

Sustainable Concrete: Utilization of Glass and Sawdust Waste in Composite Materials

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Abstract- This study investigates the feasibility of using research and development (R&D) waste and industrial by-products as substitute materials in concrete composites. With the demolition of many historic structures due to damage and deterioration, a significant amount of debris is classified as construction waste. Additionally, the construction of new buildings generates a considerable volume of solid waste—approximately 25% from existing structures and 75% from new construction activities annually.

In this research, glass waste generated from demolition and food packaging was utilized due to its pozzolanic properties, making it a viable partial replacement for cement. The waste glass was crushed into a fine powder with physical characteristics similar to cement. Alongside this, other industrial wastes such as silica dust, industrial sand, crushed glass, recycled waste, and sawdust—commonly found in urban settings—were considered. However, due to inadequate recycling infrastructure and stringent environmental regulations, much of this waste remains underutilized.

The paper presents experimental results evaluating the potential of sawdust and finely crushed glass as partial replacements for conventional fine and coarse aggregates in concrete. Field trials were conducted, and compressive strength was tested at curing periods of 7 and 28 days. The findings contribute to sustainable construction practices by promoting the reuse of industrial and construction waste in concrete production.

Keywords- Cement, Waste Material, Sand, Concrete, Compressive Strength, Silica, Dust, Broken Glass, Constructional.

I. INTRODUCTION

The solid waste problem is one of the most serious environmental and social challenges in any country. In this city, solid waste and waste of cement and other materials are not properly recycled and are dumped in landfills. In addition, rapid building development quickly destroys natural resources, especially when beach sand is used as a fine and tough aggregate [1]. Therefore, using constructional and deterioration waste as a recycling material for conventional computers is a good option for this situation [6]. In this study, only sawdust made from building materials and sawdust was used to replace the accessible parts. The feasibility of employing construction and demolition waste materials in concrete composites as a partial substitute for raw

materials is investigated in this study. Numerous historic buildings are being demolished to address deterioration and cracks, and the debris generated from these buildings called demolition waste. Construction trash is generated during the construction of new buildings about 25% of solid waste is generated annually by existing buildings and 75% by new construction projects. Small pieces of crushed material commonly used in applications such as flooring systems, packaging, light parts and kitchen cabinets are reduced to dust and replaced with fine aggregates. Wood chips absorb more water than fine aggregate. The replacement of different types of free goat and natural resources allows you to determine the actual strength of the material after hardening, the mach inability of the finished material and many other physical properties of the material.

II. USED MATERIALS IN MIX OF CONCRETE

- Cement
- Natural Coarse Aggregate (NCA)
- Natural Fine Aggregate (NFA)
- Coarse Glass Pieces (CGP)
- Crush Concrete Powder (CCP)
- Admixture
- Water

III. MIX DESIGN OF PREPARED FOR ANALYSIS

An M-25 grade compactor is used for this job. Replace the cement with 0%, 4%, 8% and 16% cement powder. The totals were replaced by 0%, 4%, 8% and 16% glasses. FA is replaced with 0%, 4%, 8% and 16% sawdust. There are two types of tests: working time and treatment time.

Here, CCP=Crushed Concrete Powder, CGP=Coarse Glass Pieces

Table 1: Mix samples for Testing Cement with CCP

No. of Mix	CCP	Cement
Mix-4	0%	100%
Mix-B	4%	96%
Mix-C	8%	92%
Mix-D	16%	84%

Table 2: Mix samples for Testing Coarse Aggregate with CGP

No. of Mix	CGP	Aggregate
Mix-I	0%	100%
Mix-II	4%	96%
Mix-III	8%	92%
Mix-IV	16%	84%

Table 3: Mix of M30 Concrete 0% substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

No. of Mix	CCP	CGP	Saw Dust
Standard	0%	0%	0%
Mix-1	0%	4%	4%

Mix-2	0%	8%	8%
Mix-3	0%	16%	16%

Table 4: Mix of M30 Concrete 4% substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

No. of Mix	CCP	CGP	Saw Dust
Mix-1	4%	0%	0%
Mix-2	4%	4%	4%
Mix-3	4%	8%	8%
Mix-4	4%	16%	16%

Table 5: Mix of M30 Concrete 8% substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

No. of Mix	CCP	CGP	Saw Dust
Mix-1	8%	0%	0%
Mix-2	8%	4%	4%
Mix-3	8%	8%	8%
Mix-4	8%	16%	16%

Table 6: Mix of M30 Concrete 16% substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

No. of Mix	CCP	CGP	Saw Dust
Mix-1	16%	0%	0%
Mix-2	16%	4%	4%
Mix-3	16%	8%	8%
Mix-4	16%	16%	16%

IV. RESULT & DISCUSSION

A. Results of Cement Test

Table 7: Consistency Test Due to Varying % of Cement Replaced with Crushed Concrete Power

No. of Mix	CCP	Cement	Consistency %
Mix-A	0%	100%	30.51
Mix-B	4%	96%	32.64
Mix-C	8%	92%	34.02
Mix-D	16%	84%	35.36

