

A Review Paper on the Study of Concrete with Partial Replacement of Cement by Glass Powder

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Abstract - The production of various materials essentially uses raw materials, which leads to depletion of raw material sources and rises the cost of it. As there is growing environmental awareness in the community, scientists and technologists have to pay their attention to think over and innovate various techniques and methodologies to recover, reuse and recycle the waste products. Such a waste product is glass powder. It contains silica as its main component which in cement provides the strength. Glass powder can be used in cement as partial replacement in order to prevent the waste of potentially useful materials which will reduce the consumption of fresh raw materials, reduce energy consumption, reduce pollution and lower greenhouse gases as compared to virgin production. Silica (Silicon dioxide) is the second largest component of cement ingredients which is about 17 to 25%. This quantity of silica helps in the formation of di-calcium and tri-calcium silicates which imparts strength to the cement. Silica if excess in cement will increase the strength of cement but at the same time setting time of cement also increased.

Key Words: Glass Powder Concrete (GPC), cement, glass powder, concrete, partial replacement.

1. INTRODUCTION

Almost all developmental activities constitute initially have Civil Engineering as an integral part where construction of buildings, highways, bridges, culverts and various structures form the major portion of work. Apart from environmental and social effects, the sustained availability of the basic raw materials required is most important. Nature has provided natural resources and raw materials on earth in abundance for their judicious use, although nothing is unlimited. With the rising cost of raw materials and depletion of raw material sources and also growing environmental awareness in the country, scientists and technologists have to pay their attention to think over and innovate various techniques and methodologies to recover, reuse and recycle the waste products - industrial and domestic, construction and demolition debris, rubbish, etc. and also to use renewable and other forms of energy resources. Recycling consists of processing used materials into new products so that the waste of potentially useful materials can be prevented; which can minimize the consumption of fresh raw materials, reduce air and water pollution by reducing the need for conventional waste disposal and lower greenhouse gas emissions as compared to virgin production which results into reduction of energy usage. Recycling is an important

component of modern waste management system and is the third component of the "Reduce, Reuse and Recycle" waste hierarchy. Such a waste product is glass powder, which can be effectively used in concrete as partial replacement of cement in strength building. Silica (Silicon dioxide - SiO₂) is the second largest component of cement ingredients which is about 17 to 25%. This quantity of silica helps in the formation of di-calcium and tri-calcium silicates which imparts strength to the cement.

As we know that now a days, most developing countries facing shortage of post consumers disposal waste site and it's become very serious problems. For this reason, regenerating and using waste products as resources and prevent environmental pollution is important. Therefore in research, considering the post-consumer waste glass, there is an effort to recover and use the waste glass; otherwise it ends up in landfills. In the present scenario most of recovered waste glass is used by glass manufactured company in producing new glass such as bottles. But only a limited amount of the waste glass recovered can be used towards the production of new glass. This is because, manufactures only can use waste glass that has been already sorted by colour and type and this exclude waste glass that is mixed with colour, where it is very expensive to produce new glass, even all the black and green glass bottles, car windshield, glass for cathode-ray tubes, glass for liquid crystal panels, glass for building materials such as windowpane, and the glass like other than the colourless and brown bottles have come to be increasingly recycled, but are mostly discarded now and this wastes colour mixed glass still ends up in landfills. Since waste glass still is a problem, maybe it should be used in the concrete mix and find the result whether the results gives us a good value, then it will be beneficial to mother earth because this can reduce a portion of waste that cannot be dissolved by the environment or by normal recycling ways.

Concrete is the most important construction material used in the construction industry. However, the production of Portland cement, an essential constituent of concrete, leads to the release a notable amount of CO₂, a greenhouse gas. It is said that one tonne of Portland cement clinker production creates approximately one tonne of CO₂ and other greenhouse gases. Environmental problems are playing an important role in the sustainable development of the cement and concrete industry. There is a need to replace a part of cement by some pozzolanic material to reduce the consumption of cement so that the environmental pollution

can be checked to some extent. Due to environmental problems, researchers are trying to use the waste glass powder into concrete as partial replacement, to create a new material to use in construction.

Generally glass does not harm the environment in any way because it does not contribute to pollution, but it can harm humans and other animals, if not dealt carefully and it is not that friendly to the environment because it is non-biodegradable. Thus, the development of new technologies is a must. The term glass contains several chemical diversities including soda-lime silicate glass, and boro-silicate glass. These types of glass powder can be used in cement and aggregate mixture as pozzolana for civil works. It also helps to reduce the volume of waste sent to landfill. As useful recycled material, glass powder can be used in civil engineering field, for example, in cement, as pozzolana (supplementary cementitious materials). Its recycling ratio is close to 100%, and used in concrete without adverse effects in concrete durability. Therefore, it is considered ideal replacement material.

2. LITERATURE REVIEW

2.1 J. M. Khatib, M. Negim (2012), "Glass Powder Utilisation In Concrete Production" conducted a study on portland cement which was partially replaced with 0 to 40% glass powder. Testing included ultrasonic pulse velocity, compressive strength and absorption. Specimens were cured in water at 20°C. The results in this particular test indicated that the maximum strength of concrete occurs at around 10% glass powder. If beyond 10% glass powder is used then the strength of concrete reduces and is lower than that of the control.

