Sand Replacement by Glass Powder in Concrete

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ABSTRACT: One of India's biggest environmental problems is the disposal of over 300 tons of waste glass every day from post-consumer beverage bottles. This problem is only getting worse because there are not many recycling options and the capacity of valuable landfill space is rapidly filling up. Because of this, a significant amount of study has been conducted over the last ten years to determine feasible methods of recycling waste glass for the creation of various concrete products, including architectural mortar, self-compacting concrete, and concrete blocks. A few of these unique glass-concrete products have found success in the marketplace and are becoming more well recognized. This essay provides a summary of India's present glass recycling and management status as well as the country's experience employing recycled glass in concrete products. Glass is used extensively in our daily life in manufactured goods like vacuum tubing, bottles, sheet glass, and glassware. Glass makes a perfect recycling material. Utilizing recycled glass contributes to energy conservation. Inspections of the usage of waste glass in various forms in different areas are accelerated by growing awareness of glass recycling. Reusing glass trash to make concrete is one of its major contributions to the construction industry. There is still room for advancement in the use of glass in architectural concrete. The use of waste glass as coarse and fine aggregates for concrete's ornamental and ASR (Alkali-Silica-Reaction) mitigation purposes was further investigated in laboratory trials.

KEYWORDS: SAND, CONCRETE, ASR, GLASS, POWDER.

I.INTRODUCTION: Utilizing ratios of 30%, 45%, and 60%, laboratory studies were conducted to evaluate the viability of crushed recycled glass as a natural sand substitute. Cement replacement ratios of 7.5%, 15%, and 25% of powdered glass were also taken into consideration for the replacement of cementation materials in concrete. The characteristics of both fresh and hardened concrete were evaluated when glass sand and cementitious ingredients were substituted with powdered glass. It was determined that while the indirect tensile strength slightly fell, the compressive and flexural strengths slightly increased when 45% broken glass was used as a natural sand substitute. The concrete that used glass instead of natural sand shrank less and had a much lower chloride diffusion coefficient. Although they met the concrete mix design requirements, concretes that used powdered glass in place of cementitious materials had somewhat higher drying shrinkage and poorer compressive strength than the control mix. A mixture of ingredients, including silica, soda ash, and $CaCO_3$, is melted at a high temperature and then cooled, causing solidification without crystallization to make glass, a clear substance. Glass is used extensively in our daily life in manufactured goods like vacuum tubing, bottles, sheet glass, and glassware. Glass makes a perfect recycling material. Utilizing recovered glass saves a significant amount of energy, and growing knowledge of glass recycling accelerates attention to the use of waste glass in a variety of applications. Reusing glass trash to make concrete is one of its major contributions to the construction industry.

The application of glass in architectural concrete still needs improvement. Several study have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to sand used in concrete. During the last decade, it has been recognized that sheet glass waste is of large volume and is increasing year by year in the shops, construction areas and factories. Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. The amount of waste glass is gradually increased over the years due to an ever-growing use of glass products. Most of the waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector. When waste glassesare reused in making concrete products, the production cost of concrete will go down (Topcuand Canbuz, 2004). Crushed glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of gravel or sand. When used in construction applications, waste glass must be crushed and screened to produce an appropriate design gradation. Glass crushing equipment normally used to produce a cullet is similar to rock crushing equipment. However, the applications are limited due to the damaging expansion in the concrete caused by ASR between high-alkali pore water in cement paste and reactive silica in the waste glasses. The chemical reaction between the alkali in Portland cement and the silica in aggregates forms silica gel that not only causes crack upon expansion, but also weakens the concrete and shortens its life (Swamy, 2003). Ground waste glass was used as aggregate for mortars and no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as fine aggregate in mortars and concrete. Estimated cost for housing is more and some construction materials like natural sand are also becoming rare. Waste glasses are used as aggregates for concrete.

