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ASSESSMENT OF CURRENT SCENARIO OF GGBS UTILIZATION IN RESIDENTIAL BUILDING CONSTRUCTION

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Abstract —*Residential buildings are one of the major types of buildings in construction sector. These buildings can be constructed in harmony with nature rather than just building blocks which consume lot of energy. It is extremely important that the key players associated with the residential industry understand this and make conscious decisions during execution. One of the major concern during the construction phase is the use of cement which requires huge amount of energy for its production. This dependency on cement can be reduced to a great extent by partial replacement of cement with industrial by-products like fly ash and GGBS. A web-based survey questionnaire was developed and distributed to a list of developers, civil engineers and architects to evaluate the existing trends of these replacements in concrete in the residential industry of developing belt of Pune city. The survey results indicated that 50% of the residential project are using M20 grade of concrete and 62.9% of these projects are not using any replacement of cement in concrete. Such 48 ongoing projects from the study area has been selected and a concrete mix for M20 grade with 50% cement replacement with GGBS has been designed for these projects. The estimation of reduction in CO_2 emission due to replacement of 50% cement with GGBS is found to be 14646 tonnes.*

Keywords- *GGBS, Concrete, CO2 emission*

I. INTRODUCTION

The number of residential buildings at any given time will always be more in number than any other type of buildings. These building, which may be a stand alone structure or a huge township are usually not constructed with a conscious understanding of the damage that these projects are having on the environment. If the residential construction industry, at this very point do not understand the need to change their practices of construction and establish sufficient measures to construct their projects in such an order that it will require lesser energy during their construction and operation then we are headed towards a catastrophe. [1]

One of the major factors that is responsible for CO_2 emission during the construction stage is the dependency of cement. This dependency can be reduced to great extent by partial replacement of cement with GGBS. [2]

Use of GGBS in concrete can lead to reduction in CO_2 emission. It is observed that majority of projects are not using GGBS or any cement replacement, hence it is essential to identify the number of project using GGBS and the number of projects not using GGBS. It is also essential to quantify the reduction in CO_2 emission that can be achieved by cement replacement with GGBS in comparison to OPC concrete.

II. METHODOLOGY

The main objective of this study is to find out the awareness level of use of GGBS in concrete as replacement of cement and also up what extent it is being used in residential projects of developing areas of Pune city. This has been evaluated by developing and distributing a web-based questionnaire survey to a list of developers, civil engineers and architects.

The projects using only OPC concrete were identified and the total quantity of concrete required by these projects was computed. Based on this information, the amount of CO_2 that will be emitted due to these projects was estimated.

Further, a concrete mix with 50% cement replacement with GGBS was designed and the reduction in the amount of CO_2 emission that can be achieved by replacement of cement with GGBS was estimated.

III. WEB BASED QUESTIONNAIRE SURVEY

A web based questionnaire survey was conducted in order to understand the currents trends of cement replacement adopted by residential industry; 116 professionals participated in the survey of which 81% were civil engineers, 15.5% were developers and 3.5% were architects. The questionnaire included few open ended questions and few multiple choice questions.

The first four questions were related to the professional information of the respondent, information such as occupation of the respondent and their total working experience was obtained in this section. The next four focused on the concrete used by the respondents on their sites, information such grade and type of concrete was obtained from these questions and the last two questions were intended to understand if the respondent is aware of the advantages of using GGBS in concrete and if they are planning to use it in their future projects.

