Feasibility of study on effect of waste glass Powder as a partial replacement of cement on compressive strength of concrete

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Abstract— The aim of the present work was to use glass powder as a replacement of cement to evaluate the pozzolanic action of fine glass powder in concrete and compare its results of compressive strength with other pozzolanic materials such as silica fume and fly ash. A series of tests were carried out to study the effect of 15% and 20% replacement of cement by, glass powder, fly ash and silica fume on compressive strength and durability in the form of capillary absorption. Many experiments has been done in the concrete industry to use waste glass as partial replacement of fine or coarse aggregates and cement. Glass powder was partially replaced as 5%, 10%, 15% and 20% and tested for its compressive, flexural and Tensile strength up to 28 days of age and were compared to the of conventional concrete, from the results attained, it was found that glass powder can be utilized as cement replacement material up to particle size less than 75μm to avoid alkali silica reaction. Mix of 28 days target strength of 38.25N/mm² using (IS code) was accepted. Initially compressive strength increased till 15% and after it was decreased.

Key words: Concrete, Fine aggregate, Glass Powder

I. INTRODUCTION

Concrete manufacture uses large quantities of natural resources as aggregates and contributes to the release of carbon dioxide from the production of cement. One ton of carbon dioxide is released into the atmosphere for the manufacture of one ton of cement, which is about 7% of the world’s total yearly production of CO₂ (Meyer 2004). Concrete is a regular construction material in India and its production effects the same environmental concerns as that of regular concrete. In recent years, there has been an rising incentive to reduce the environmental effect of the construction industry by the programs such as the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which rewards points for sustainable construction practices (CaGBC, 2009). Greater sustainability of the construction industry can be attained if a portion of the virgin aggregate or cement is replaced with desecrate materials like waste glass powder. Better sustainability of the construction industry can be achieved if a portion of the virgin aggregate or cement is swap with waste materials. Significant experimental work were done on the use of recycled concrete aggregate to swap virgin aggregate and on the use of pozzolanic materials to be used as partial replacement of cement in concrete, such as silica fume, fly ash and ground granulated blast furnace slag. Due to the successful use of these waste materials into regular concrete there is increased need to find new post-consumer materials which can be used as a partial replacement to cement. The experimental work presented in this research looks at the utilize of glass, as an green material to replace cement in the manufacture of concrete masonry blocks. The main objective of this study was to evaluate the result of waste glass powder on the compressive strength and the additional properties of concrete and to evaluate the option of using glass powder in concrete without reducing the strength. The major problem of today is about the utilization of natural resources in order to meet the human desires and maintain the economic progress without exhausting the resources and imperiling the environmental considered.

− Partial replacement for the ordinary portland cement.
− To examine the structural behavior of such replaced concrete components.
− To determine the percentage of glass powder which attains maximum strength when compared to organized concrete.

According to result published by the University of Dunee (2005), 1.85 million tonnes of glass cullet, derivative from Waste Glass (WG), are collected in the UK each year. The biggest essential on which life economic affluence and our security depend. The following were also proportion of glass cullet is given back for new glass production but the remaining extra of Waste Glass needs alternative markets. The reuse of Waste Glass in concrete has recently captured concentration not only as secondary aggregate, but also as a replacement for Portland cement in concrete, Mukesh.c \(c\) in(2004), Bignozzi, M. C., in (2009). Extensive research funded by Waste and Resources Action Programme (WRAP) has been carried out on Waste Glass inclusion in Portland cement concrete by Byars, E. A., et al (2004a and 2004b)

The research results indicate that Waste Glass can be used as aggregate or as partial replacement of Portland cement in concrete. Poutos in(2004) found that glass has an fast effect on the strength development of concrete when glass is used as an aggregate due to the thermal properties of glass. However, Byars, E. A. et al (2004a and 2004b), has pointed out that the main shortage of incorporating waste glass aggregates, either in form of coarse or fine portion, is the resultant Alkali-Silica Reaction (ASR) which undermines strength of concrete. My research has following main aims: (a) To determine the changes in compressive strength of cement concrete. (b) To determine the changes in compressive strength of cement concrete at various percentages of waste water glass powder.

