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SUSTAINABLE CONCRETE BY PARTIAL UTILIZATION OF CEMENT AS GLASS POWDER

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ABSTRACT

Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. Glass is an ideal material for recycling. The use of recycled glass helps in energy saving. The increasing awareness of glass recycling speeds up inspections on the use of waste glass with different forms in various fields. One of its significant contributions is to the construction field where the waste glass was reused for concrete production. The application of glass in architectural concrete still needs improvement. Laboratory experiments were conducted to further explore the use of waste glass as cement (Alkali-Silica-Reaction) alleviation as well as the decorative purpose in concrete. The quantities of waste glass have been increasing significantly without being recycled increasing the risk to public health due to the scarcity of land area. This growing problem of waste glass can be alleviated if new disposal options other than landfill can be found. The main goal is to investigate the possibility to improve the compressive strength over a range of glass percentages. Waste glass is the least expensive of all the concrete constituents and is much less expensive than natural aggregates and sand, thus the idea is to replace as much of the natural aggregates and sand as possible to save money and to reduce the amount of disposable wastes, as well, but care has to be taken in order not to weaken the concrete by adding too much glass. Glass is subjected to alkali silica reaction. In order to mitigate ASR fly ash is added. Fine aggregate is partially replaced by Glass powder by 0%, 5%,15%10%,20%.The tests on fresh concrete and hardened concrete are to be done and the result is to be compared with the conventional concrete

INTRODUCTION

Solid wastes are substances and masses resulted by the various human activities that have to be dumped. Solid waste materials usually include industrial waste, medical waste, and domestic waste. In particular, construction waste is the output result of construction and destruction, rehabilitation, repair, removal of existing structures, and installations. This waste is composed of sand, stone, gravel, tiles, ceramic, marble, glass, aluminum, wood, plastic, paper, paints, plumbing pipes, electric parts and asbestos, and other materials. Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and $CaCO_3$ at high temperature followed by cooling where solidification occurs without crystallization. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. Glass is an ideal material for recycling. The use of recycled glass saves lot of energy and the increasing awareness of glass recycling speeds up focus on the use of waste glass with different forms in various fields. One of its significant contributions is the construction field where the waste glass was reused for concrete production. The application of glass in architectural concrete still needs improvement.

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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 glasses are reused in making concrete products, the production cost of concrete will go down. Crushed glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of cement.

GLASS POWDER

Theoretically, glass is a fully recyclable material; it can be recycled without any loss of quality. There are many examples of successful recycling of waste glass: as a cullet in glass production, as raw material for the production of abrasives, in sand-blasting, as a pozzolanic additive, in road beds, pavement and parking lots, as raw materials to produce glass pellets or 9 beads used in reflective paint for highways, to produce fiberglass, and as fractionators for lighting matches and firing ammunition. Waste glass can also be produced from empty glass bottles and pots, and come in several distinct colors containing common liquids and other substances. This waste glass is usually crushed into small pieces that resemble the sizes of gravels and sands. Therefore - as an alternative - there is a potential to partially replace the concrete mix aggregate with waste glass.

In its original form, glass comes as a balanced combination from three main raw natural materials: sand, silica, and limestone, in addition to a certain percentage of recycled waste glass utilized in the manufacturing process. The glass recycling process produces a crushed glass product called "cullet", which is often mixed with virgin glass materials to produce new end products. Table lists some of approximate compositions and the corresponding uses of various common forms of glass.

Despite the fact that glass materials can be recycled forever and the same glass can be recycled so many times over to produce various products, but, in order to keep producing the best end product the recycled materials must be of a high quality. Therefore, continuous residual amounts of waste glass resulting from construction deteriorations, domestic and medical disposals, and industrial output junk materials are still cumulating and hence need to be land filled or reused in concrete mixes as a partial substitute for coarse aggregates and/or fine aggregates. Technically, glasses are usually manufactured in the form of tubes, rods, hollow vessels and a variety of special shapes, as well as flat glass and granulate for use mainly in chemistry, laboratory technology, pharmaceuticals, optoelectronics, various

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domestic uses, and household appliance technology. For the purposes of classification, the multitude of technical glasses can be roughly arranged in four main groups, according to their oxide composition (in weight percent).

Borosilicate glasses is the first main category with the presence of substantial amounts of silica (SiO_2) and boric oxide ($B_2O_3 > 8\%$) as glass network formers. The amount of boric oxide affects the glass properties in a particular way. Apart from the highly resistant varieties ($B_2O_3 \leq 13\%$) there are others that – due to the different way in which the boric oxide is incorporated into the structural network – have only low chemical resistance ($B_2O_3 > 15\%$).

Secondly, the Alkaline-earth aluminosilicate glasses are free of alkali oxides and contain 15 – 25% Al_2O_3, 52 – 60% SiO_2, and about 15% alkaline earths. Very high transformation temperatures and softening points are typical features. Main fields of application are glass bulbs for halogen lamps, display glasses, high-temperature thermometers, thermally and electrically highly loadable film resistors and combustion tubes.

Alkali-lead silicate glasses are the third main category and such glasses typically contain over 10% lead oxide (PbO). Lead glasses containing 20–30% PbO, 54–58% SiO_2 and about 14% alkalis are highly insulating and therefore of great importance in electrical engineering. They are used in lamp stems and lead oxide is also of great importance as an X-ray protective component (radiation shielding glass and cathode ray tube components).

