Analysis of Glass Powder as a Partial Replacement of Cement in Concrete

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Abstract:- **Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases, such as CO_2, to the atmosphere. Among the greenhouse gases, CO_2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently extensive research is ongoing into the use of cement replacements, using many waste materials and industrial by products. Efforts have been made in the concrete industry to use waste glass as partial replacement of fine aggregates and cement. In this study, finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using Glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 0%, 25%, 35% and 50% and tested for its compressive, Tensile and flexural strength up to 7 days and 28 days of age and were compared with those of conventional concrete; from the results obtained , it is found that glass powder can be used as cement replacement material.**

Keyword – Glass powder, Partial replacement, Cement, Concrete.

I. INTRODUCTION

Concrete is the composition of cement, aggregate such as gravel, limestone, or granite, plus a fine aggregate such as sand, admixtures, and water. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, pipe, architectural structures, foundations, motorways / roads, bridges / overpasses, parking structures, brick / block walls and footings for gates, fences and poles.

As of 2005, the total global waste glass production estimate was 130 Mt, in which the European Union, China and USA produced approximately 33 Mt, 32 Mt and 32 Mt, respectively (IEA, 2007; Rashed, 2014). Being non-biodegradable in nature, glass disposal as landfill has environmental impacts and also could be expensive.

Sustainable construction practice means creation and responsible management of a healthy built environment considering resource efficiency and ecology (Plessis, 2007). Being versatile and economical, concrete became prime construction material over the world, However, it has impacts on the environment (Naik, 2008). Manufacturing of cement (key ingredient used for the production of concrete) is a major source of greenhouse gas emissions (Imbabi et al., 2012). The use of supplementary cementitious materials (SCMs) to offset a portion of the cement in concrete is a promising method for reducing the environmental impact from the industry. Several industrial by products have been used successfully as SCMs, including silica fume (SF), ground granulated blast furnace slag (GGBS) and fly ash (Islam et al., 2011; Imbabietal., 2012). These materials are used to create blended cements which can improve concrete durability, early and long term strength, workability and economy (Detwiler et al., 1996). Another material which has potential as a SCM, however, has not yet achieved the same commercial success is waste glass (Rashed, 2014). Researches indicated that glass has a chemical composition and phase comparable to traditional SCMs (Ryou et al., 2006; Binici et al., 2007; Nassar and Soroushian, 2012). It is abundant, can be of low economic value and is often land filled (Byars et al., 2003). Milling of glass to micro-meter scale particle size, for enhancing the reactions between glass and cement hydrates, can bring major energy, environmental and economic benefits when cement is partially replaced with milled waste glass for production of concrete (Rashed, 2014). Studies also focused on used of waste glass as aggregate in concrete production (Rashed, 2014; Taha and Nounu, 2009). Study on durability of concrete with waste glass pointed better performance against chloride permeability in long term but there is concern about alkali-silica reaction.

A.GLASS POWDER

It finds only little use in pyrotechnics, where it is generally contained in striker compositions. Glass powder is an important ingredient in safety matches. Waste glass available locally in Pondicherry shops is been collected and made into glass powder. Glass waste is very hard material. Before adding glass powder in the concrete it has to be powdered to desired size. In this studies glass powder ground in ball/ pulverizer for a period of 30 to 6o minutes resulted in particle sizes less than size 150 µm and sieved in 75 µm. Glass powder in concrete improves both the mechanical and durability characteristics of the concrete.

The use of recycled glass as the partial re-placement of cement greatly enhances the aesthetic appeal of the

concrete. Recent research findings have shown that concrete made with recycled glass powder have shown better long term strength and better thermal insulation due to its better thermal properties of the glass powder. Glass powder is used to increase strength and durability of concrete, but generally requires the used for more resistant towards corrosion.

B. PROPERTIES OF GLASS POWDER

SPECIFIC GRAVITY

The specific gravity of a Glass powder is considered to be a measure of strength or quality of the material. Glasses having low specific gravity are generally weaker than those with higher specific gravity values. Specific gravity of a material may be defined as the ratio of density of the material to the density of water at a specified temperature.

II MATERIALS AND METHODS

CEMENT

Ordinary Portland cement of 43 grade was used throughout the work.

- *COARSE AGGREGATE*

Crushed granite metal obtained from a local source was used as a coarse aggregate that passed through 21mm and retained in 16mm sieve was used.

- *WATER*

Potable water was used for mixing and curing properties.

- *GLASS POWDER*

Glass powder of Grade 920-D, densified bag of 50kg was obtained from "A.R.P.N.ALAGAPPA NADAR AND BROS" was used.

