INTERNATIONAL JOURNAL OF ADVANCED INNOVATIVE TECHNOLOGY IN ENGINEERING

Published by Global Advanced Research Publication House Journal

Home page: www.ijaite.co.in

Experimental Investigation on Concrete Cube Using Glass Beads Material

[1]Sakshi A. Zambre, [2]Poonam N. Lende, [3]Sarthak S. Nande, [4]Ankita V. Kalkekar, [5]Pooja V. Bhalkar

[1,23,4,5]Department of Civil Engineering, SSPACE, Wardha, Maharashtra, India

[1]zambresakshi@gmail.com.

Article History

Received on: 10 Feb. 2025
Revised on: 28 Feb. 2025
Accepted on: 30 March 2025

Keywords: Compressive Strength, Glass Bead, Temperature Gradient, Thermal Conductivity.

e-ISSN: 2455-6491

DOI: 10.5281/zenodo.15378489

Production and hosted by
www.garph.org

ABSTRACT

Glass is a special substance that is commonly utilized for many different purposes and comes in a wide range of colours and shapes. A significant amount of glass garbage is composed of coloured bottles. Glass garbage may be less harmful to the environment if it is recycled. Some indecomposable wastes, however, are buried. The ecosystem will suffer as a result of this. Using coloured glass as a replacement material in other industries, including the concrete industry, is a practical way to reduce the amount of non-recyclable trash. The impact of substituting discarded glass particles for aggregate on the weight and compressive strength of concrete is examined in this study. 36 cubic examples were cast in order to accomplish the goal; the specimens were composed of grade M30 concrete mix, with leftover glass bead fragments mixed in with the remaining specimens. To prevent the Alkali Silica Reaction (ASR), Alccofine 1203 was added to the mixture of glass bead specimens. Overall, the findings demonstrated that the concrete's compressive strength was enhanced by substituting glass bead particles for fine aggregate by more than 20%. In each case, the weight of the concrete is almost the same. In summary, the findings suggest that 20% is the ideal percentage for substituting glass particles for aggregate.

1. INTRODUCTION

It should be mentioned that the lack of land filling sites and low recycling rate of waste glass have made its rise a major concern, even though a sizable quantity of colourless waste glass has been recycled and recycled back into the industry. They also take a long time to break down, which makes them a serious environmental danger. Given the foregoing, researchers have recently concentrated on replacing other elements, such concrete aggregate, with glass particles. Even while using glass in some businesses would be costly, as facilities are expanded and replicating technology improves, the amount of waste glass produced would decrease, making concrete manufactured from waste glass economically viable. [2] Researchers have conducted a great deal of research since there are numerous benefits to employing waste glass in the concrete industry. Z.Z. Ismail and E.A. Al- Hashmi (2009) examined the characteristics of concrete that contained glass fragments as a subsurface component. This study assessed the strength characteristics and ASR expansion of concrete mixtures that substituted 10%, 15%, and 20% crushed waste glass for sand.

The findings showed that waste glass had 80% pozzolanic strength activity after 28 days. The mix that was exposed to 20% broken glass outperformed the control specimen in terms of both flexural strength (4.23%) and compressive strength (10.99%). In comparison to the control specimen, the test on the mortar bar showed that the waste glass that had been finely crushed decreased the size growth by 66%. [3]. The effects of replacing fine aggregate with recycled glass trash on the fresh and hardened properties of self-compacting concrete (SCC) were examined by E.E. Ali and Sh.H. Al-Tersawy (2012). Eighteen specimens with varying cement concentrations (350, 400, and 450 kg/cm3) and a W/C ratio of 0.4 in size were created for this experimental investigation.

