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Green Concrete for a Better Future Incorporating Glass Powder and Marble Waste as Aggregate Replacement

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ABSTRACT

Green Concrete for a Better Future: Incorporating Glass Powder and Marble Waste as Aggregate Replacement The construction industry is one of the largest consumers of natural resources, leading to environmental depletion and increased carbon emissions. As sustainability becomes a priority, the development of green concrete which incorporates industrial waste as a replacement for natural aggregates offers an innovative solution. This study explores the potential of using waste glass powder as a partial substitute for fine aggregates and marble waste as a replacement for coarse aggregates in concrete production. The research focuses on M40 grade concrete, where fine aggregate is replaced with glass powder at varying levels (%), while 30% of coarse aggregate is substituted with marble waste. The objective is to evaluate the workability, strength, and durability of the modified concrete mix, ensuring its suitability for construction applications. Glass powder, due to its pozzolanic properties, enhances the concrete's strength and reduces permeability, improving long-term durability. On the other hand, marble waste, with its fine texture and chemical composition, contributes to better binding and structural integrity. By incorporating these waste materials, the study aims to reduce landfill waste, lower carbon footprints, and promote a circular economy in construction. Experimental tests, including slump tests, compressive strength tests, and water absorption tests, will help determine the most effective combination of waste materials without compromising performance. The expected outcome is an environmentally friendly concrete mix that balances strength, cost-effectiveness, and sustainability. By adopting waste-based concrete solutions, the construction industry can significantly reduce environmental impact while maintaining infrastructure quality. This research not only promotes sustainable material usage but also paves the way for a greener, more responsible approach to modern construction.
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Keywords: Green Concrete, Eco-Friendly Construction, Composite Material, Marble Waste, Glass Powder.

1. INTRODUCTION

Demand towards of normal resources for concrete preparation, dragging project's attention towards technical enhancements that are essential in construction field by raising material comfort levels in the infrastructure world. River sand as one of the ingredient of mix preparation consuming normal materials, depress the water table, Constructions will adjust down, attrition banks of river and enhanced costs for disposal searching for an alternative to normal sand. One among is replacing with crushed glass for preparation of mix to use in different purposes. Concrete with Crystal glass form in structure is robust and harmless. One of the sustainable expansions in construction area is unused crumpled glass in the form of totals in mix. The utilization of shattered glass as substitute for totals is very much attracted so many investigators waste cut-glass substantial as substitute for aggregate decreases fascination of water, shrinkage changes, and more resistance to scratch. Exceptional assets of cut-glass made utilization of unused glass in mix preparation. In general, ASR (Alkali Silica Reaction) enlargement drops with decrease in crystal size of glass total. Utilization of Creased glass in building decreases municipal solid unused putting in open lands. LCD panes are fetching major utilization ones in TVs, PCs, android phones, cameras, etc. as they are slim, less power consumption, and lightweight. Boundaries for glass remanufacturing challenging for reproduction of glass from waste glass. As glass remanufacturing is challenging, during categorization protective measures are to be taken, during sorting as it has composite materials and contaminants which are not viable technically. Generally, waste crushed glass (WCG) increases the confrontation in contrast to chloride diffusion of concrete which gives more advantage in shielding the RCC exposed to seawater and melting salts. There by the reinforcement in the concrete will be endangered from the consequence of rusting. Cut-glass practice also alters unexploited to useful product, decreases conveyance cost as it is available locally from solid waste. As discarded glass in concrete is reducing water captivation and contraction, resistance against scratching will be increased.

2. LITERATURE REVIEW

V. Gokulnath , B. Ramesh, K. Priyadharsan (2019) They have concluded that usage of unused Glass Powder and additional fibers are like steel yarns, glass filaments, polypropylene, Industrial wastes like fly ash and silica fume getting as increasing strengths. They concentrated on mechanical characteristics and fresh characteristics with respect to own-consolidated concrete with altered grades concrete by addition of fibers of various percentage. They did workability and hardened tests on mix of SCC. By adding fibers in concrete strength gained slightly when comparing to conventional concrete. Concrete is effective with Machine-sand and adding of glass powder in SCC and cured 7, 28, 56 & 90 days in enhance the strength. The comparison for manufacturing-sand and river-sand was also done. By addition cutglass powder and other fibers in self-compacting concrete with cumulative percentage the Bending, compressive and ductile strength enhancement was observed. It evades fissures bounces performance and upsurges fresh properties of mix.

