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Concrete Hollow Block with Reused Glass

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Abstract
Concrete is being used a lot in construction. As urbanization accelerates globally, the demand for sustainable construction materials is becoming increasingly critical. Traditional concrete, a staple in the construction industry, is known for its environmental impact due to high energy consumption in production and the extensive use of natural resources. In response to these concerns, researchers and industry practitioners are exploring innovative approaches to enhance the sustainability of construction materials. One promising area of investigation is the incorporation of recycled materials into concrete mixtures. In this study, we aimed to determine the level of glass replacement resulting in optimal compressive strength. The objectives of this study are to produce a concrete hollow block with reused glass and to find out whether the reused glass can be used as partial replacement for aggregates. Three concrete samples were tested at 7, 14 and 28 days for glass replacement proportions of 10%, 15% and 20%. Based on its maximum load at failure, 10% of reused glass substitution is applicable for interior wall. The hollow concrete produced by using 10% of reused glass with sized 320cmx180cmx180cm.

Keywords: *Concrete Hollow Block ;Construction Material: Used Glass*

1. Introduction

Waste management has become a significant issue in today's rapidly growing society. With population levels around the globe increasing at an alarming rate, we are witnessing unprecedented levels of waste material accumulation. Among these materials, glass stands out as a particularly concerning issue due to its non-biodegradable nature, making it unsuitable for disposal in landfills. Fortunately, glass can be recycled indefinitely without any loss in quality, which presents an excellent opportunity for sustainable resource management. However, this recycling process begins with the need to sort glass by color, a crucial yet expensive step that complicates the recycling efforts.

As a result, waste glass is increasingly being utilized in applications where mixed colors are acceptable, such as in aggregates for civil construction projects. This alternative use of waste glass not only helps to reduce the volume of material sent to landfills but also offers an environmentally friendly solution for the construction industry. Waste glass constitutes a major component of the solid waste stream in many countries, appearing in various forms, such as container glass, flat glass (such as windows), bulb glass, and cathode ray tube glass from outdated televisions and monitors.

At present, despite the fact that a small percentage of post-consumer glass is recycled and reused effectively, a substantial amount remains problematic, with approximately 84% of the waste glass generated in the UK being sent to landfill sites. This is a significant waste of

a valuable resource, as glass is a 100% recyclable material that boasts high performance and unique aesthetic properties, making it suitable for widespread applications across various industries.

Moreover, the current state of recycling and the effects of legislative forces exert considerable pressure on glass recycling and reuse initiatives, prompting the need for better policies and practices. The innovative use of glass as aggregates in concrete has shown great potential for future high-quality concrete development, providing a pathway towards a more sustainable construction industry and highlighting the importance of efficient waste management strategies. By investing in better recycling technologies and public awareness campaigns, we can significantly reduce the environmental impact of waste glass and harness its full potential as a recyclable material.

