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Short Communication

Strength Characteristics of Pre Cast Concrete Blocks Incorporating Waste Glass Powder

Patel Dhirendra, Yadav R.K. and Chandak R.
Department of Civil Engineering, Jabalpur Engineering College, Jabalpur, MP-482011, INDIA

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Abstract

In developing countries like India growth of nation along with waste produced going it simultaneously, and the latter one is the effect of first. This paper deals with studies on the use of waste glass powder in concrete with moderate level of decrease in compressive strength at 28 days , is locally available, and its use as a cement replacement material presents an efficient waste management option, without compromising concrete performance.

Keywords: Waste glass powder, compressive strength, cements replacement, 28 days.

Introduction

In recent years there has been significant increase in the use of waste material in construction projects, due to the fact that they are not detrimental to the short or the long term properties of concrete and providing the platform for their effective disposal. Waste glass powder is one such material.

A glass is defined as an inorganic product of fusion which has been cooled to a rigid condition without crystallization. According to this definition, a glass is a noncrystalline material obtained by melt quenching process.

In 2005, approximately 12.8 million tons of waste glass was generated in the United States, and only about 20% of it was recycled[1]. Due to dwindling landfills and increasing cost of land-filling, recycling and reusing glass has become imperative.

Research studies on the use of waste glass in concrete have been reported. Crushed glass aggregates are being used in several decorative concrete applications, and there is reported literature on its use as coarse aggregate in conventional concretes[2-7] and precast blocks[8]. The fact that glass has a high silica content has led to laboratory studies on its feasibility as a raw material in cement manufacture[9,10]. The use of finely divided glass powder as a cement replacement material has yielded positive results[11-16]. Glass is amorphous with high silica content, thus making it potentially pozzolanic when the particle size is less than 75 µm[12]. Studies have also shown that finely ground glass does not contribute to alkali-silica reaction[5,11].

The environmental and economic benefits of reusing waste glass in concrete have been outlined in[17]. Successful implementation of waste glass powder in concrete will provide a boost to the use of such non-conventional materials which are typically of local or regional origin.

Literature Review: Research studies on the use of waste glass in concrete has been reported. Glass concrete products can be categorized as commodity products and value –added products. For simple commodity products, the primary objective is to utilize as much waste glass as possible. On the other hand in case of the value added products the esthetic potential of the glass is utilized because its attractiveness, and there is reported literature on its use as coarse aggregate in conventional concretes[4-9]. The use of finely divided glass powder as a cement replacement material has yielded positive results[10-15]. Glass is amorphous with high silica content, thus making it potentially pozzolanic when the particle size is less than 75 micron[16]. Studies have also shown that finely ground glass does not contribute to alkali-silica reaction[5,11]. The Environmental and economic benefits of reusing waste glass in concrete have been outlined in[17].

Research Significance: In the research reported in this study, waste glass powder obtained from the grinding process is used as a cement replacement material in concrete. The ultimate focus of this work is to ascertain the performance of concrete containing fine glass powder and compare it with the plain concrete. This is expected to provide: i. To partially replace cement content in concrete and mortar as it directly influences economy in construction. ii. Environmental friendly disposal of waste glass. iii. Contribution in strength development and durability of concrete. iv. To enhance the use of such non-conventional materials which are typically of local or regional origin. v. Necessary data to concrete and block manufacturers on the applicability of glass powder in concrete.

Material and Methods

Ordinary Portland cement confirming to I.S 269-1976[18] was used for this study. The fine glass powder had a particle size such that 80% finer than 45 micron is used in this study. The chemical compositions of these materials are given in table 1.

The glass powder has higher silica content than the cement, while having the least alumina content.

Table-1
Chemical Composition of Cement, Glass Powder used in this study

Composition (% by mass)	Cement O.P.C 43 Grade Birla Gold	Glass Powder
Silica (SiO_2)	20.6	72.20
Alumina (Al_2O_3)	5.2	1.54
Iron Oxide (Fe_2O_3)	2.9	0.48
Calcium Oxide (CaO)	64.5	11.42
Magnesium Oxide (MgO)	2.7	0.79
Sodium Oxide (Na_2O)	0.21	12.85
Potassium Oxide (K_2O)	0.92	0.43
Sulfur Trioxide(SO_3)	1.8	0.09
Fineness % Passing 45 micron	97	80
Density (Kg/m^3)	3150	2480

Experimental Program for the Study on Precast Concrete Block: Plain mix concrete and modified with various waste fine glass powder content as listed in are prepared. To achieve similar workability as the control concrete the w/c of glass powder was adjusted. Needless to say, such an approach will present the replacement materials in a better light, but the aim of this study is to show that the use of glass powder as a direct cement replacement without any other changes in the concrete mixture is feasible. The concrete mixtures were made and pre cast concrete solid blocks of size 40x20x20 cm are cast and compressive strength was determined as per IS 2185[19] (Part 11979. Fine Aggregate used confirming to IS: 383-1970[20] (Grading Zone II). Coarse Aggregate used confirming to IS: 383-1970 (20mm down).

Results and Discussion

Compressive strength test was conducted to evaluate the strength development of pre cast concrete block containing various % of waste glass powder at the age of 28 days (table 3) respectively.

Conclusion

Table 2 depict the replacement of cement by glass powder in concrete generally decreases the ultimate strength of concrete. The % decrease in 28 days strength of concrete by replacement of cement with 20% glass powder is only about 10%. It is clear that about 15% of cement replacement by fine glass powder provide the most optimal strength results because with this replacement the decrease in strength is less than 6%. The enhancement in cement hydration facilitated by the lower water absorption of glass powder and the secondary reaction of glass powder is responsible for this behavior. Even though the strength loss due to dilution effect is not completely compensated by the use of glass powder, a 15% replacement of cement by glass powder seems to be a viable option in concretes that are designed for 28 day compressive strengths. The result from this study is expected to provide an impetus to the use of waste glass powder as a partial cement material in region where this material is locally available. The economical and environmental impacts result from the potential to use waste glass powder as construction material and the possibility of minimizing cement content. The results from this study are expected to provide an impetus to the use of waste glass powder as a partial cement material in region where this material is locally available. The economical and environmental impacts result from the potential to use waste glass powder as construction material and the possibility of minimizing cement content.

Table-2
Mix Specification (for 1 m3 of Concrete)

Particulars	0% FGP	5 % FGP	10% FGP	15 %FGP	20 % FGP
Cement in Kg	362	344	326	308	290
Fine Aggregate in Kg	615	615	615	615	615
Coarse Aggregatein Kg	1194	1194	1194	1194	1194
Glass in Kg	0	18	36	54	72
Water in Kg	181	181	181	181	181

Table-3
Compressive strength in N/mm^2

% Replacement with glass powder	Pre cast concrete block marka	28daysCompressive strength in N/mm^2
0 %	plain	25.5
5%	5 FGP	24.42
10%	10FGP	24.33
15%	15FGP	24.00
20%	20FGP	23.11

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