A.DETAILS OF SPECIMENS

Size of casted cubes: 150mm x150mm x 150mm
Grade of concrete: M20.

TABLE. 1. DETAILS OF SPECIMEN

Grade	Curing days	Normal	25%	35%	50%
M20	7 days	3	3	3	3
	28days	3	3	3	3

Total number of cubes for M20 grade concrete = 16 cubes
Total number of cylinders for M20 grade concrete = 08 cylinder

B. PREPARATION OF SPECIMEN

Preparation of test specimen includes following procedure.

BATCHING

There are two types of batching available namely, weight batching and volume batching. We are going to follow weight batching. In practical, volume batching is easy and followed in India. But, Weight Batching will give accurate proportion of concrete. The quantity of ingredients was arrived by conducting proper weigh batching and stored separately for mixing. We used balance of accuracy 0.01g.

MIXING OF CONCRETE

Proper mixing of concrete was carried out manually in a good way. Initially, the ingredients are mixed well in dry state. Then water is added little by little and mixed well to a workable state.

FIG. 2 MIXING

PLACING

Mixed concrete is placed in a mould in such a way that there is no chance of segregation. Proper compaction was done by using tamping rod.
finishing and curing. After placing the concrete, the surface of the surface of the specimen was finished properly in a smooth manner. After one day the moulds are removed and the specimen was subjected to curing.

FIG. 3 AFTER FINISHING

TEST SETUP

The specimens are tested under universal testing machine. The entire specimen are placed on the loading frame and tested under axial loading.

IV RESULT AND GRAPH

A. ULTIMATE LOAD TEST ON CUBE

Size of casted cube : 150mm x 150mm x 150mm
Coarse aggregate : pass through 20mm and retain at 16mm
Fine aggregate : pass through 2.36mm and retain at 1.86mm
Water : potable

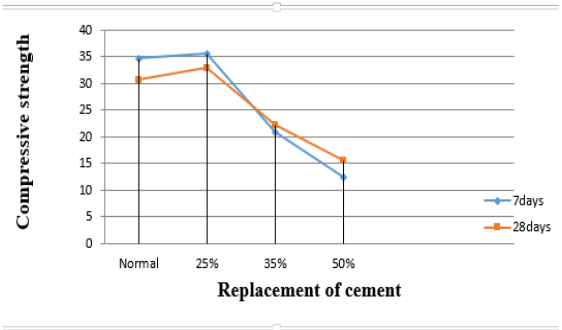

FIG. 4 GRAPH FOR M20 CUBE

- The above graph shows the compressive strength for M20 grade of 7 days ans 28 days cube
- This graph represents the 25% replacement of glass powder in concrete gives the maximum compressive strength
- The other similar percentages of 35% and 50% shows the lesser value when compared to the compressive strength of 25%
- The maximum compressive strength of 25% replacement value is 35.55 kN / mm^2

B. ULTIMATE LOAD TEST ON CYLINDER

Size of casted cylinder: Dia-150mm ,
Depth – 300mm.
Coarse aggregate : Pass through 20mm and retain at 16mm
Fine aggregate : Pass through 2.36mm and retain at 1.86mm
Water : portable

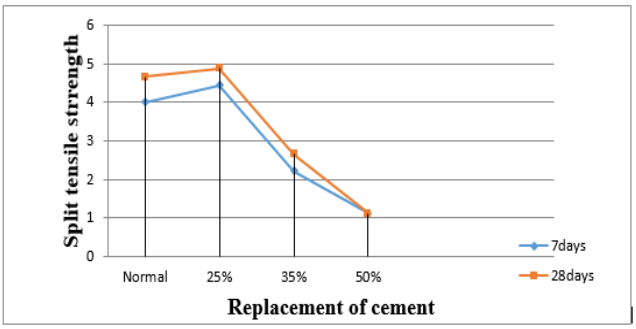

FIG. 5 GRAPH FOR M20 CYLINDERS

- The above graph shows the Split tensile strength for M20 grade of 7 days and 28 days cylinders
- This graph also represents the 25% replacement of glass powder in concrete gives the maximum Split tensile strength
- The other similar percentages of 35% and 50% shows the lesser value when compared to the Split tensile strength of 25%
- The maximum Split tensile strength of 25% replacement value is 4.4kN/mm^2.

V. CONCLUSION

By using the glass powder in concrete will reduce the greenhouse effect produced by the cement manufacturing industry. Glass powder concrete increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete. Beyond 25% there is a decrease in compressive strength and Split tensile strength for 28 and 7days curing period. There is a decrease in workability as the replacement level increases, and hence water consumption will be more for higher replacements. The maximum replacement level of Glass powder is 25% for M20 grade of concrete.

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