



REDUCTION OF GLOBAL WARMING GAS EMISSIONS FROM THE MANUFACTURE OF PORTLAND CEMENT USING HIGH VOLUME FLY ASH CONCRETE

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ABSTRACT

The Global warming gases are increasing steadily in the world due to the advent of industrialization. In 1800 before the industrial revolution started, the concentration of CO₂ gas in the atmosphere was estimated to be 260 ppm only. The concentration of CO₂ in the year 1988 was observed in Hawaii to be 350 ppm. The data indicate that the rate of concentration of global warming gases (GWG) in the atmosphere has increased considerably in the past few decades. This pushes the average global surface temperature by about 0.7°C. The United Nations Intergovernmental Panel on Climate Change (IPCC) has taken the view that average global temperature could rise by 1.4°C-5.8°C by the end of this century. This paper discusses some aspects of global warming and the role of admixtures in reducing emissions of CO₂ to the atmosphere.

INTRODUCTION

The Portland cement manufacturing industry is the significant contributor of green house gases (GHG). It is estimated that the production of 1 ton of cement releases about 1.1 ton of CO₂ gas along with minor quantities of other global warming gases like methane.

The world cement production in the year 1995 was about 1.4 billion tons, which could have emitted about the same amount of CO₂ gas. This accounts for almost 7% of the total world CO₂ gas emissions (Malhotra 2006). Developing countries like India is increasing cement production to meet out the infrastructural facilities for developmental activities. The anticipated cement production by the year 2020 is 3 billion tons and the amount of CO₂ is 3.2 billion tons.

Next to the cement industry, almost the same amount of CO₂ is released by automobiles. This is due to the burning of gasoline, which produces about 2.5 kg of CO₂ gas from one litre of fuel (Malhotra 2006). Apart from the land automobiles, the evolution of CO₂ gas by aircrafts is also sharply increasing. The emission of CO₂ to the environment by civil aviation in Europe in 2002 shows considerable increase from the year 1990 (30.3%), UK (6.1%), Japan (6%) and USA (14.3%) (Watt 2007).

This paper emphasizes the increased use of admixtures and other supplementary materials to reduce the global warming gases. One such admixture is use of fly ash obtained from thermal power stations. Utilization of fly ash will also help sustainable development and effective disposal of the solid waste. By using high volume fly ash concrete (HVFC), the portland cement production and thereby the global warming gases can be reduced.

MATERIALS AND METHODS

In this research, standard cube strength study, cylinder strength study and beam study using fly ash

were carried out by replacing cement by (30%, 40% and 50%) for the effective reduction of ash in cement industry. The control and fly ash concrete cubes of size 150 mm × 150 mm were cast and tested at 14, 28, 56 and 90 days curing.

RESULTS AND DISCUSSIONS

By various replacements of cement by fly ash, cube strength up to the period of 56 days shows that compressive strength gradually reduces as the volume of fly ash increases (Table 1). Same results have earlier been found by Krishnaveni & Jinto John (2006). For the period above 56 days of curing for M₂ to M₄ mix, the compressive strength increases to a considerable amount at the age of 90 days study as also reported by Sivasundaram & Malhotra (2004) and Sivasundaram (2004). From the results we came to a conclusion that the 90 days strength of the concrete with replacement of cement by HVFA up to 50% produces comparable result with the M₁ mix (100% Portland Cement). Hence, we can reduce the production of cement by 50% by replacing cement using fly ash.

The projected world cement production in the year 2010 is 1.9 billion tons and for 2020 the production is expected to be 3 billion tons but already countries like USA has exceeded their expected level of cement production (Malhotra 2006) (Table 2). Developing countries like India has increased production capacity in order to meet the growing infrastructural growth. Since, the CO₂ emissions by cement industries is quite high, either ecofriendly technology or reduction of cement production has to be achieved to check the increase in emissions of global warming gases. Replacing cement by fly ash to a certain extent is opted today. With 50% replacement of cement by fly ash 50% of CO₂ emissions can be reduced without compromising the strength of the concrete except for the concrete that requires early strength.

Similar to cement industries, automobile industries also contribute the same amount of CO₂ gas (7% of global warming gases to the total). The consoling factor is that much research work is going on to reduce the emissions from automobile industries. But the major concern is that how to check

Table 1: Compressive strength cement and HVFC.

Mix	Percentage of Fly Ash	14 Days (MPa)	28 Days (MPa)	56 Days (MPa)	90 Days (MPa)
M1	0	-	57.55	57.55	58.6
M2	30	39.55	43.25	48.88	53.33
M3	40	28.415	38.51	41.33	48.44
M4	50	22.44	34.667	40	43.55

Table 2: CO₂ Emission reduction for high volume fly ash concrete.

Year	World Cement Production (WCP) Billion tons	CO ₂ released For OPC Billion tons	CO ₂ released for various replacement levels, Billion ton			%Reduction in CO ₂ by using fly ash cement concrete		
			30%	40%	50%	30%	40%	50%
1995	1.5	1.56	1.05	0.936	0.78	30	40	50
2010	1.9	1.981	1.38	1.186	0.988	30.33	40.15	50.126
2020	3.0	3.12	2.184	1.872	1.56	30.00	40.00	50.00

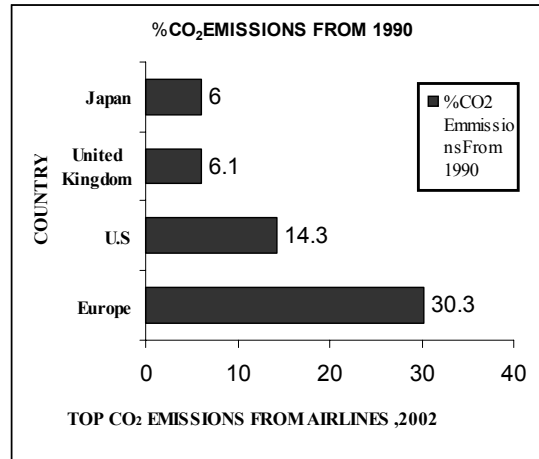


Fig. 1: Carbon dioxide emissions from airlines (Europe), 2002.

the CO₂ emissions from airlines which has increased much in 2002 compared to 1990 (Fig.1) (Watt 2007). So effective measures have to be taken to develop new fuels that will allow us to burn less energy and emit less.

CONCLUSION

The past ten years with the exception of 1996 have been the warmest on record. The view expressed by the United Nations Intergovernmental Panel on Climate Change gives concern in global warming. Like research in the cement replacement by blending, many steps have to be taken by the Government and nongovernmental Organizations to tackle this problem. Every individual should help to reduce his carbon foot print. All the industries, which are responsible for emissions, will have to trade CO₂ allowances to reduce emissions by enacting suitable international laws.

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