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COMPARATIVE STUDY OF GGBS CONCRETE WITH OPC CONCRETE FOR ASSESSMENT OF CO_2 EMISSION REDUCTION AND COST SAVING

Swapnil Sardar[1], Deepa A. Joshi[2]

[1] *PG Student, Civil Engineering, Dr.D.I.T, Pimpri, Pune*
[2]*Professor, Civil Engineering, Dr.D.I.T, Pimpri, Pune*

Abstract— In India, over the last few decades there has been a boost in the demand for residential buildings which had led to construction of buildings with a very little understanding and concern about the environmental impacts. During the construction phase one of the most important aspect that needs to be considered for sustainable construction is to reduce the use of virgin materials, like cement. In this paper, a comparative study of GGBS concrete and OPC concrete by considering the case study of a high rise residential project has been presented. It was estimated that by the use of GGBS, CO_2 emission can be reduced by 51.77% and cost saving of 33.41% can be achieved.

Keywords—GGBS, Concrete, Cost saving, CO_2 emission

I. INTRODUCTION

Construction industry is growing rapidly day by day, Concrete is the prime material used for construction. In order to ensure sustainable development in the construction sector it is essential to work on ingredients of concrete. Today 40% of energy related global emission are attributed to buildings, 60% of waste comes from buildings or related activities. All these factors have lead to increasing greenhouse gas levels, rising global temperature, rising sea level and dramatic resource depletion [1].

This can be reduced by the use of green concrete. By increasing the dependence on recycled materials to reduce the dependence on virgin material, effective use of supplementary cementitious material that is partial replacement of cement can be done by the by products of industrial processes, such as fly ash, blast furnace slag, as the production of Portland cement is responsible for generation of CO_2 and huge energy is consumed during manufacturing of cement [2].

Ground Granulated Blast furnace Slag (GGBS) is a by-product from the blast furnaces used to make iron. These operate at a temperature of about 1500 degrees centigrade and are fed with a carefully controlled mixture of iron ore, coke and limestone. The iron ore is reduced to iron and the remaining materials from a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimises the cementitious properties and produces granules similar to coarse sand. This granulated slag is then dried and ground to a fine powder [3]. Use of GGBS in concrete can lead to reduction in CO_2 emission. It is essential to quantify the reduction in CO_2 emission in comparison with OPC concrete. Also the replacement of cement by GGBS can reduce the cost of materials in the project.

II. METHODOLOGY

The main objective of this study is to estimate the amount of reduction in CO_2 emission and cost saving that can be achieved by use of GGBS in concrete by partial replacement of cement. This has been estimated by considering a high rise residential project in which GGBS has been used as partial replacement of cement in concrete. The detailed Quantity Surveying was done for the selected case study and the quantity, costing and CO_2 emission for concrete with GGBS and with only OPC has been calculated.

III. CASE STUDY

Panchashil High Rise Towers is an ongoing residential project in Pune city consisting of 9 towers of 32 floors each. This particular project was selected for case study as concrete with 50% replacement of cement with GGBS is being used in this project.

All the towers are to be constructed using Mivan formwork technology which implies that there will be no masonry work and all the walls will be constructed in concrete. Therefore concrete plays a vital role in this project as it will be consumed in a very large quantity. The major grades of concrete used are M40 and M50.

All the relevant drawings were studied and Quantity Surveying was done to estimate the total quantity of concrete required and thereby a comparative study was done to estimate the CO_2 emission of Concrete with 50% GGBS replacement and Concrete with only OPC. The economical aspect was also considered by comparing the cost required in production of these two types of concrete.