II.PROPOSED SYSTEM: The researcher believes that glass bottles can be processed into construction grade cullet using any convenient mechanical method. For cullet-aggregate blends, glass cullet can be blended with natural aggregates by any convenient mechanical method. Normal precautions should be followed to prevent segregation. Typical aggregates for construction include sands, gravels, crushed rock and recycled concrete. The glass cullet and cullet aggregate blends should be compared with these standard specifications for each specific application. The intent of this research is to encourage regulatory departments to amend specifications to allow glass cullet and cullet aggregate blends as an alternative to conventional aggregate in numerous applications. Several states in United States of America, including the Washington State Department of Transportation, have already included specifications for glass aggregate. The researcher investigates the effects of using recycled glass bottles as an alternative fine aggregate. As shown in figure 1, the researchers used recycled bottles from junkshops. These bottles were cleaned to prevent foreign materials or chemicals from contaminating the specimens. After cleaning, they were crushed manually and sieved to ensure uniformity in particle size. The researcher used Class A mix which has 1:2:4 proportion of cement, sand and gravel respectively. Some percentage of sand was replaced by crushed recycled bottles (25%, 50%, 75%, and 100%) and control mixture was also made available. Three (3) specimens were collected from each mixture using 6”x12” cylindrical molds and these specimens were tested for compressive strength using UTM upon its 7th, 14th, 21st, and 28th day of its curing. Then, the results were evaluated

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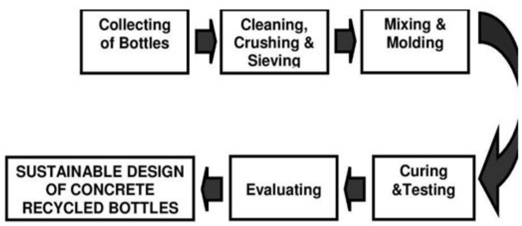
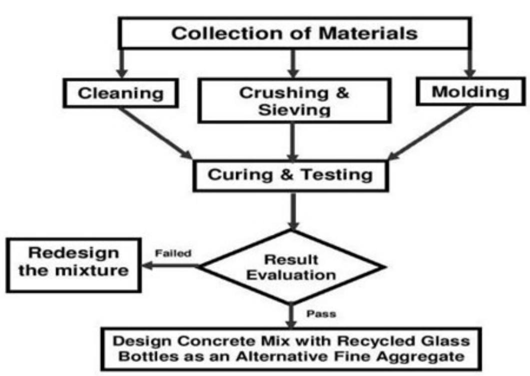


2.1 PROJECT DESIGN

The identification for the specimens is started by a letter which starts from “A” to “D” to designate the curing age of the specimens. The specimens noted with “A” were those tested at its 7th day of curing period. Moreover, those specimens tested on its 14th,21st and 28th day of curing period were designated with “B”, “C” and “D” respectively. Specimens noted with “D” were the most critical because these were tested on its 28th day of curing period and it will be the basis for the final compressive strength (fc’) and modulus of elasticity (E). After the letter, it is followed by a numerical value which ranges from “25” to “100” with an increment of twenty-five (25), which represents the percentage of crushed bottle present in each specimen. The specimens were noted with “25”, “50”, “75” and “100” based on the percentage of crushed bottle as against to sand. The last number represents the sample number represents the sample number. Since three (3) samples are prepared for each mixture for every curing period, it is necessary to have sample number to avoid confusions. Specimens with no crushed bottle aggregate serve as the control specimens. Thus, these samples were labeled as “Control”. From the above discussion, figure 2 can be identified as “sample 1 of 7th day curing age with 100% crushed bottle as fine aggregate”.