Mohammed Seddik Meddah (2019) From the outcomes of this study, on the physical parameters of the crumpled glass aggregate resulting from the unused glass are appropriate as a fine aggregate for concrete manufacture in terms of profile, dimension, gradation and relative density. While flaky grain form of crumpled glass may have effect on the fresh properties of concrete but it was extremely beneficial in strength enhancement. The presence of powdered glass as a fractional substitute for ordinary sand has resulted in a small reduction in strength in compression, tension, and flexure. Concrete’s Permeability and water absorption with varying glass aggregate quantities have somewhat augmented as equated to the standard mix.

M.K. Sharbatdar, A. Kavyani , H. Dabiri , M. Baghdadi (2018) In this studyto assess result by substituting filler material with unused cut-glass element in concrete, 27 samples were primed and verified, compressive strength and weight of samples were studied. Inference from this study is that with unused glass element in its place of sand in concrete combination containing Micro silica, upsurge the compressive strength of concrete. The strength in compression increases as the fraction of glass element increases.The optimal fraction of glass element used in this research was 50%. As stated earlier, the only worry of concretewith waste glass is ASR taht might be prohibited by addition Micro silica in concrete. Furthermore on the basis of outcomes addition of Micro silica in concrete combination upsurge the strength of concrete in compression. Substituting sand with unused glass particle does not affect the mass of concrete. The dead load due to concrete construction does not alter by using waste glass particle.

A. W. Otunyo,and B. N. Okechukwu (2017) The authors observed Strength of the concrete in compression at 7 and 28 days improved as the WG standby rate amplified to extreme readings at 15% additional. This indicates that best proportion of fine aggregate containing WG happened at 15% standby rate. The strength of concrete in flexure varied as fraction additional of WG augmented. The authors suggested that more research be should done in this area. Beyond 15% WG substitution level, WG as fine aggregate had negative effect on the growth of strength of concrete in compression. As the proportion of WG increased up to 15% standby rate, the initial and final setting times reduced. This approves that fine WG aggregate can be used as a concrete retarder up to a 15% substitution rate. The water captivation reduced as the WG fraction amplified. The study's outcomes normally indicated that fractional fine aggregate standby with WG is cost-effective. Because the amount of costly sand may be decreased to a 15% spare rate, and because WG is commonly discarded and could be found for less or no price in contrast to sand, the cost of producing concrete could be comparatively cheap employing this waste. Since WG (non-biodegradable) is often a problem to dispose of, using it in concrete will result in long-term environmental protection.

Kamel et al (2009), studied the effects of using stone cutting waste on the compressive strength and slump characteristics and concluded that the slurry sludge generating from stone cutting may be used for concrete up to 25% of total volume of water required for producing the concrete.

Bahar Demirel (2010), conducted the experimentation on concrete. During production of concrete waste marble dust as fine sand was used. The marble dust was mixed in the proportions of 0, 25, 50 and 100%. Compressive strength, Ultra pulse velocity, Dynamic modulus of elasticity tests were conducted. Addition of waste marble dust passing though 0.25mm sieve, showed enhancing of strength results.

Marmol et al (2010), examined the use of granite sludge waste in production colored cement based mortars. He reported the use of granite sludge was as replacement to cement up to 10% will not affect the strength characteristics.

Ali Ergun (2011), was studied the usage of diatomite and marble waste powder as the partial replacement of the cement on the mechanical properties of concrete. The results are revealed that, 10 percent Diatomite and percent of waste marble powder as replace to the cement is having good compressive strength.

BabooRai et al (2011), studied the effect of using powdered and granules of marble as fines in mortar or concrete by partially reducing cement and other filler materials to improve fresh and durability characteristics.

Hebhoud et al (2011), conducted the experimental work on concrete with the marble aggregate as coarse aggregate. The results showed that use of marble aggregate up to 70% of any formulation is beneficial for the concrete resistance.

3. PROPOSED SYSTEM

The proposed system focuses on developing green concrete by incorporating waste glass powder (GW) and marble waste (MW) as partial replacements for fine and coarse aggregates, respectively. This system aims to enhance workability, compressive strength, and tensile strength while promoting sustainability in the construction industry. The research is structured into key phases:

1. Selection and Processing of Materials

- Cement: Ordinary Portland Cement (OPC) is used as the primary binding material.
- Fine Aggregate Replacement: Waste glass powder is ground to a fine consistency and used as a partial substitute (0–50%) for natural sand.
- Coarse Aggregate Replacement: Waste marble chips are crushed and used as a 30% replacement for conventional coarse aggregates.
- Water and Admixtures: Clean potable water and necessary admixtures are used to maintain the desired consistency and workability.

