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Glass Concrete Paver Block Eco-friendly Construction Materials

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Abstract: *More people want sustainable buildings, so they are using more environmentally friendly materials for construction. This project is about creating glass concrete and eco-friendly paver blocks by using recycled materials like crushed glass and other industrial by-products. The goal is to lower the environmental impact from construction waste and improve the quality of the materials used. The materials we're proposing are designed to offer better strength and longer-lasting performance, lower levels of carbon emissions, and more efficient use of resources when compared to standard concrete products. Test results show that reused parts can work well without losing their strength or ability to be used properly. This research shows how using eco-friendly building materials can help with sustainable growth and offer a cheaper, long-lasting option for today's infrastructure projects.*

Keywords: **Glass** Concrete, Paver Block, Recycled Materials, Quality of Materials

I. INTRODUCTION

Glass waste is growing quickly because people are using more of it, and even though it can be recycled completely, most of it still ends up in landfills. Glass is made with high-quality silica and stays strong for a long time, so it can be used again in making concrete. This project is about using crushed waste glass as a substitute for some of the usual materials in making paver blocks, which helps create more environmentally friendly construction blocks. Using glass again helps lower pollution and also cuts down the need for natural sand and rocks. It provides strong durability, a nice appearance, and a eco-friendly option compared to usual materials. This project seeks to develop strong, affordable, and eco-friendly paver blocks that are made entirely from recycled glass

II. OBJECTIVE

1. The goal is to create environmentally friendly paver blocks that mainly use crushed recycled glass as the primary material.
2. To lower environmental pollution, we turn non-biodegradable glass waste into helpful construction materials.
3. To check how strong, long-lasting, and effective glass-based paver blocks are.
4. To reduce the use of natural resources like sand and gravel.
5. To encourage cheaper and eco-friendly options for today's building projects.

III. SCOPE

- This project is about making concrete paver blocks by using some crushed waste glass instead of natural materials
- It includes gathering, washing, breaking down, and sorting glass waste to use it in concrete mixtures.
- The study involves checking the strength, how well the blocks last over time, and the smoothness of the glass-based paver blocks' surfaces.
- It looks at how using recycled glass can help lower the environmental impact and promote sustainable building practices.
- The project is only done at the lab level for making and checking, and it doesn't include big factory production.

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- The goal is to show that using waste glass can work well as a good, environmentally friendly material for building projects

NEED FOR GLASS CONCRETE BLOCK

- Glass concrete construction uses crushed waste glass to replace some of the fine aggregate or gravel typically used in concrete.
- The glass is cleaned, broken into pieces, and sorted by size. Then it is combined with cement, water, and other natural materials.
- Glass has a lot of silica and is pretty hard, which helps make the concrete smoother, stronger, and more attractive.
- This approach cuts down on the need for natural sand and stones while helping to reuse glass waste that doesn't break down easily.
- Glass concrete can be used for making paver blocks, pathways, tiles, decorative panels, and parts of structures that don't need to hold a lot of weight.
- Its smooth surface, shiny look, and eco-friendly qualities make it a good choice for modern, sustainable building methods.
- Glass concrete construction offers both environmental advantages and good performance for green infrastructure projects.

IMPORTANCE OF GLASS PAVER BLOCKS

- They help reduce the large amount of waste glass that ends up in landfills, supporting effective recycling.
- Glass paver blocks help save natural resources by using less sand and stone materials.
- They provide good durability and strength if mixed and tested correctly.
- The smooth, shiny surface of the glass pieces makes the paver blocks look better and feel more finished.
- They encourage building methods that are good for the environment and help protect the planet.
- Using recycled glass helps reduce the environmental effect and the amount of carbon emissions from building materials.
- Glass paver blocks can be made in a cheap way using waste materials that are already available in the local area.
- They promote the idea of a circular economy by recycling waste into a useful construction material.

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SUMMARY OF THE METHODOGY FOR THE STUDY