In this project, glass is produced in many forms, including packaging of container glass (bottles, jars), flat glass (windows, windscreens), bulb glass (light globes), cathode ray tube glass (TV screens, monitors, etc.), all of which have a limited life in the form they are produced and need to be reused/recycled in order to avoid environmental problems that would be created if they were to be stockpiled or sent to landfill. Most of the glass produced is in the form of containers, and the bulk of what is collected post-consumer is again used for making containers. The efficiency of this process depends on the method of collecting and sorting glass of different colors [12, 14]. If different color glass (clear, green, amber) could be separated, then they could be used for manufacturing similar color glass containers. However, when the glass colors get mixed, they become unsuitable for use as containers, and are then used for other purposes, or sent to landfill. As shown in figure 2, materials needed in the study were collected. The glass bottles were cleaned to make sure that it is free from contaminants and then, it were crushed manually and sieved. The crushed bottles are then added to concrete mixture in replace of some percentage of sand. Upon the 7th, 14th, 21st, and 28th day of its curing, the samples were tested using universal testing machine.



2.2 PROJECT DEVELOPMENT

The requirement which forms the basis of selection and proportioning of mix ingredients are:

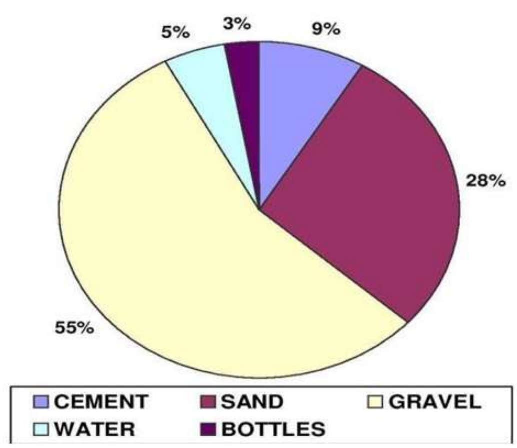
(1) The minimum compressive strength required from structural consideration.

(2) The adequate workability necessary for full compaction with the compacting equipment available.

(3) Maximum water cement ratio and/or maximum cement content to give adequate durability for the particular site conditions.

(4) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

III.RESULTS:

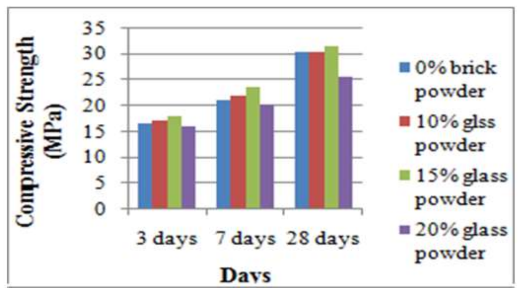


3.1 Design of Concrete Mixture with Recycled Glass Bottles

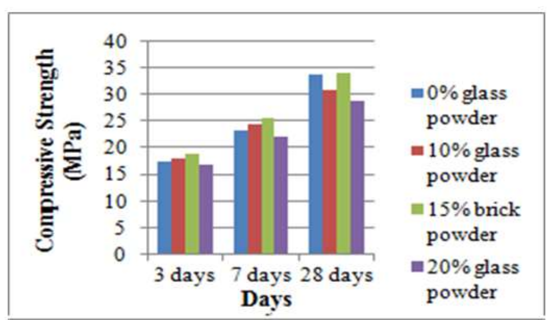
Compressive strength: As per design obtained in accordance to code IS-10262, mix proportion of various materials (viz. Cement, Sand, Aggregate and Water) is calculated for M-20, M-25 and M- 30 grade of concrete. The cubes were crushed in the laboratory in accordance to code IS 1343-1980. The results of crushing strength of cubes for 3, 7 and 28 days of various grades of concrete prepared as per mix design are shown below: It is observed that the compressive strength of cubes (sand is partially replaced by brick powder) of M-20 mix decrease initially at 10% brick powder. But as percentage of brick powder increased to 20% strength increases and further increase in brick powder again reduces the strength.

Compressive strength of cubes (sand is partially replaced by brick powder) of M-20 mix increases up to 15% glass powder. As glass powder exceeds 15%, compressive strength decreases. In M-25 and M-30 concrete mix, compressive strength also follows the same trend as it did in the M- 20 mix. Compressive strength is maximum at 20% brick powder, and then it starts decreasing. Optimum percentage of glass and brick which can replace sand is 15% and 20% respectively. Compressive strength of cubes corresponding to these percentages of glass and brick powder is more than the strength corresponding to 0% glass and brick powder which clearly indicates that sand can be partially replaced by glass or brick powder.