In order to replace fine aggregate, glass beads were used in percentages of 0%, 10%, 20%, 30%, 40%, and 50%. The results showed that the more recycled glass there was, the higher the slump flow. According to this study, recycled glass particles can be used to produce SCC because they decreased the concrete's compressive strength, splitting tensile strength, flexural strength, and static elasticity modulus as the quantity of recycled glass particles increased [4]. Y. Sharifi et al. evaluated the effects of replacing fine aggregate with glass on the properties of SCC in 2013. In this investigation, fine aggregate was substituted with crushed glass in weight percentages of 0%, 10%, 20%, 30%, 40%, and 50%. The results demonstrated that using waste glass enhanced the specimens' flow-ability while decreasing their compressive, flexural, and splitting strengths. Due to the little amount of concrete strength loss, glass particles can be used in place of fine aggregates to form SCC. [5]. In order to assess the performance of concrete specimens with varying percentages of crushed glass up to a maximum size of 5–20 mm and glass marble up to 20 mm in size to be used as coarse aggregate, T.S. Serniabat et al. carried out another experimental investigation. The test findings demonstrated that the specimen with the balanced ratio of glass particles and round marbles had the highest compressive strength because glass beads are good at forming bonds and powerful marbles are very strong. [6]. The impact of substituting crushed glass bottles for coarse aggregate on the mechanical and physical properties of the concrete mix was examined experimentally by T. Ganiron Jr. A mix design of 5% weight insertion to the concrete mix will result in an adequate compressive strength, according to the results, and recycled crushed glass can replace up to 10% of the coarse aggregate weight in the concrete mix [7]. A.B. Keyron and G. J. Ibrahim carried out comparable studies on the mechanical properties of both fresh and hardened concrete that included window waste glass. The results demonstrated that replacing coarse aggregate with window glass particles increased compressive, splitting, and bending strength while decreasing slump and fresh density due to the grain's angular structure. Additionally, the findings demonstrated that when the proportion of waste glass grew, the strength rapidly climbed up to a certain point before decreasing. [8]. A. M. Rashad examined the mechanical, fresh, abrasion, water absorption, penetration of chloride ions, permeability, resistance to chemical and carbonation, drying shrinkage, and expansion of the alkali-silica reaction of mortar/concrete mixtures that used waste glass in place of fine aggregate in 2014. [9]. Waste glass can effectively replace coarse aggregate (up to 50%) without significantly changing strength, according to another study by V. Srivastara et al. [10].The effect of ground waste glass (GWG) microparticles as cementary material on the mechanical and durability response qualities of SCC was evaluated by Y. Sharifi et al. in 2015. The results demonstrated that as the proportion of GWG microparticles in fresh concrete rose, so did its workability. Additionally, the toughened strength of concrete will be increased if GWG microparticles are replaced at a rate of 15%. Additionally, ASR expansion decreased as the ratio of GWG particles increased; hence, GWG can be used as a cementary material to generate SCC [11].

When 13% of the cement was replaced with neon glass, the concrete's flexural and compressive strengths increased. However, when green glass was used, the splitting tensile strength increased to its maximum size at the same ratio, according to another experimental study on the effect of recycled glass on the mechanical properties of green concrete. [12]. H.G. Patel and S.P. Dalal investigated the mechanical and physical properties of concrete that contained waste glass particles. The results of their investigation demonstrated that the mechanical, physical, and durability properties of concrete remained within the permissible range given by codes. The PVC and glass particles were uniformly dispersed throughout the concrete, according to the microstructure examination. [13]. he use of fluorescent light tube waste as fine aggregate in concrete was studied in 2017 by P. Seenu and K. Kavieya. The results demonstrated that replacing fine aggregate with fluorescent tube light waste at a rate of less than 10% results in the maximum amount of replacement. [14].

The main goal of this study is to find out how using glass instead of sand affects the weight and compression strength of concrete. The Alkali Silica Reaction, a chemical reaction between the alkali material in the concrete mix and the microsilica in glass, is the main problem with concrete that uses glass instead of aggregate. This contact may cause corrosion in concrete. Concrete mixtures containing pozolanic elements, like microsilica, are an effective way to stop ASR. The specimens that contained waste glass particles were therefore augmented with microsilica [2, 15-17]. Furthermore, explored is the effect of using microsilica on the a fore mentioned concrete qualities.

METHODOLOGY

The following flow chart depicts the main stages of project.

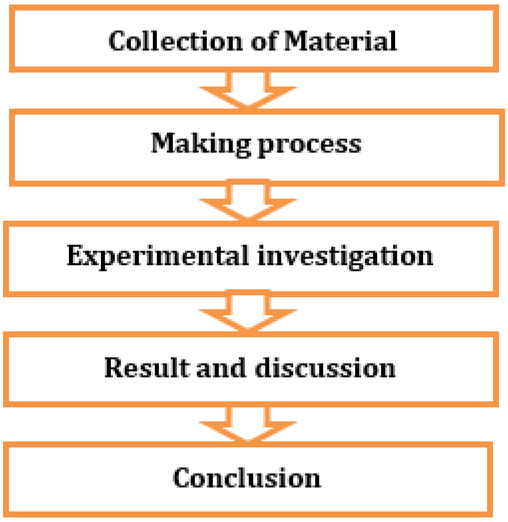

Figure 1: Flowchart of Proposed Methodology

Cement: In this work, Ordinary Portland Cement (OPC) of Ultratech (53 grade) brand, as shown in Fig. 1, obtained from a single batch, was used. The physical properties of OPC, as determined, are given in the following table. The cement satisfies the requirements of IS 12269:1987. The specific gravity was found to be 3.15, and the fineness was 2800 cm^2/g.