2. Concrete Mix Design

- The concrete mix is designed for M40 grade as the reference concrete.
- Different mix proportions are tested by varying glass powder content (0%, 10%, 20%, 30%, 40%, and 50%), while keeping 30% marble waste constant.
- Standard mix design guidelines are followed to ensure strength and durability.

3. Testing and Analysis

- Workability Test: Slump tests are conducted to analyze the flowability and consistency of the concrete mix.
- Compressive Strength Test: Cube specimens (15cm x 15cm x 15cm) are cast and tested at 7, 14, and 28 days to measure the load-bearing capacity.
- Tensile Strength Test: Cylindrical specimens (300mm height x 150mm diameter) are tested to determine split tensile strength at 28 days.
- Durability Assessment: Additional tests for water absorption and resistance to environmental factors can be conducted to evaluate long-term performance.

4. Performance Evaluation and Optimization

- The test results are analyzed to determine the optimal mix proportion for achieving the best strength, workability, and durability.
- The most effective replacement ratio is found to be 30% glass powder – 30% marble waste (GW-MW), which provides the highest compressive and tensile strength.
- Comparative analysis with conventional concrete ensures that the modified mix meets or exceeds industry standards.

5. Implementation and Sustainability Benefits

- Cost Reduction: Utilizing industrial waste as aggregate replacements reduces reliance on natural resources, lowering material costs.
- Environmental Impact: Reusing waste materials helps in waste management, reducing landfill accumulation and promoting sustainable practices.
- Practical Applications: The optimized concrete mix can be used for structural components, pavements, and eco-friendly construction projects.

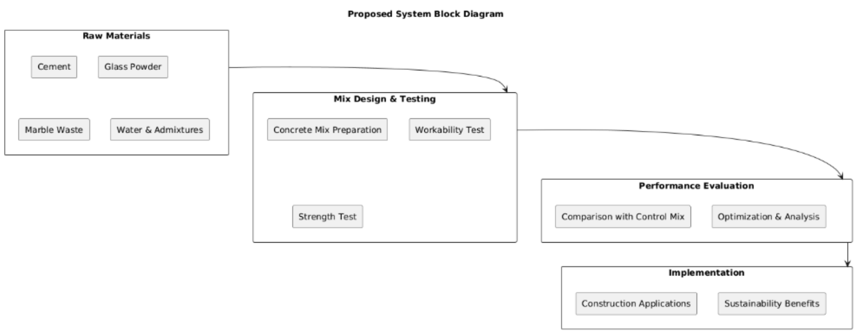

Figure 1 Presents the Block Diagram of Proposed System.

4. RESULTS AND DISCUSSIONS

The Slump test was performed on the Glass powder – marble waste based concrete to check the workability of it at different replacements. According to which it can be concluded that with the increase in % of Glass powder – marble waste from M0 to M6, workability increases. The results obtained for Slump test are shown below in Table 4.1.

Table 4.1: Results of Slump test

Mix No.	MW - GW	Slump (mm)
M0	0 – 0	102
M1	30 - 0	104
M2	30 – 10	107
M3	30 – 20	109
M4	30 – 30	112
M5	30 - 40	116
M6	30 - 50	120

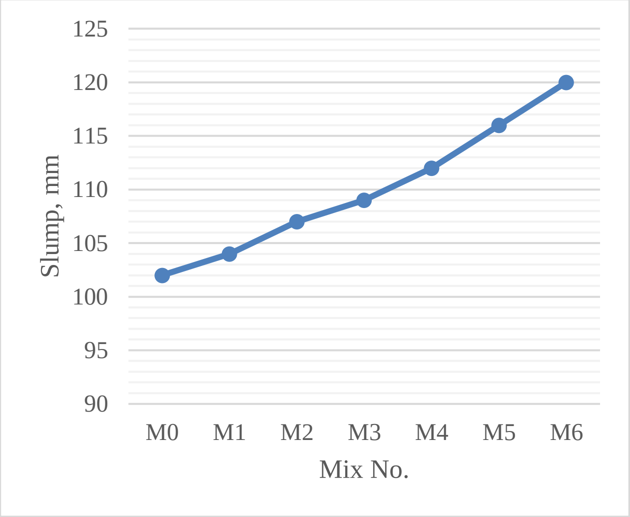

Fig 4.1: Slump test results

The above figure 4.1 shows the slump results. It was observed that, the slumps increased from M0 to M6 mix with increased GW – MW in the mix. It was varied from Medium Workability to High workability.