Table 8: Initial and Final Setting Time of Cement due to Varying % of Cement Replaced with Crushed Concrete Power (CCP)

No. of Mix	CCP	Cement	IST (min.)	FST (min.)
Mix-4	0%	100%	32	603
Mix-B	4%	96%	31	608
Mix-C	8%	92%	33	612
Mix-D	16%	84%	34	616

B. Results of Aggregate Test

Table 9: Impact, Crushing and Abrasion test due to varying % of Aggregate replaced with Crushed Glass power (CGP)

No. of Mix	CCP	Cement	Impact %	Crushing %	Abrasion %
Mix-I	0%	100%	22.63	28.56	31
Mix-II	4%	96%	27.06	25.48	33
Mix-III	8%	92%	28.94	24.39	34
Mix-IV	16%	84%	30.59	23.32	35

C. Results of Concrete Test

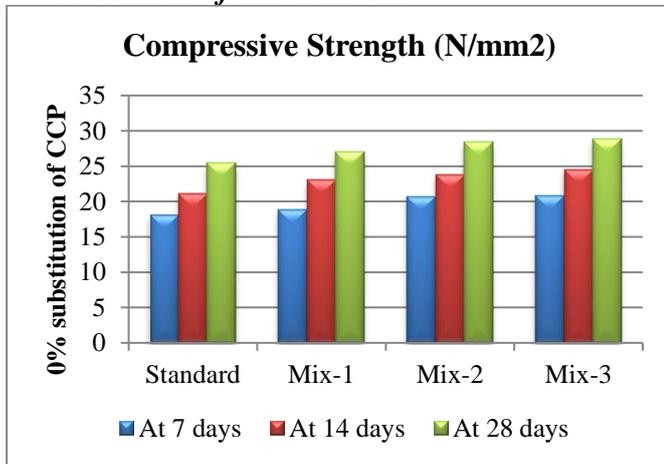


Fig. 1: Concrete Compressive Strength Test at 7, 14 & 28 days Due to 0% Substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

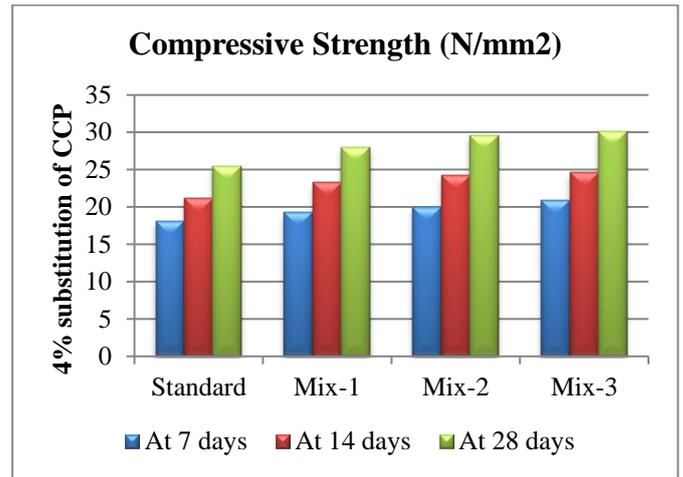


Fig. 2: Concrete Compressive Strength Test at 7, 14 & 28 days Due to 4% Substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

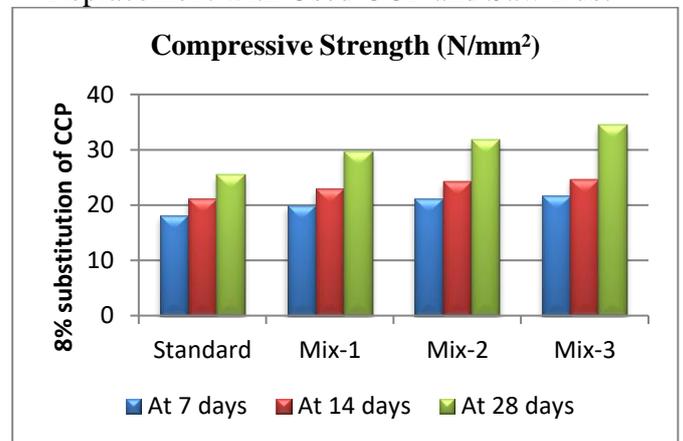


Fig. 3: Concrete Compressive Strength Test at 7, 14 & 28 days Due to 8% Substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