2. Methodology

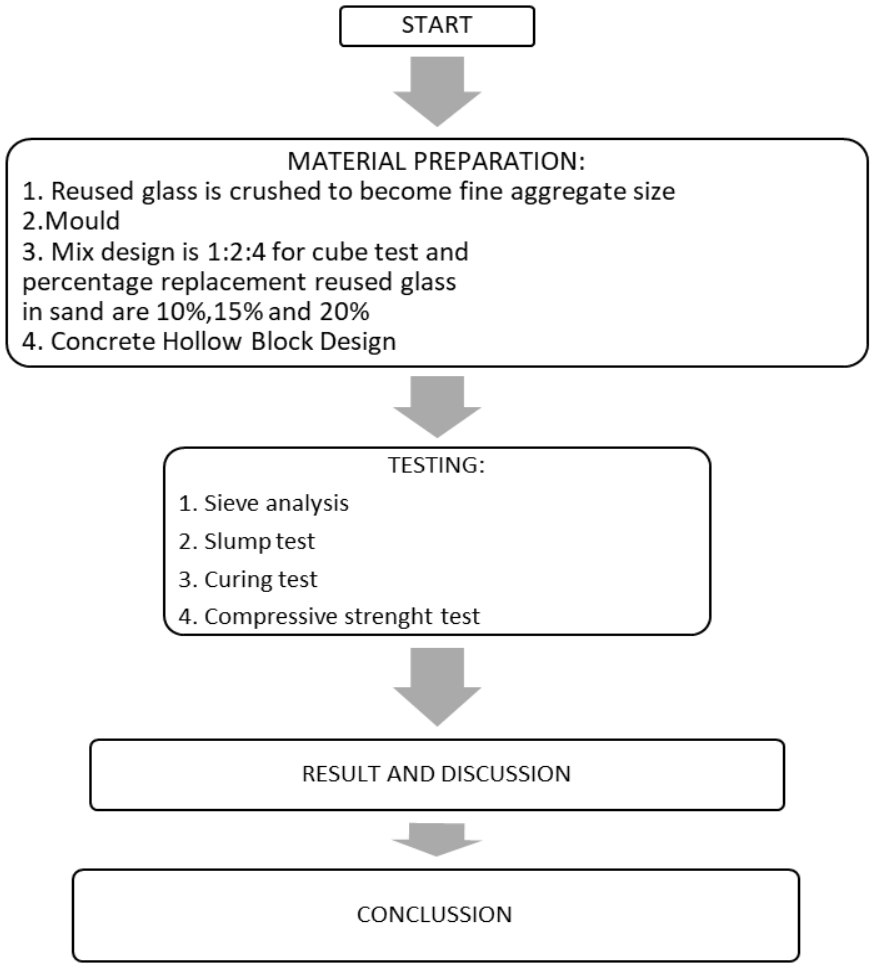

Figure 1. Flow Chart of Research Methodology

3. Results and Discussion

3.1 Sieve Analysis

From the graph in figure 3.1 its shown that size is 5.00mm and minimum aggregate size is 0.3mm. Based on the distribution, its indicate that the size of reused glass is in medium zone (Malaysia Standard 29:1995). The use of fine aggregate with the appropriate size and quality will ensure that the concrete hollow blocks produced have sufficient strength to be used in construction, as well as being durable and stable in the long term.

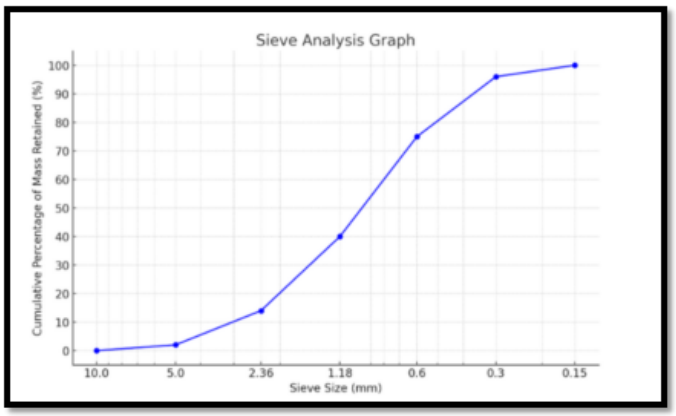

Figure 2. Sieve Analysis Graph

3.2 Slump Test

Mix Design: 1:2:4

Water cement ratio : 0.6 = 2.021 liter

From table 3.1, we can see that the value of slump is increase from control specimen followed by 10%, 15% and 20% of reused glass. The higher slump in concrete containing reused glass is mainly attributed to the smooth, non-porous surface of glass particles, which results in less water absorption and lower internal friction within the mix. This leads to increased workability and a higher slump value compared to conventional concrete, where traditional aggregates tend to have more porous, angular surfaces that absorb water and create more interlocking, reducing workability.