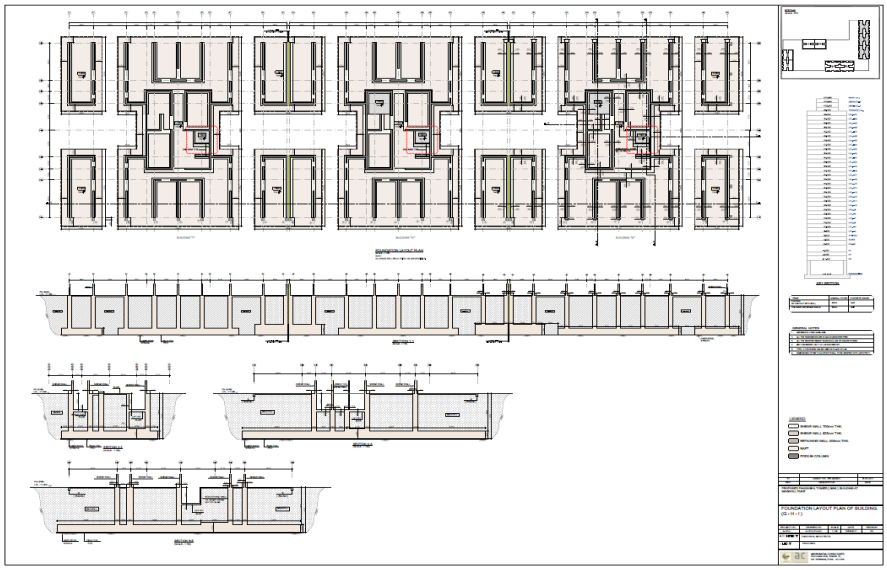


Fig. 1 Foundation Layout Plan

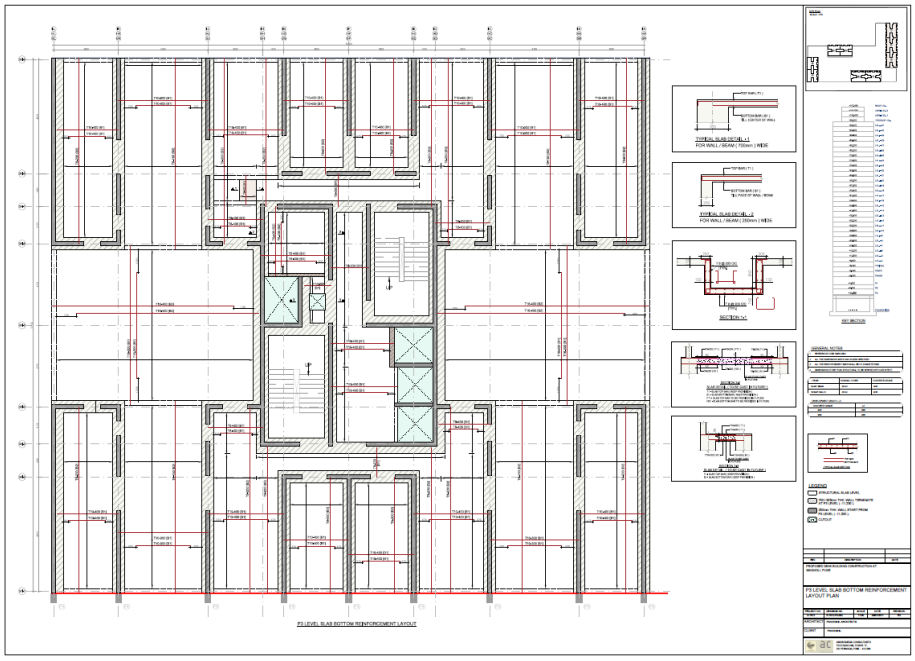


Fig. 2 Slab Layout Plan

TABLE I
SUMMARY OF CEMENT CONSUMPTION

SUMMARY OF CEMENT CONSUMPTION WITH AND WITHOUT REPLACEMENT WITH GGBS									
Sr. No	**Particulars**	**Grade of concrete**	**Total Concrete required**	**Cementitious content Ratio(Cement + GGBS)**	**Total Cementitious content**	**Replacement Percentage**	**Cement consumption only with OPC(Tonne)**	**Cement consumption with GGBS replacement(Tonne)**	**GGBS required (Tonne)**
1	Footing	M40	3674.96	190+270	460	58.69	1690.48	698.24	992.24
2	700mm thick shear wall	M50	3129.06	250+250	500	50	1565	782	782.27
3	250 mm thick shear wall	M50	18220.84	250+250	500	50	9110.42	4555.21	1518.40
4	Slabs	M40	10711.01	190+270	460	58.69	4927.06	2035.09	2891.97
Total cement consumption (Tonne)							**17292.49**	**8070.81**	**6184.88**

From Table I it can be interpreted that the dependence on cement is decrease by the use of GGBS in concrete. It can be also seen that when GGBS is used the dependence on cement is reduced by 4,256 tons which is 53.32% as that of OPC.

It is estimated that the production of one ton of cement releases one ton of CO_2 into atmosphere [2]. Considering this as basis for the CO_2 emission calculation, CO_2 emission for both the types of concrete is calculated and presented here in Table II.

TABLE II
REDUCTION IN CO_2 EMISSION

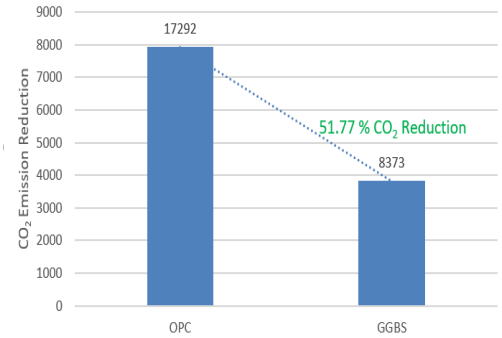
TYPE OF CONCRETE	CEMENT	GGBS	CO_2 EMISSION
WITH ONLY OPC	17292.49	-	17292.49
WITH GGBS REPLACEMENT	8070.81	8646.25	8373.43

Hence 51.77% of reduction in CO_2 emission can be obtained by replacing around 50% of cement by GGBS.

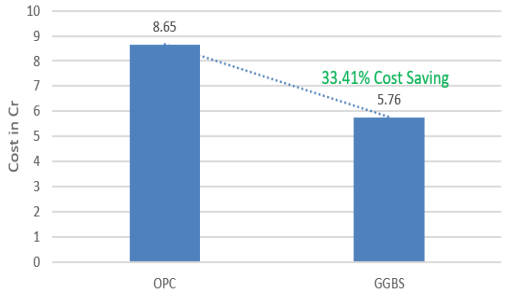
TABLE III
COST ANALYSIS

TYPE OF CONCRETE	WITH ONLY OPC	WITH GGBS REPLACEMENT
CEMENT CONSUMED	17292.49	8070.81
RATE OF CEMENT	5000	5000
GGBS CONSUMED	-	8646.25
RATE OF GGBS	-	2000
TOTAL COST (CR.) OF CEMENT	8.65	5.76
PERCENTAGE OF COST REDUCTION BY GGBS REPLACEMENT		33.41%

Hence 33.41% of cost saving can be obtained by replacing around 50% of cement by GGBS.



GRAPH I
CO_2 EMISSION REDUCTION



GRAPH II
COST ANALYSIS

The CO_2 emission reduction and the cost saving that can be achieved by the use of GGBS in concrete has been presented in Graph I and graph II.

IV. CONCLUSIONS

From the case study, it was estimated that there is a reduction in CO_2 emission by 51.77% and a total cost saving of 33.41% can be achieved by the use of GGBS. This concludes that in order to incorporate sustainable construction in the residential sector the use of GGBS to replace cement will prove to be a panacea.

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