Figure 2: Cement

Fine Aggregate (Sand): In this project, natural sand was used as fine aggregate, as shown in Fig. 2. It results from the natural disintegration of rock and is typically deposited by streams or glacial agencies. River sand was used as the source of natural fine aggregate. The sand used passed through a 4.75 mm sieve. The specific gravity of the sand was found to be 2.605, as determined by the pycnometer test.

Figure 3: Natural Sand

Coarse Aggregate: Coarse aggregate refers to crushed stone used for making concrete. The commercial stone is typically quarried, crushed, and graded. Common types of crushed stone include granite, limestone, and trap rock. In this study, crushed angular granite metal of 10 mm size from local sources was used as coarse aggregate, as shown in Fig. 3. The aggregate used had a specific gravity of 2.884 and a fineness modulus of 6.05. The aggregates used were those passing through a 12.5 mm sieve and retained on a 10 mm sieve.

Figure 4: Coarse Aggregate

Alccofine (Admixture): Fig. 4 shows Alccofine 1203, which is a type of pozzolanic material. This means it reacts with calcium hydroxide in the presence of water to form cementitious compounds. It is commonly used as a partial replacement for cement in concrete mixtures.

Figure 5: Alccofine Admixture

Glass Beads: Glass beads are mostly used in the abrasive blast cabinet. They are round in shape and smoothly clean metal parts with a smooth polish as shown in fig 5. The pressure on which glass beads are blasted is 60-90 PSI to get the highest productivity result.

Figure 6: Glass Beads

TEST PROCEDURE

Having been prepared, the 150X150X150mm cubic molds were coated by industrial oil to prevent adhesion of concrete. Then, concrete was casted in three 30 mm layers and each of which was compacted using steel bar and shaking table. After one day the molds were removed from concrete and the specimens were placed in water. Having been cured for 7 days, 14 days, 28 days the weight of specimens was measured using digital balance and then axial force was applied to specimens using concrete compression machine as shown in Figure 6.

Figure 7: Compressive Testing Machine

RESULTS AND DISCUSSION

The measured weight and the results of concrete compression test are provided in Table 1.and it is graphically shown in fig 7.

Table 1. Average Compressive Strength

	7 Days	14 Days	28 Days
0 %	19.86	27.15	29.97
10%	21.11	28.26	30.52
20%	22.38	29.46	30.65
30%	19.12	27.07	29.09

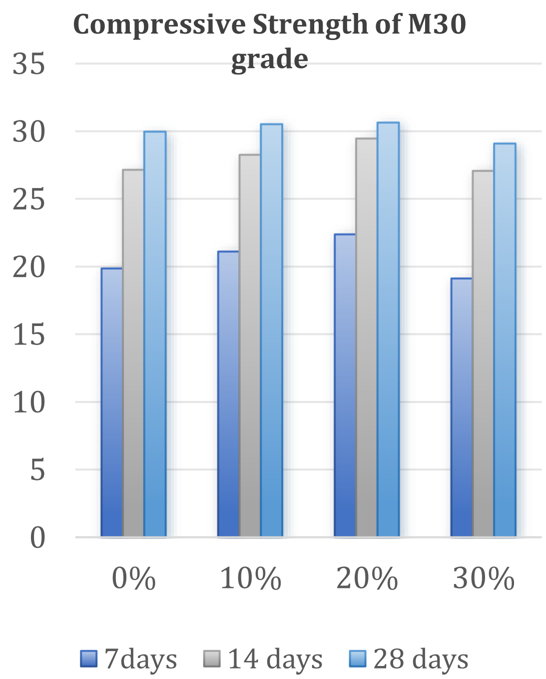

Figure 8: Comparison of average compressive strength of specimens

CHALLENGES AND FUTURE SCOPE

In the fields of materials engineering and construction, experimental research on concrete cubes employing glass beads as an additive or material substitute may offer both difficulties and promising prospects for the future. The following are some major issues and potential futures:

Waste Glass Utilization: An environmentally friendly method is to use glass waste to make concrete beads. This can support recycling, lessen glass waste, and encourage more environmentally friendly building techniques.

The feasibility of adding more recycled glass beads to concrete mixtures may be investigated further, which could reduce the need for natural aggregates.

Strength and Durability Enhancement: Examining the possibility of using glass beads as an additive to enhance particular concrete qualities, such weight reduction (lightweight concrete), compressive strength, or thermal insulation.

Concrete's strength and durability may be increased by better bonding with glass beads thanks to new surface treatments or coatings.

High-Performance Concrete (HPC): Glass beads may be investigated for use in high-performance concrete (HPC) applications that call for particular characteristics like surface finish, light weight, or visual appeal. For usage in specialist projects (such as bridges, high-rise buildings, etc.), studies could concentrate on optimizing the glass bead content to produce concrete that is strong, long-lasting, and sustainable.