Table 1. Slump Test Result

Mixture	**Slump Value (Decrease)(mm)**			**Average Decrease (mm)**	**Type of Slump**
	Test 1	**Test 2**	**Test 3**	**T1+T2+T3/3**	
Control	21	22	22	21,7	True Slump
10% of Reused Glass	25,5	26	23	28,9	True Slump
15% of Reused Glass	27	27	28	29,9	True Slump
20% of Reused Glass	29	29	29	30	True Slump

3.3 Water Curing Test

The concrete cube was cured at an average temperature of 29.35°C. Although this does not fully comply with the standard curing temperature of 20°C as specified by BS 1881: Part 111: 1983, however the specimen was water-cured in a tank, with the water level maintained at least 15mm above the top of the cube. The highest temperature recorded during curing was 30.5°C, while the lowest was 27°C.

3.4 Compressive Strength Test

From Table 3.2 and Graph 3.2 as shown below, the compressive strength for the ordinary cube is the highest among the other specimen which is 24.38N/mm2 at day 28. However, specimen with 10% of reused glass achieved second highest compressive strength with 22.67N/mm2 followed by specimen with 15% used glass with 18.67 N/mm2. The lowest compressive strength is specimen with 20% of used glass. So, in this study, we decide to produce the concrete hollow block by using 10% reused glass.

Table 2. Compressive Strength Test Result

NAME OF SPECIMEN	PERCENTAGE REUSED GLASS (%)	AGE (DAYS)	COMPRESSIVE STRENGTH (N/mm²)			AVERAGE (N/mm²)
			TEST 1	TEST 2	TEST 3	
7CT	0%	7	17.78	18.56	16.84	17.73
7S10	10%		15.11	15.65	14.95	15.23
7S15	15%		16.23	15.11	13.82	15.05
7S20	20%		18.22	19.15	18.60	18.66
14CT	0%	14	19.60	20.34	17.64	19.19
14S10	10%		16.44	16.85	17.38	16.89
14S15	15%		17.30	16.52	14.96	16.26
14S20	20%		18.40	19.20	18.82	18.80
28CT	0%	28	24.00	25.50	23.64	24.38
28S10	10%		23.62	21.80	22.59	22.67
28S15	15%		17.86	19.00	19.15	18.67
28S20	20%		18.62	18.22	18.96	18.60

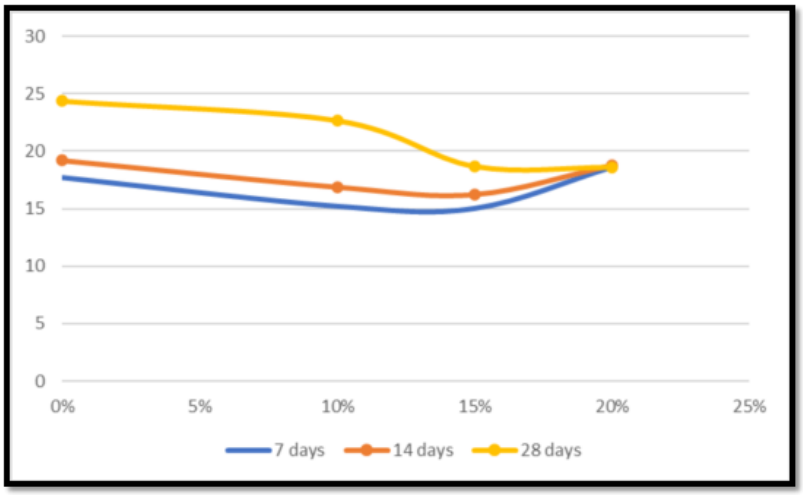

Figure 3. Compressive Strength Test Result

3.5 Product

Figure 3.4 is shows the new design and dimension of concrete hollow block with reused glass. The dimension of block is 320mm (L) x 180mm(H) x 180mm(W). We decided to use 10% reused glass as partial replacement of aggregate to construct the concrete hollow block which the compressive strength is up to 22.67N/mm2. The maximum applied load can withstand below 510kN load.