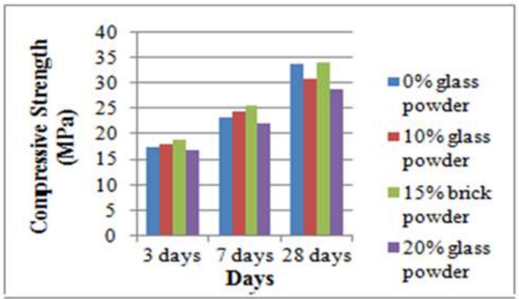
Workability The slump tests were performed according to IS 1199-1959. The value is presented in table below: The results show that with increase in brick powder, the slump value decreases and with increase of glass content, the slump value increases.



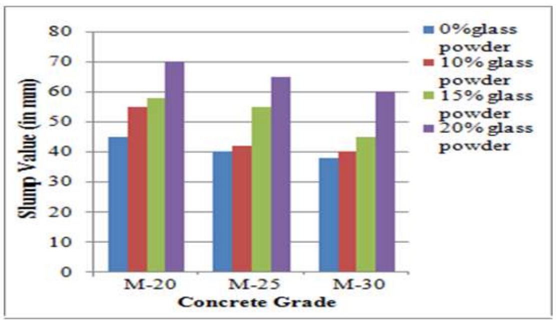
3.2 Comparison of compressive strength of M-20 mix for different percentage of Glass powder



3.3 Comparison of compressive strength of M-25 mix for different percentage of Glass powder



3.4 Comparison of compressive strength of M-30 mix for different percentage of Glass powder



3.5 Variation of slump value of concrete with glass powder content

IV.CONCLUSION: The following conclusions can be made based on the results: (1) Crushed brick powder is found to be a very effective substitute for fine aggregate. The ideal replacement percentage is 20%, at which point the concrete's strength after three, seven, and twenty-eight days is greater than that of concrete made without sand replacement. The strength attained at 3, 7, and 28 days is somewhat reduced, even when 30% of the sand is replaced. For M-20 grade concrete, the desired strength is 26.6 MPa; however, in 28 days, the actual strength is 25.10 MPa, meaning that there is only a 5.6% shortfall. For M-25 grade concrete, the desired strength is 31.6 MPa; however, at 28 days, the actual strength is 28.5 MPa, indicating a little 9.81% shortfall. For M-30 grade concrete, the desired strength is 38.25 MPa; however, at 28 days, the actual strength is 37.40 MPa, indicating a mere 2.22% shortfall.

(2) Likewise, it has been shown that replacing fine aggregate with crushed glass powder works incredibly well. The ideal replacement percentage is 15%, at which point the concrete's strength after three, seven, and twenty-eight days is greater than that of concrete made without sand replacement. The strength attained at 3, 7, and 28 days decreases slightly even when 20% of the sand is replaced. For M-20 grade concrete, the desired strength is 26.6 MPa; however, at 28 days, the actual strength is 25.80 MPa, indicating a little 3% shortfall. For M-25 grade concrete, the desired strength is 31.6 MPa; however, after 28 days, the actual strength is 28.8 MPa, meaning that there is only an 8.86% shortfall. For M-30 grade concrete, the desired strength is 38.25 MPa, however the

actual strength at 28 days is 35.90 MPa, meaning that there is only a 6.14% shortfall.

REFERENCES:

• Specification for Coarse and Fine Aggregate from Natural Sources for Concrete. IS 383-1970, Bureau of Indian Standard, NewDelhi.

• IS Method of Mix Design IS 10262-1981, Bureau of Indian Standard, NewDelhi.

• Method of Tests for Strength of Concrete. IS 516-1959, Bureau of Indian Standard, NewDelhi. • Code of Practice for Plain and Reinforced Concrete. IS 456-2000, Bureau of Indian Standard, NewDelhi.