Lifecycle Assessment and Environmental Impact: Future studies can concentrate on the lifetime analysis (LCA) of glass-bead-containing concrete to evaluate the environmental advantages in terms of lower waste, energy use, and carbon footprint. Research could create methods for optimizing glass beads' positive environmental effects while reducing any possible drawbacks, such processing that requires a lot of energy.

CONCLUSION

To evaluate the effect of replacing sand with waste glass particle in concrete, 36 specimens were prepared and tested; compressive strength and weight of specimens were analysed. Taking the results into account, following conclusions could be drawn:

- The most notable conclusion in this study is that using glass beads instead of sand in concrete mix containing Micro-silica, increase the compressive strength of concrete. To put it simply, by increasing the percentage of glass beads, the compressive strength rise. In this study the optimum percentage of glass beads is 20%.
- As mentioned before, the only concern with using glass beads in concrete is ASR which could be prevented by Adding Micro-silica to concrete mix [2, 15-17]. Moreover, based on the results adding Micro-silica to concrete mix increase the compressive strength of concrete.
- Replacing sand with glass beads does not affect the weight of concrete. To put it another way, the dead load due to concrete structure does not change by using waste glass particle.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

FUNDING SUPPORT

The author declare that they have no funding support for this study.

REFERENCES

[1] Batayneh, Malek, Iqbal Marie, and Ibrahim Asi. "Use of selected waste materials in concrete mixes." Waste management 27.12 (2007): 1870-1876.

[2] Park, Seung-Bum, and Bong-Chun Lee. "Studies on expansion properties in mortar containing waste glass and fibers." Cement and concrete research 34.7 (2004): 1145-1152.

[3] Ismail, Zainab Z., and Enas A. Al-Hashmi. "Recycling of waste glass as a partial replacement for fine aggregate in concrete." Waste management 29.2 (2009): 655-659.

[4] Ali, Esraa Emam, and Sherif H. Al-Tersawy. "Recycled glass as a partial replacement for fine aggregate in self compacting concrete." Construction and Building Materials 35 (2012): 785-791.

[5] Sharifi, Yasser, Mahmoud Houshiar, and Behnam Aghebati. "Recycled glass replacement as fine aggregate in self-compacting concrete." Frontiers of Structural and Civil Engineering 7 (2013): 419-428.

[6] Serniabat, T. S., M. N. N. Khan, and M. F. M. Zain. "Use of waste glass as coarse aggregate in concrete: a possibility towards sustainable building construction." International Journal of Civil and Environmental Engineering 8.10 (2014): 2014.

[7] Ganiron Jr, Tomas U. "The effect of waste glass bottles as an alternative coarse aggregate in concrete mixture." International journal of ICT-aided architecture and civil engineering 1.2 (2014): 1-10.

[8] Keryou, Abdelmaseeh Bakos, and Gailan Jibrael Ibrahim. "Effect of using windows waste glass as coarse aggregate on some properties of concrete." Engineering and technology journal 32.6 Part A (2014).

[9] Rashad, Alaa M. "Recycled waste glass as fine aggregate replacement in cementitious materials based on Portland cement." Construction and building materials 72 (2014): 340-357.

[10] Srivastava, Vikas, et al. "Glass wastes as coarseaggregate in concrete."Journal of Environmental Nanotechnology 3.1 (2014): 67-71.

[11] Sharifi, Yasser, et al. "Utilization of waste glass micro-particles in producing self-consolidating concrete mixtures." international journal of concrete structures and materials 10 (2016): 337-353.

[12] AL-Zubaid, Aseel B., Kadum Muttar Shabeeb, and Aynoor Ibrahim Ali. "Study the effect of recycled glass on the mechanical properties of green concrete." Energy procedia 119 (2017): 680-692.

[13] Patel, Harshad G., and Sejal P. Dalal. "An experimental investigation on physical and mechanical properties of concrete with the replacement of fine aggregate by poly vinyl chloride and glass waste." Procedia engineering 173 (2017): 1666-1671.

[14] Seenu, P., and K. Kavya. "Strength and durability properties of concrete by using fluorescent light tube waste replacing as fine aggregate." International journal of engineering research and technology 6.06 (2017).

[15] Turgut, P., and E. S. Yahlizade. "Research into concrete blocks with waste glass." International Journal of Civil and Environmental Engineering 1.4 (2009): 203-209.

[16] Naohiro, S. "The strength characteristics of mortar containing glass powder." Proc. 49th Cement Technology Conf., Tokyo. 1995.

[17] Shayan, Ahmad, and Aimin Xu. "Value-added utilisation of waste glass in concrete." Cement and concrete research 34.1 (2004): 81-89.

[18] Standard, A. S. T. M. "C618-08a: standard specification for coal fly ash and raw or calcined natural pozzolan for use in Concrete." Annual Book of ASTM standards (2008).