The last category is the oldest glass type and nominally the Alkali alkaline-earth silicate glasses (soda-lime glasses). It comprises flat glasses (window glass) and container Variants of the basic composition glasses, which are produced in large batches. Such glasses contain about 15% alkali (usually Na_2O), 13 – 16% alkaline earths (CaO+MgO), 0–2% Al_2O_3 and about 71% SiO_2. can also contain significant amounts of BaO with reduced alkali and alkaline-earth content

GLASS TYPE

Type of Glass	Composition (by weight)	Usages
Soda-Lime-Silica	73% Silica – 14% Soda – 9% Lime – 3.7% Magnesia – 0.3% Alumina	Glass Widows – Bottles – Jars
Boro-Silicate	81% Silica – 12% Boron Oxide – 4% Soda – 3% Alumina	Pyrex Cookware – Laboratory Glassware
Lead (Crystal)	57% Silica – 31% Lead Oxide – 12% Potassium Oxide	Lead Crystal Tableware

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Alumino-Silicate	64.5% Silica – 24.5% Alumina – 10.5% Magnesia – 0.5% Soda	Fiberglass Insulation – Halogen Bulbs

EXPERIMENTAL INVESTIGATION

FLEXURAL STRENGTH TEST

- The main aim of this experimental test is to determine the maximum load carrying capacity of beam specimens.
- The specimen is subjected to two points loading and the load at the failure of the specimen is noted down.
- Prisms of size 100 mm × 100 mm × 500 mm were cast. Three numbers of specimens for each set were tested at 7days, 14 days and 28days.The mean value of the specimen of each type is taken as final flexure value.
- Flexural strength of the specimen is expressed as the modulus of rupture.
- The flexural strength was calculated using the formula

$$\text{Flextural Strength} = \frac{PL}{BD^2}$$

Where,

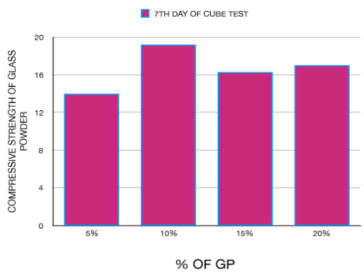
Flexural strength of specimen in MPa.

P = Maximum load in N applied to the specimen.

L = span in mm.

B = Measured width of the specimen in mm.

D = Measured depth of specimen in mm at the point of failure.



COMPRESSIVE STRENGTH AT 14 DAYS

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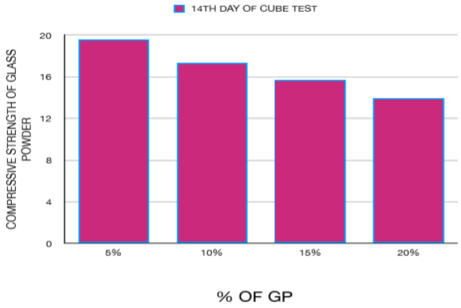
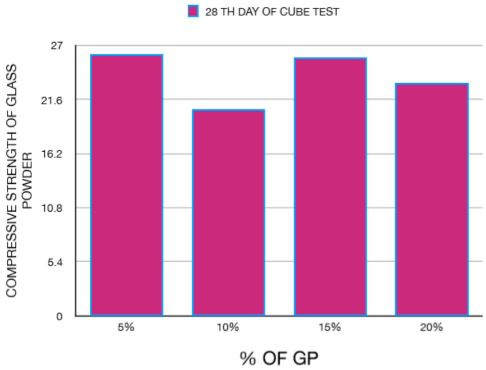
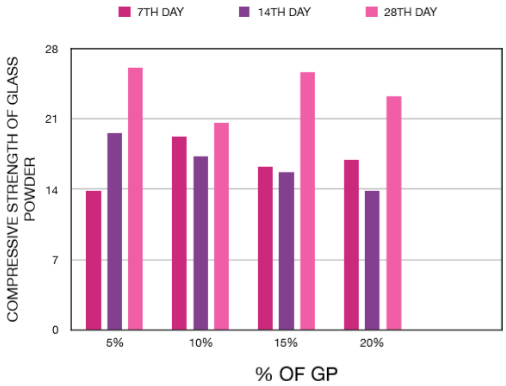
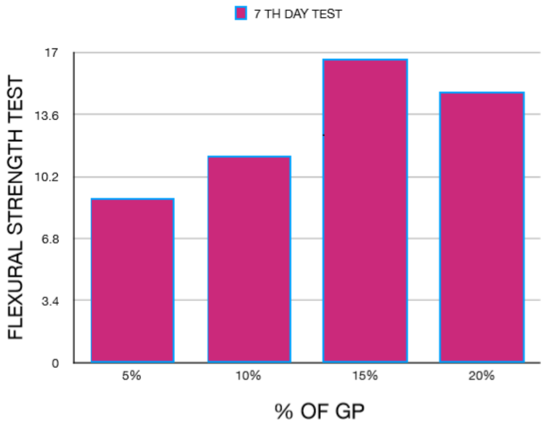




COMPARISON OF COMPRESSIVE STRENGTH AT 7&28 DAYS



FLEXURAL STRENGTH AT 7 DAYS



FLEXURAL STRENGTH AT 28 DAYS

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FLEXURAL STRENGTH AT COMPARISON OF 7 & 28 DAYS

CONCLUSIONS

The rate and total heat generated during hydration the dilution consistently decreased with higher GP content due to the dilution of cement in the mix. Owing to its negligible water absorption capability, higher glass powder content in the initial stage and its consumption by glass powder content in the initial stage and its consumption by glass powder pozzalanic reaction at the later stage. Calcium hydroxide was almost depleted at 91 days when more than cement was substituted by glass powder.

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