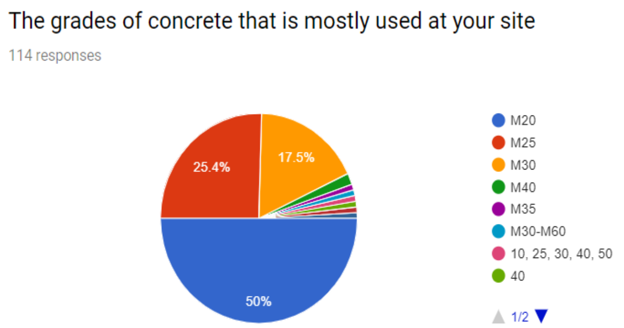

FIGURE I
GRADE OF CONCRETE

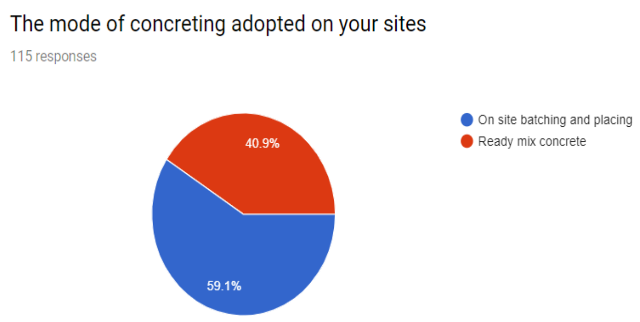

FIGURE II
MODE OF CONCRETING ADOPTED

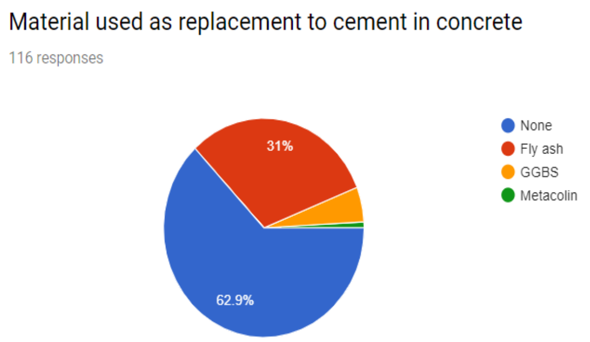

FIGURE III
CEMENT REPLACEMENT

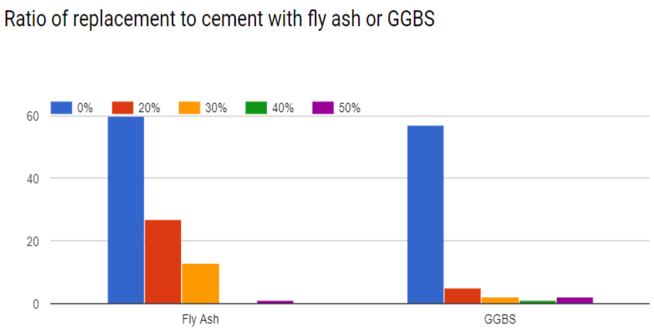

FIGURE IV
RATIO OF REPLACEMENT

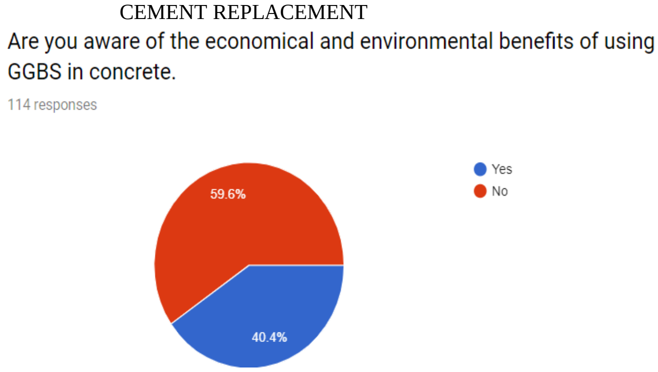

FIGURE V
AWARENESS OF GGBS

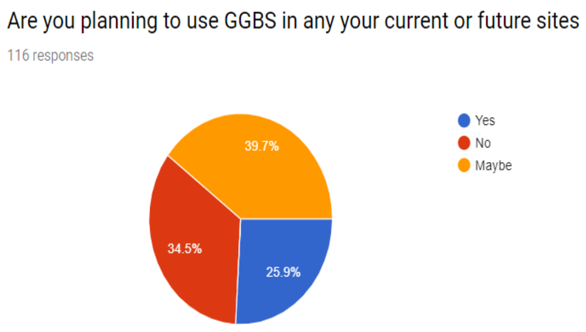

FIGURE VI
PLANNING FOR FUTURE USE

The responses obtained from the web based questionnaire survey are presented in Graph I, Graph II, Graph III, Graph IV, Graph V and Graph VI.

IV. DATA COLLECTION AND CONCRETE MIX DESIGN

To estimate the total quantity of concrete that would be required by these 48 projects selected, detailed information of these projects such as built up area, total number of apartments, grade of concrete that would be used and its estimated quantity was collected from the developers on their official letterhead. The total quantity of concrete that would be consumed by all these 48 projects summed up to 120580 m^3.

A concrete mix design for M20 grade of concrete with 50% cement replacement with GGBS was done, the mix calculations obtained are presented in Table I.

TABLE I
MIX DESIGN PROPORTIONING

Ingredients of concrete	Quantity
Cement	172.5 kg/m^3
GGBS	172.5 kg/m^3
Water	140 kg/m^3
Fine aggregate	904.2 kg/m^3
Coarse aggregate	1150.8 kg/m^3
Water-cement ratio	0.4

V. CO_2 EMISSION ANALYSIS

As this entire concrete is OPC concrete which has no replacement of cement it implies that such concrete will consume huge amount of cement and thereby there will more CO_2 emission in the atmosphere.

The quantity of cement consumed cannot be calculated directly as this total quantity of concrete is a summation of all the concrete that will be done on different sites having different mix design proportioning.

Therefore, to calculate the cement content an assumption is made based on IS 456.

As per Table 5, IS 456 the minimum cement content for M20 grade of concrete shall not be less than 300 kg/m^3.

This implies that the minimum cement content of this total concrete should be 300 kg/m^3 irrespective of the mix proportioning.

Therefore the total minimum cement requirement = 120580 m^3 x 300 kg/m^3
= 36174 tonne

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, the total amount of CO_2 that will be emitted due to the use of OPC concrete will be 36174 tonne

TABLE III
REDUCTION IN CO_2 EMISSION

Type of concrete	Concrete with only OPC	Concrete with 50% cement replacement with GGBS
CO_2 Emission (tonne)	36174	21528
Reduction in CO_2 Emission (tonne)	14646	

Now for the same quantity of concrete if the use of GGBS as partial replacement to cement as per the mix design proportioning is considered the following quantities will be consumed.

Cement = 20800 tonnes
GGBS = 20800 tonnes

The amount of CO_2 emitted by the production of GGBS is 35 kg per tonne [2]. Considering this as basis for the CO_2 emission calculation, the total amount of CO_2 that will be emitted by GGBS concrete will be 21528 tonnes. It can clearly be seen that there is reduction in CO_2 emission by 14646 tonnes. The comparative CO_2 emission of OPC concrete and GGBS concrete is presented in Table II.

VI. CONCLUSIONS

From the questionnaire survey, it was evaluated that majority of projects are only using OPC concrete.

It was further interpreted that 59.6% of the stake holders of the residential industry, the civil engineers, architects and developers are not aware of the environmental and commercial benefits of using GGBS as partial replacement of cement in concrete and they would not be using GGBS for their future projects.

It was estimated that for the 48 selected projects if cement in concrete is replaced by 50% of GGBS as per the mix design proportioning a CO_2 emission reduction of 14646 tonne can be achieved.

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