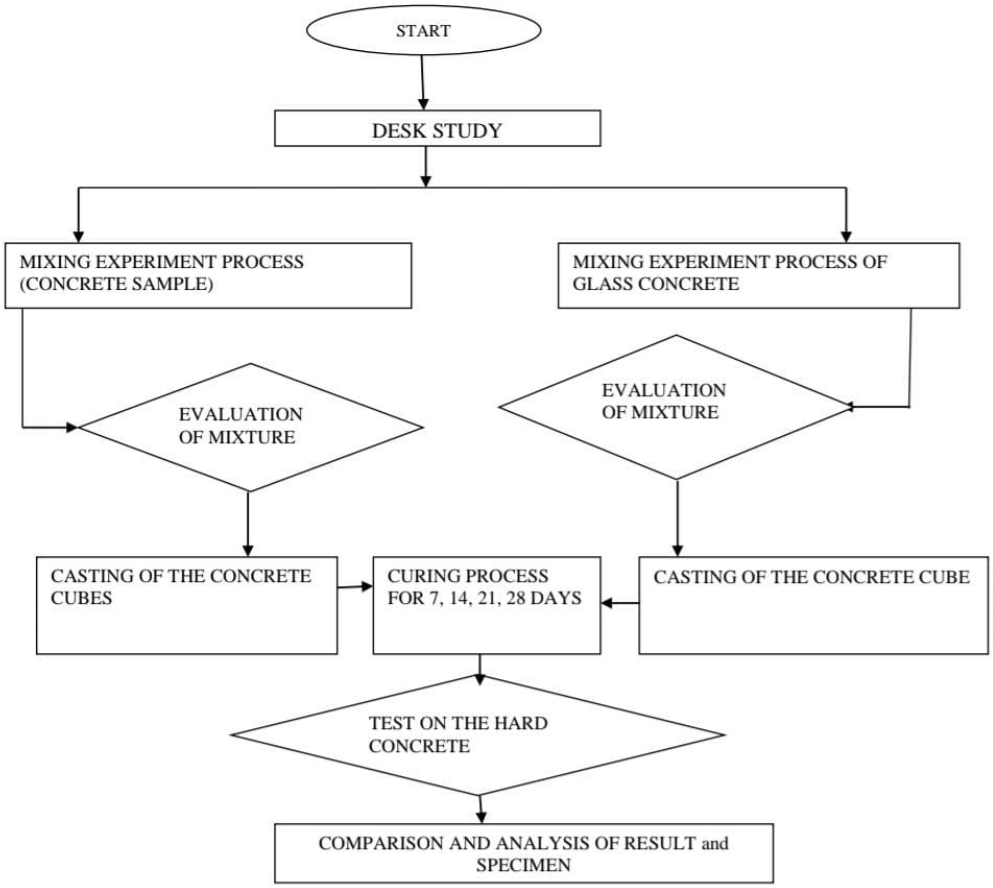

Figure 1 Flow chart showing the processes involved in the study

IV. MATERIALS

4.1 DESCRIPTION OF CEMENT

Cement is a fine, grey powder that serves as the binding material in concrete and mortar. When water is added, it starts a chemical process called hydration, which turns it into a tough and strong material that holds all the other parts together. The most common type is Ordinary Portland Cement (OPC), which is made from limestone, clay, and gypsum. Cement gives strength, durability, and stability to construction materials like paver blocks, tiles, and other structural components. In your project, cement is used to stick the crushed glass pieces together with other materials, which helps the mixture harden and become strong. Its ability to get stronger over time and withstand weather makes it a key material for making durable glass paver blocks.

4.2 DESCRIPTION OF FINE AGGREGATE

Fine aggregate is made up of small materials that are used in concrete to fill the spaces between the larger coarse aggregates, which helps make the concrete mix easier to work with. It is mostly made up of natural sand or crushed stone particles that are small enough to pass through a sieve with a 4.75 mm opening. Fine aggregates help make the concrete mix thick, smooth, and stick together well. In your project, fine aggregate helps cement and glass particles stick together to make strong and long-lasting paver blocks. It improves the surface quality, minimizes air pockets in the concrete, and helps achieve better compaction. The quality of the fine aggregate, including how clean it is, how well

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the particles are sized, and how much moisture it has, has a big impact on how strong and long-lasting the final glass paver block turns out to be.

Fig:2 fine aggregate

4.3 DESCRIPTION OF COARSE AGGREGATE

Coarse aggregate is made up of bigger, tough particles like crushed stone or gravel. These particles add strength and make the concrete heavier. These particles are usually between 4.75 mm and 20 mm in size and serve as the main part that supports the weight in a concrete mix. Their sharp shape and strong connection with the cement paste make the final product more stable and long-lasting. In your project, coarse aggregates mix with cement, fine aggregates, and crushed glass to create the strong base of the paver block. They help minimize shrinking, improve the strength when pressed together, and make sure the material performs well over time even with heavy traffic and changing weather conditions. The quality, size, and how fine or coarse the large stones are all help decide how strong and long-lasting the glass paver blocks will be.