2.2 Patel Dharendra, Yadav R. K. and Chandak R. (2012), "Strength Characteristics of Pre Cast Concrete Blocks Incorporating Waste Glass Powder" aimed to study concrete as follows. In developing countries like India growth of nation along with waste produced go side by side, and the latter one is the effect of first. This experiment deals with studies on the use of waste glass powder in concrete and checked the compressive strength at 28 days, is locally available, and its use as a cement replacement material presents an efficient option, without compromising concrete performance. It is found that the 15% replacement is viable in this experiment.

2.3 Jitendra B. Jangid and A. C. Saoji (2014), "Experimental Investigation Of Waste Glass Powder As The Partial Replacement Of Cement In Concrete Production" studied concrete. Which further elaborate concrete is a mixture of hydraulic cement or Portland cement, fine aggregate, coarse aggregate, and water, with or without admixtures. The concrete industry consumes natural resources due to which sustainability of concrete industry is under threat. The environmental problems and economics concern is the biggest challenge the concrete industry is facing. The global cement industry contributes about 7% of greenhouse gases emission in to the earth's atmosphere. Today many researchers are ongoing within the use of

supplementary cementitious materials using many waste materials like Pulverized ash (PFA) and Ground Granulated furnace Slag (GGBS). Like PFA & GGBS a waste glass powder also act as a filler material in partial replacement of cement which takes some a part of reaction at the time of hydration. Very finely ground glass powder shows pozzolanic properties as it contains high SiO₂ and hence it can be replaced in concrete with cement and contribute to strength development. During this study Glass Powder partially replaced at varying percentage 0 to 40, at interval of fifty and tested for its Compressive, Tensile, and Flexural strength up to 60 days old and were compared with those of conventional concrete. Waste Glass Powder could be utilized in concrete as a good substitute of cement by the overall test results.

2.4 Dhanraj Mohan Patil and Dr. Keshav K. Sangle (2013), "Experimental Investigation of Waste Glass Powder As Partial Replacement of Cement In Concrete" conducted a study on concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. In this study, waste glass powder is used as replacement to the concrete ingredient i.e. cement and the mechanical properties like compressive strength are measured. Also they studied the size effect of glass powder on strength of concrete. In this experiment the glass powder is replaced at 10%, 20% and 30% with cement. For study of size effect of glass powder, the powder is divided into two grades; one of glass powder have size less than 90 micron and another glass powder have particle size ranges from 90 micron to 150 micron. It is found from study, initial strength gain is very less due to the addition of glass powder on 7th day but it increases on the 28th day. It is found that 20% addition of glass powder gives higher strength. And also powder size less than 90 micron is very effective in enhancement of strength.

2.5 R. Vandhiyan, K. Ramkumar and R. Ramya (2013), "Experimental Study on Replacement of Cement by Glass Powder" worked towards concrete development as follows. In a growing country like India a huge amount of industrial waste are polluting the environment. With this issue, this study aims of using such industrial byproduct for value added application. In addition the waste can improve the properties of construction materials. The recycled glass has been used in the form of powder. The glass powder is tested with both concrete and mortar. Cement is replaced by the glass powder in the values of 5%, 10% and 15%. The compressive strength, split tensile strength, consistency and flexural strength were conducted for the above replacements. The result concluded that glass powder improves the mechanical properties. This experiment made conclusion that by replacing of glass powder with cement is economically cheap and a better concrete can be made.

2.6 Gunalaan Vasudevan and Seri Ganis Kanapathy Pillay (2013), "Performance of Concrete using Waste Glass Powder in Concrete as Replacement of Cement". This study is conducted to investigate the effect of using waste glass powder in concrete. Laboratory work is conducted to determine the performance of control sample and concrete with used waste glass powder. The performance of these types of concrete is determined by the workability test, density test and compressive strength test. Meanwhile,

compressive strength test is done to determine the strength of concrete. For each type of concrete, a total of six 150mm x 150mm x 150mm cubes is casted. The cubes are tested at the ages of 7, 14 and 28 days to study the development of compressive strength. The results indicate that the concrete using waste glass powder were able to increase the workability of concrete and also the compressive strength. However, the density is reduced compared to standard mixture of concrete.

3. CONCLUSIONS

1. The problem of waste glass powder would be solved up to notable extent by using this waste in the cement as partial replacement, which will directly help the environment by keeping a check on environment.
2. About 20% of partial replacement of cement with glass powder have performed better than conventional concrete in many of the researches.
3. The glass powder would be proved as an ideal replacement of cement in the concrete as a partial replacement of cement as it having high silica content thus making it potentially pozzolanic.
4. Glass powder have a high potential to increase the concrete strength with reducing the usage of 100% Portland cement by being an admixture.
5. The workability property can be increased.
6. Studies shown that finely ground glass does not contribute to alkali – silica reaction.
7. Glass powder provide better thermal insulation due to its better thermal properties.
8. It prevents crack propagation in concrete structures.
9. Last but not the least, the cost of construction would be reduced due to the use of glass powder which will be economically helpful.

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