 g CaO = 100 g $CaCO_3$

Hence 600 g of CaO = 100*600/56 g $CaCO_3$

= 1071.4 g $CaCO_3$

100 g $CaCO_3$ = 44 g CO_2

Hence 1071.4 g $CaCO_3$ = 44*1071.4/100 CO_2

= 471.416 g of CO_2

= 0.471 kg of CO_2

Thus, production of 1 kg cement produces 0.471 kg CO_2 by lime cracking. Since 4.5 kg coal is used to form 1 kg of cement.

Therefore total CO_2 emission in cement industry will be:

Coal + Lime = Cement produced

4.5 kg coal = 4.05 Kg CO_2 + 1 kg lime = 0.47 CO_2 = 1 kg Cement

4.05 + 0.47 CO_2 = 1 kg Cement

4.52 kg CO_2 = 1 kg Cement

Thus theoretically 4.52 kg of CO_2 will be liberated during 1 kg of cement production, approximately considering coal as pure carbon, but coal is not a pure carbon and has impurities as per the grade of coal. Therefore the total CO_2 emission per kg of cement production will be much less than 4.52 kg of CO_2 liberated [18].

CONCLUSIONS

In 2007 India had annual production of cement as 100 million metric tons per year (Ramchandra 2007). Hence it produces 137 million MT of CO_2. If 10% fly ash is used in all cement constructions, CO_2 emission shall reduce by 14 MMT/year. In other words, India can earn a carbon credit of 14 MMTs. In addition to this, it will solve the problem of fly ash disposal by reusing it in agricultural and wasteland development and earn more carbon credits.

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