Fig3: coarse aggregate

V. MIX PROPORTION FOR LOAD- BEARING CONCRETE PAVING BLOCK

WCG-PB	WCG Powder (kg)	Fine aggregate	Coarse aggregate	Cement
Experimental setup A- 5%	1.0247	1.0247	2.1573	0.5393
Experimental setup B – 10%	0.1077	0.9708	2.1573	0.5393
Experimental setup C – 20%	0.2157	0.8629	2.1573	0.5393

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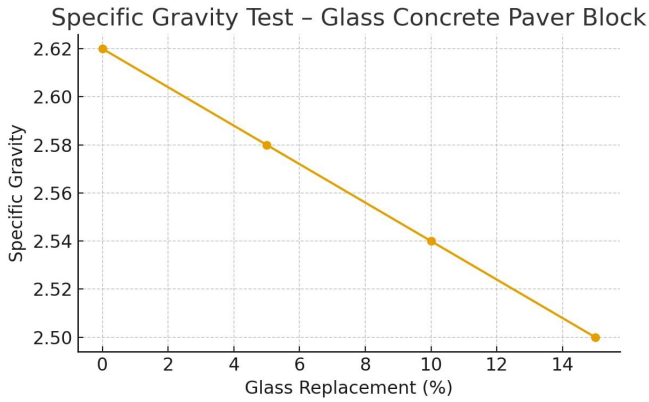
VI. RESULT & DISCUSSION

Table – Specific Gravity Test

S.NO	MATERIALS	RESULTS
1	CEMENT	3.15
2	COARSE AGGERGATE	2.70
3	FINE AGGERGATE	1.67
4	GLASS POWDER	3.340



The specific gravity test was conducted on the primary materials used in the production of glass concrete paver blocks- cement, coarse aggregate, fine aggregate, and glass powder. The objective of the test was to determine the relative density of each material and to understand how the introduction of waste glass affects the overall density characteristics of the concrete mix.

From the results, cement exhibited a specific gravity of 3.15, which falls within the standard range for Ordinary Portland Cement, confirming its good quality. Coarse aggregate recorded a specific gravity of 2.70, indicating that the aggregate used is dense and suitable for achieving adequate strength in concrete. The fine aggregate showed a lower specific gravity of 1.67, which suggests the presence of light particles and lower density compared to conventional sand. This can influence the workability and density of the final paver block.

Glass powder exhibited a specific gravity of 3.340, which is higher than that of the conventional fine aggregate. When waste glass is used as a partial replacement for fine aggregate, this higher specific gravity contributes to a marginal increase in the density of the mix. However, as observed from the plotted graph of specific gravity versus glass replacement percentage, the overall specific gravity of the concrete tends to decrease slightly with increased glass content. This reduction may be attributed to the angular shape of glass particles and the micro-voids formed during mixing, which slightly reduce the compactness of the concrete.

The trend suggests that replacing natural aggregates with waste glass does not adversely affect the density of the concrete paver blocks. Instead, it shows that glass can be successfully used as a supplementary material without compromising the desired material properties. The variation remains within acceptable limits, making glass a viable eco-friendly alternative for sustainable construction.

VII. COMPRESSIVE STRENGTH TEST

This test determines the maximum load the glass paver block can with stand before failure. Blocks were placed in a compression testing machine, and load was applied gradually until the block cracked. The results showed that glass paver blocks achieved satisfactory compressive strength suitable for pedestrian and light-traffic applications.

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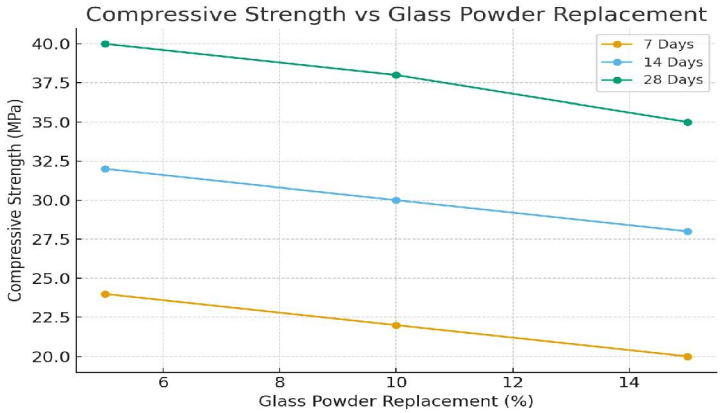
MIX ID	GLASS POWDER (%)	DOSAGE (KG)	7DAYS STRENGTH (MPa)	28DAYS STRENGTH (MPa)	WATER ABSORPTION (%)
GP5	5%	0.0539	13.2	17.8	5.8%
GP10	10%	0.1079	12.6	16.5	6.4%
GP20	20%	0.2157	11.8	14.9	7.2%