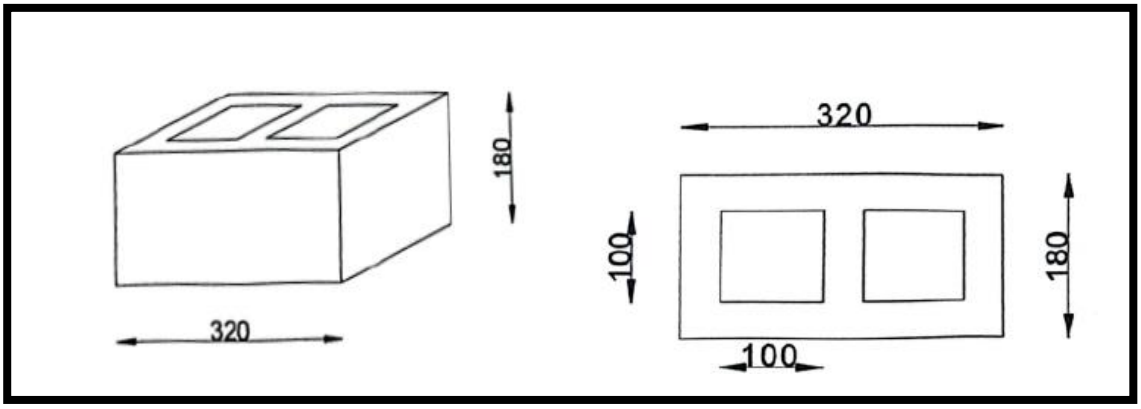

Figure 4. Design of Concrete Hollow Block

Figure 5: Concrete Hollow Block (320mm(L)x180mm(H)x180mm(W))

4.Conclusion

In conclusion, concrete hollow blocks incorporating reused glass have been successfully produced. The results indicate that the compressive strength of concrete containing reused glass is lower than that of conventional concrete. However, this product remains suitable for use in non-load-bearing applications, such as inner walls, where high compressive strength is not as critical. Additionally, the use of recycled glass contributes to environmental sustainability by reducing waste and promoting the use of eco-friendly materials in construction. The study also emphasizes the critical importance of achieving the correct mix ratio. Without an optimal mix, the quality and performance of the concrete hollow blocks

are compromised. Therefore, ongoing research is needed to refine these mixtures and explore other potential additives that may further improve both the strength and sustainability of concrete blocks incorporating recycled materials.

Reference

A. M. Neville, Properties of concrete (London: Longman,1995)

British Standard Institution (2013). Aggregates for concrete. United Kingdom: BS EN 12620.

British Standards Institution (2009). Testing fresh concrete– Part 2: Slump test. United Kingdom: BS EN 12350-2.

British Standards Institution (1983). Testing fresh concrete– Part 111: Method of normal curing of test specimens (20 °C method). United Kingdom: BS EN 1881-111.

BS 1881-122:2011 Part 122: Method for determination of water absorption

British Standards Institution (1983). Testing concrete– Part116: method for determination of compressive strength of concrete cubes. United Kingdom: BS 1881-116:1983.

MS EN 1991-1-1:2021 Eurocode 2-Part 1-1: Design of concrete structure- General rules and rules for buildings, Department of Standards Malaysia

Kumari, P., Sajad, D., Bhat, A., & Goyal, Y. (2020). Effect of replacement of fine and coarse aggregate by sawdust in solid concrete blocks for different mix proportions

Oyedepo, O. J., Daniel, S., Sunmbo, O., & Akande, P. (n.d.). (November 2022).Investigation of properties of concrete using sawdust as partial replacement for sand.

Mama, C. N., Nnaji, C. C., Onovo, C. J., & Nwosu, I. D. (2019). Effects of Water Quality on Strength Properties of Concrete. International Journal of Civil, Mechanical and Energy Science, 5(2), 7–13. https://doi.org/10.22161/ijcmes.5.2.2