4.2 Harden properties of concrete

The compressive strength test was performed on the cubes of size 15 cm x 15 cm x 15 cm to check the compressive strength of GW – MW based concrete and the results obtained are given in Table 4.2.

Table 4.2: Results of compressive strength test

Mix No	RHA % - FLYASH %	Compressive strength of cubes (N/mm^2)		
		7 days	14 days	28 days

M0	0 – 0	26	38	41.9
M1	30 - 0	27.28	40	44
M2	30 – 10	28	41.2	45.3
M3	30 – 20	29.16	42.7	47
M4	30 – 30	31	43.8	49.2
M5	30 - 40	27.4	40.2	44.2
M6	30 - 50	26.5	38.5	42.4

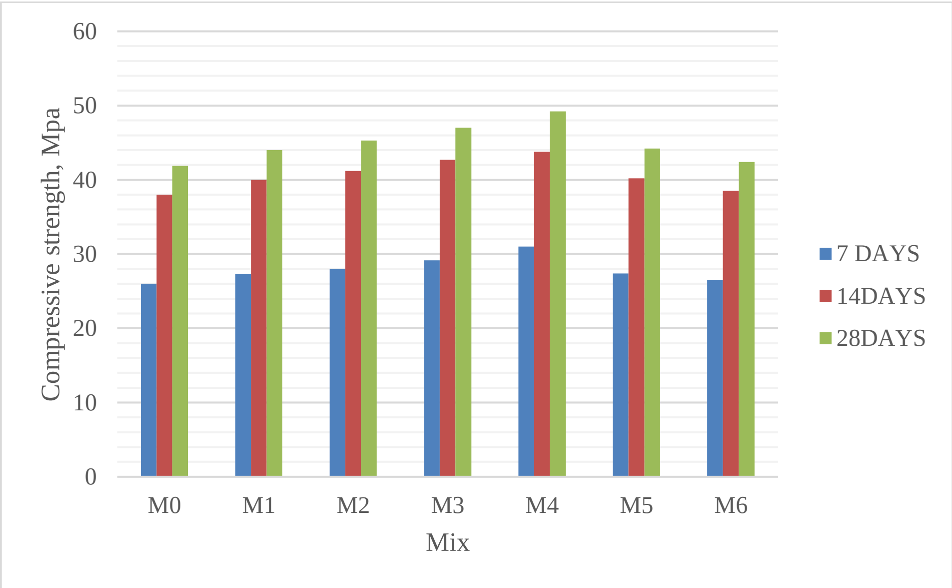

Fig 4.2: 7days Compressive strength test result graph

From the above results it was observed that with the increase in percentage of GW – MW from M1 to M6 in concrete the compressive strength more than control mix M0. The maximum compressive strength gained for 30% marble waste replacing with coarse aggregate and 30% glass waste replacing with fine aggregate of concrete. The optimum dosage suggested from this study was 30% GW – 30% MW.

4.3 Tensile Strength Test

The Tensile test was performed on the beams of size 300mm height x 150 diameter mm to check the Tensile strength of the concrete and the results obtained while performing the Tensile test on CTM are given in Table 4.3.

Table 4.3: Result of Tensile strength

Mix No	RHA % - FLYASH %	Tensile Strength for 28 days (N/mm^2)
M0	0 – 0	4.94
M1	30 - 0	5.19