(c) To determine the increasing the dead weight of cement concrete samples at various percentages of waste water glass powder. (d) To determine the maximum safe percentage of waste water glass powder into cement concrete to get maximum compressive strength (e) To find out appropriate aspect ratio of water and waste glass powder in cement concrete. (f) alterations & changes in the Mix design of M-30 Grade of concrete due to use of water and waste glass powder in cement concrete as cement.
II. MATERIALS AND METHODS

A. Material Used:

1) Cement:
Ordinary Portland cement of Grade 53 conforming IS 8112 [1] was used in the work.

2) Aggregates:
Fine aggregates used all through the study comprised of river sand and strictly pass from 4.75mm IS sieve, conforming to zone II as per IS383-1970 [2] with specific gravity of 2.62. Coarse aggregates taken of machine crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve with specific gravity of 2.72.

3) Glass Powder:
Waste glass was taken from Swastik Glass Industry, Bhopal. Consisting of waste window glass (Soda Lime glass). It was crushed in Los Angeles abrasion apparatus and then sieved through 1.18mm IS sieve. The specific gravity of waste glass was 2.4.

B. Mix Design:
Mix design of the concrete is made strictly as per the specification of the IS 10262 : 2009. From IS code specification mix of M30 grade is designed; 5 different types of mix are made with dissimilar percentage of Glass powder as Partial Replacement of cement. CC mix is prepared with 0% of Glass Powder or we can also pronounce it is controlled concrete, GP0 5 mix contains 05% of the Glass Powder. While GP10, GP15 and GP20 contains 10, 15and 20 percentage of Glass Powder respectively.

C. Test Performed

1) Test on Fresh Concrete:
Slump Test The workability of all concrete mixtures was found out by slump test utilizing a metallic slump mould. The difference in grade among the height of mud and that of the uppermost level of the subsided concrete was measured and known as a depression. The slump tests were performed according to IS1199- 1959 [3].

2) Tests on Hardened Concrete:
From each concrete mixture, cubes of size 15cm x 15cm x 15cm for the determination of compressive strength. The concrete mix design was planned by using Indian Standard for control concrete. The replacement levels of cement, glass powder in concrete. Chemical admixture is not used here. Cube specimens of size 15cm x 15cm x 15cm of 45 numbers were casted for dissimilar proportions with glass powder and matched up with the properties of concrete made without glass powder (control mix). Compression test was carried out on the concrete at 7 and 14 & 28 days of curing. The mix proportion was attained for various percentages of glass powder i.e., 5%, 10%, 15%, and 20% substitute for ordinary portland cement. In the first trial, water content was kept constant. However in the second trial water /cement ratio was kept constant.

III. RESULT AND DISCUSSION

A. Fresh Concrete:
Table 1 represents the slump value of the all concrete mix. The slump increased with the increase in waste glass content. Waste glass particles absorbed less water as compared to sand and hence increasing the workability of concrete admixture.
On the base of outcomes received, the following conclusions can be made:

1) 15% replacement of cement by waste glass showed a 15% increase in compressive strength at 7 days and 25% raise in compressive strength at 28 days.

2) Cement can be replaced by waste glass up to 15% by weight showing a 9.8% raise in compressive strength of 28 days.

3) Workability of concrete mix rise with an increase in waste glass content.

4) Utilization of waste glass in concrete can be economical as it is no useful waste and has no spare of cost.

5) Utilization of waste glass in concrete will eliminate the disposal problem of waste glass and simple to be eco-friendly, thus paving way for eco-friendly concrete.

6) Utilization of waste glass in concrete will maintain natural resources, mainly river sand and therefore constitute the concrete construction industry sustainable.

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