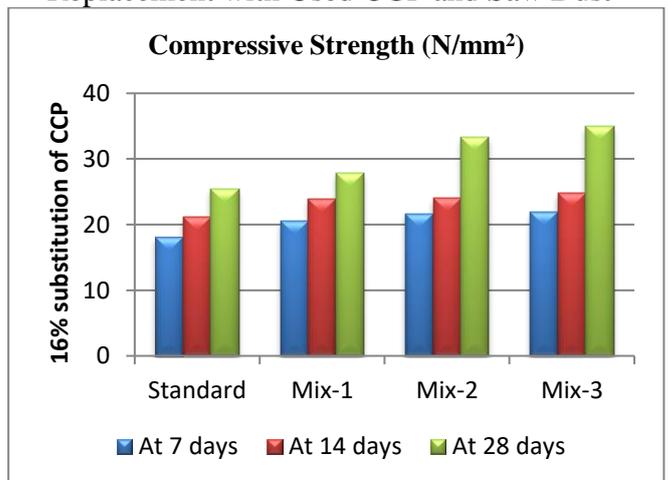


Fig. 3: Concrete Compressive Strength Test at 7, 14 & 28 days Due to 0% Substitution of Cement with CCP and Varying % of Aggregate Replacement with Used CGP and Saw Dust

V. CONCLUSION

- Consistency test value of cement due to varying % of cement replaced with Crushed concrete power (CCP) is 30.51% occurs minimum in (mix-A) but after that as increase as percentage of Crushed concrete power (CCP).
- Initial setting time of cement due to varying % of cement replaced with Crushed concrete power (CCP) is 31(min.) occurs minimum in (mix-B) but after that as increase as percentage of Crushed concrete power (CCP).
- Final setting time of cement due to varying % of cement replaced with Crushed concrete power (CCP) is 603(min.) occurs minimum in (mix-A) but after that as increase as percentage of Crushed concrete power (CCP).
- Impact test value of Aggregate due to varying % of Aggregate replaced with Crushed Glass power (CGP) is 22.63% occurs minimum in (mix-I) but after that as increase as percentage of Crushed Glass power (CGP).
- Crushing test value of Aggregate due to varying % of Aggregate replaced with Crushed Glass power (CGP) is 23.32% occurs minimum in (mix-IV) but after that as decrease as percentage of Crushed Glass power (CGP).
- Abrasion test value of Aggregate due to varying % of Aggregate replaced with Crushed Glass power (CGP) is 31% occurs minimum in (mix-I) but after that as increase as percentage of Crushed Glass power (CGP).
- Maximum value of slump for 0% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust occurs 121mm in mix-1 after addition of Used CGP and saw dust this will reduced to 118mm in mix-3.
- Maximum value of slump for 4% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust occurs 119mm in mix-1 after addition of Used CGP and saw dust this will reduced to 117mm in mix-3.
- Maximum value of slump for 8% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust occurs 118mm in mix-1 after addition of Used CGP and saw dust this will reduced to 115mm in mix-3.
- Maximum value of slump for 16% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust occurs 117mm in mix-1 after addition of Used CGP and saw dust this will reduced to 115mm in mix-3.
- Maximum value of Compressive Strength at 7days for 0% substitution of Cement with CCP and Varying % of aggregate replacement with Used CGP and saw dust compressive strength is 20.88N/mm² in mix-3 and minimum compressive strength is occurs 18.80N/mm² in mix-1.
- Maximum value of Compressive Strength at 14days for 0% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 24.53N/mm² in mix-3 and minimum compressive strength is occurs 23.06N/mm² in mix-1.
- Maximum value of Compressive Strength at 28days for 0% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 28.86N/mm² in mix-3 and minimum compressive strength is occurs 27.07N/mm² in mix-1.
- Maximum value of Compressive Strength at 7days for 4% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 20.87N/mm² in

mix-3 and minimum compressive strength is occurs 19.26N/mm² in mix-1.

- Maximum value of Compressive Strength at 14days for 4% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 24.63N/mm² in mix-3 and minimum compressive strength is 23.31N/mm² in mix-1.
- Maximum value of Compressive Strength at 28days for 4% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 30.12N/mm² in mix-3 and minimum compressive strength is 27.94N/mm² in mix-1.
- Maximum value of Compressive Strength at 7days for 8% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 21.62N/mm² in mix-3 and minimum compressive strength is occurs 19.84N/mm² in mix-1.
- Maximum value of Compressive Strength at 14days for 8% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 24.66N/mm² in mix-3 and minimum compressive strength is occurs 22.88N/mm² in mix-1.
- Maximum value of Compressive Strength at 28days for 8% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 34.52N/mm² in mix-3 and minimum compressive strength is occurs 29.68N/mm² in mix-1.
- Maximum value of Compressive Strength at 7days for 16% substitution of Cement with CCP and Varying % of Aggregate replacement with Used CGP and saw dust compressive strength is 21.91N/mm² in mix-3 and minimum compressive strength is occurs 20.53N/mm² in mix-1.
- Maximum value of Compressive Strength at 14days for 16% substitution of Cement with CCP and Varying % of Aggregate

replacement with Used CGP and saw dust compressive strength is 24.78N/mm² in mix-3 and minimum compressive strength is occurs 23.87N/mm² in mix-1.

- Maximum value of Compressive Strength at 28days for 16% substitution of Cement with CCP and Varying % of aggregate replacement with Used CGP and saw dust, compressive strength is compressive strength is occurs 34.97N/mm² in mix-3 and minimum compressive strength is occurs 27.91N/mm² in mix-1.

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