M2	30 – 10	5.34
M3	30 – 20	5.52
M4	30 – 30	5.67
M5	30 - 40	5.2
M6	30 - 50	5.0

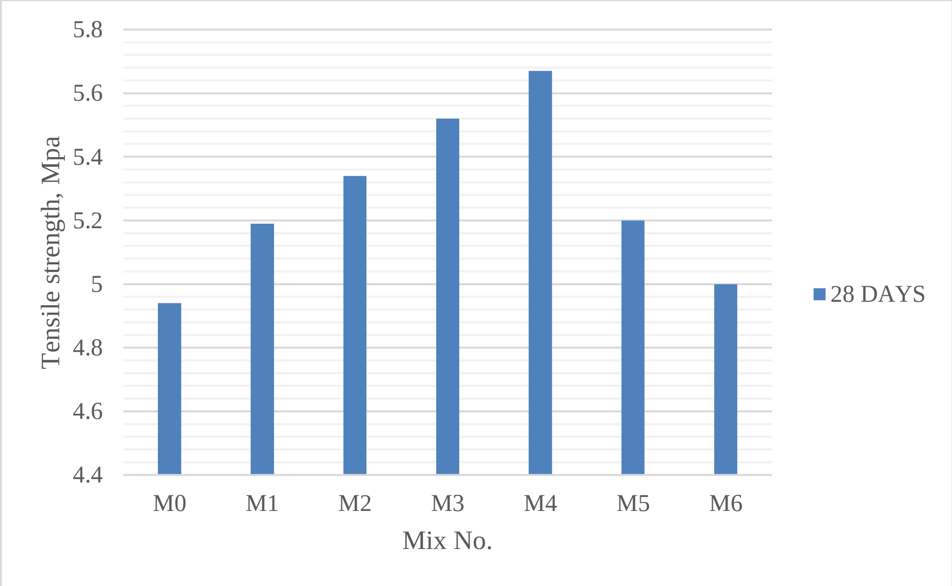

Fig 4.4: Tensile strength graph

From the above results it was observed that with the increase in percentage of GW – MW from M1 to M6 in concrete the tensile strength more than the control mix M0. The maximum Cylinder tensile strength gained for 30% marble waste replacing with coarse aggregate and 30% glass waste replacing with fine aggregate of concrete. The optimum dosage suggested from this study was 30% GW – 30% MW.

5. CONCLUSIONS

The Aimed to evaluate the effects of glass waste (0–50%) and marble waste (30%) as partial replacements for fine and coarse aggregates in concrete. Based on the results, several key conclusions can be drawn regarding the workability, strength, and overall benefits of using these waste materials in construction. One of the most notable findings was the improvement in workability when glass and marble waste were used in the mix. The smooth surface texture of these materials allowed for better flow and easier handling compared to conventional concrete. This makes the modified mix more practical and efficient for construction applications. Apart from structural benefits, this research highlights economic and environmental advantages. Using glass and marble waste in concrete helps reduce construction costs by lowering the demand for natural aggregates. At the same time, it addresses the growing issue of industrial waste disposal, promoting a more sustainable approach to construction. Overall, this study demonstrates that green concrete can be both strong and eco-friendly, paving the way for a more sustainable future in the building industry.

REFERENCES

[1] Aman Roy Patil Assess the Appearance of Concrete by using Waste Glass as Aggregate Volume 6 Issue6 June 2019

[2] T O Ogundairo et al. "Sustainable use of recycled waste glass as an alternative Material for building construction "Conference Series Materials Science and Engineering -NOV 2019

[3] Mohammed Seddik –"Properties of glass concrete" Conference Series: Materials Science and Engineering

[4] H. Dabiri et.el "The Influence of Replacing Sand with Waste Glass Particle on the Physical and Mechanical Parameters of Concrete" civil engineering journal AUG-2018

[5] M. Adaway& Y. Wang " Recycled glass as a partial replacement for fine aggregate in structural concrete – Effects on compressive strength" Ejse/International Special Issue: Electronic Journal of Structural Engineering 14(1) 2015.

[6] Bhupendra Singh Shekhawat et al "Utilisation of Waste Glass Powder in Concrete A Literature Review " International Journal of Innovative Research in Science, Engineering and Technology An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 7, July 2014.

[7] T. S. Serniabat "Use of Waste Glass as Coarse Aggregate in Concrete" A Possibility towards Sustainable Building Construction World Academy of Science, Engineering and Technology International Journal of Civil, Structural, Construction and Architectural Engineering Vol:8, No:10, 2014.

[8] Sadoon Abdallah et al "Characteristics of concrete with waste glass as fine aggregate replacement International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-2, Issue-6, June 2014

[9] Yasser Sharifi et al. "Recycled glass replacement as fine aggregate in selfcompacting concrete" Frontiers of structural and civil engineering Volume 7, Issue 4, pp 419–428 December 2013

[10] Dr. Zubaidah Abdullateef "Mechanical Properties And Behaviour of Sustainable concrete"-Journal of Engineering and Development- ISSN: 1813- 7822 volume:17 2013