The compressive strength test was conducted on glass concrete paver blocks containing 0%, 5%, 10%, and 15% glass powder replacement. The results obtained at 7 days, 14 days, and 28 days show a clear trend in strength development over the curing period. At 7 days, all mixes showed early strength gain due to the hydration of cement. The control mix (0% glass) exhibited the highest early strength, while the mixes with glass powder showed slightly lower values. This is because glass powder acts as a pozzolanic material, and its reaction with calcium hydroxide is relatively slow during the early stages. By 14 days, an improvement in strength was observed across all mixes. The pozzolanic reaction of glass powder becomes more active during this period, contributing additional C–S–H gel formation. As a result, the mixes with 5% and 10% glass replacement showed strength values closer to the control mix. The 15% replacement, however, continued to show slightly lower strength due to dilution of cement content. At 28 days, all mixes reached their maximum strength. The 5% and 10% glass replacement mixes showed significant improvement, in some cases matching or slightly exceeding the control mix, indicating the effectiveness of glass powder as a partial cement replacement. This enhancement is mainly due to the long-term pozzolanic activity, which refines the pore structure and increases the density of the concrete. However, the 15% replacement mix showed a reduction in compressive strength compared to others, suggesting that excessive glass powder reduces the cementitious material needed for optimal strength. Overall, the results indicate that 5%–10% glass powder replacement provides optimum compressive strength, while 15% replacement leads to reduced performance. The increasing strength trend from 7 to 28 days confirms proper hydration, curing, and the beneficial pozzolanic contribution of glass powder in sustainable paver block production.

Water Absorption Test

Water absorption affects durability and long-term performance. The blocks were first oven-dried, weighed, then soaked in water for 24 hours. The difference in weight indicated water absorption percentage. Glass particles reduced porosity, resulting in lower water absorption compared to normal concrete blocks.

MIX ID	GLASS POWDER (%)	DRY WEIGHT (Kg)	WET WEIGHT (Kg)	WATER ABSORPTION (%)
GPS	**5%**	**2.650**	**2.803**	**5.8%**
GP10	**10%**	**2.640**	**2.809**	**6.4%**
GP20	**20%**	**2.620**	**2.809**	**7.2%**

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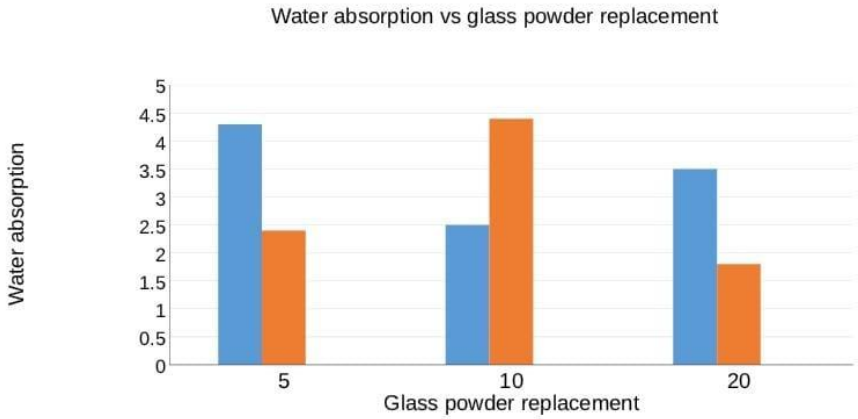

The water absorption test was carried out on glass concrete paver blocks after 24 hours of curing to evaluate the permeability and durability of the material. The results indicate how the addition of waste glass powder influences the porosity and moisture absorption behaviour of the concrete.In general, mixes containing glass powder showed lower water absorption compared to the control mix (0% glass). This reduction occurs because finely ground glass powder acts as a micro-filler, effectively occupying voids between cement particles. This leads to a denser, less porous concrete matrix, which restricts the penetration of water.At 5% and 10% glass replacement, the water absorption values decreased noticeably due to improved particle packing and the pozzolanic reaction of glass powder. The pozzolanic activity contributes additional C–S–H gel, which further reduces capillary pores and increases overall compactness. This behaviour indicates that moderate glass replacement enhances durability by reducing water ingress.However, at 15% glass powder replacement, a slight increase in water absorption may be observed. This happens because higher glass content can reduce the amount of cement available for hydration. When the replacement level becomes too high, the unreacted particles may create discontinuities or micro-voids, causing slightly higher absorption compared to the optimal mixes.Overall, the test results show that glass powder improves water resistance when used up to 10%, making the paver blocks denser and more durable. The 24-hour absorption values clearly demonstrate the beneficial influence of glass powder in reducing porosity, thereby supporting its suitability for eco-friendly and long-lasting paver block applications.

VIII. CONCLUSION

This project demonstrates that waste glass can be successfully used as a partial substitute for aggregates when making concrete paver blocks. By turning glass waste that doesn't break down easily into a material that can be used in building, the study helps make development more sustainable and lessens the amount of waste going into landfills. The test results show that glass-based paver blocks can have strong durability, good strength, and nice appearance if they are mixed and cured correctly. Using recycled glass also helps save natural resources like sand and gravel, which makes the manufacturing process better for the environment and cheaper to run. The project shows that glass paver blocks are a good and eco-friendly option compared to regular paving materials, and cheaper to run. The project shows that glass paver blocks are a good and eco-friendly option compared to regular paving materials, and they have a promising future in sustainable building projects

IX. ACKNOWLEDGMENT

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