Eco – Friendly Building Practices: Incorporating Construction and Demolition Waste as Coarse Aggregates for Sustainable Construction in Building Units

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Abstract - *This study presents a comprehensive study on the utilization of construction and demolition (C&D) waste in building units as a replacement for coarse aggregates at varying percentages (0%, 25%, 50%, 75%, and 100%). The research focuses on evaluating the Compression strength and water absorption test values and environmental impact of the resulting materials. Various mixes were prepared, and physical and mechanical tests were conducted to assess the feasibility and effectiveness of incorporating C&D waste at different replacement levels. The findings provide insights into the optimal percentage of C&D waste replacement, highlighting the potential for sustainable construction practices and resource efficiency in building material production. This study contributes to the ongoing discourse on eco-friendly construction solutions and waste minimization strategies.*

Key Words: *recycled aggregates, Construction and demolition waste, Building Units*

1. INTRODUCTION

The increasing volume of construction and demolition (C&D) waste poses a significant environmental challenge, necessitating innovative approaches to mitigate its impact. This introduction explores the potential of C&D waste utilization in building units, aiming to transform this waste stream into a valuable resource for sustainable construction practices. As urbanization accelerates, so does the generation of C&D waste, comprising concrete, bricks, wood, and other materials. Traditional disposal methods contribute to environmental degradation and resource depletion.

In response, researchers and practitioners are turning their attention to the prospect of repurposing C&D waste in the construction industry. By considering C&D waste as a resource rather than mere refuse, there emerges an opportunity to address two critical issues concurrently: the reduction of waste in landfills and the demand for raw materials in construction. This paradigm shift aligns with the principles of the circular economy, emphasizing the reuse and recycling of materials to minimize environmental impact.

1.1 OBJECTIVES

- The primary objective of this study is to ascertain the optimal percentage of recycled aggregates, specifically at replacement levels of 0%, 25%, 50%, 75% and 100%, in the production of building units.
- This investigation seeks to undertake a comprehensive assessment of the strength and durability parameters inherent in the prepared building units.
- Examine the cost-effectiveness of blocks made from construction and demolition waste (CDW) aggregates in comparison to conventional blocks.

1.2 MATERIALS

A. Cement: Portland Pozzolonic Cement (P.P.C.) according to IS 1489 (PART1): 1991 is used and obtained from local market.

B. C and D waste: as coarse aggregate 20 mm down size according to IS code.

C. Coarse aggregate: 10 mm down size according to IS code.

D. Water: Potable water.

1.2 METHODOLOGY

- Procurement of materials required for study.
- Characterization of materials for physical, properties by performing laboratory tests.
- Mixing the materials with varying percentage i.e., 0%, 25%, 50%, 75%, 100% of recycled aggregate as a replacement of coarse aggregate in concrete bricks and previous paver blocks.
- Preparing the test specimens.

- Curing the specimens for 28 days.
- Study the influence of variation in percentage of recycled aggregate as coarse aggregate on engineering characteristics i.e. Compressive Strength test and water absorption test.
- Identifying the optimum percentage of recycled aggregate as a replacement of coarse aggregate for manufacturing of concrete bricks and permeable paver blocks.

2. MATERIAL CALCULATION

2.1 Concrete bricks

Figure 1: Moulded Concrete bricks

For 1 concrete brick, amount of materials required are calculated according to the mix ratio 1:4:5

Brick Size =101.6x203.2x406.4mm=0.00839mm^3

Materials required per Brick

1/10*0.00839=0.000839*1440=1.280 kg (cement)

4/10*0.00839=0.003556*1600=5.36kg (fine aggregate)

5/10*0.00839=0.004195*1800=7.55kg (coarse aggregate)

Table 1: Material Calculations for Concrete bricks

Sl No	Mix Ratio	Cement (kg)	Fine aggregate(kg)	Coarse aggregate (kg)	Recycled aggregate (kg)
1	0%	1.280	5.36	7.5	0
2	25%	1.280	5.36	5.66	1.887
3	50%	1.280	5.36	3.8	3.775
4	75%	1.280	5.36	1.887	5.663
5	100%	1.280	5.36	0	7.5

2.1 Permeable paver blocks

Bricks Size =115.5*60mm = 0.006930mm3

Cement = 1/6*0.00693 = 0.001155*1440=1.6632kg

30% Cement replaced by GGBS = 30/100*1.6632 = 0.495kg

= 1.6632 - 0.495, Cement = 1.1682kg

Coarse Aggregate = 6/7*0.006930=0.00594*1800=10.692kg

Table 2: Material Calculations for permeable paver blocks

Sl No	Mix Ratio	Cement (kg)	GGBS (kg)	Coarse aggregate (kg)	Recycled aggregate (kg)
1	0%	1.168	0.495	10.692	0
2	25%	1.168	0.495	8.019	2.673
3	50%	1.168	0.495	5.346	5.346
4	75%	1.168	0.495	2.673	8.019
5	100%	1.168	0.495	0	10.692

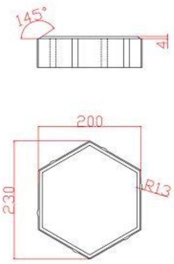

Figure 2: Hexagonal shape Paver blocks

Figure 3: Previous Paver blocks

3. EXPERIMENTAL WORK

3.1 Physical properties of aggregates

Table 3: Physical properties of aggregates

Property	Standard	virgin		Recycled Coarse aggregates
		Fine aggregate	Coarse aggregate	
Absorption (%)	ASTM C127-C128	2.3	0.9	6.2
Fineness modulus	ASTM C136	3	–	–

Los Angeles abrasion (%)	ASTM C131	–	33	52.3
Moisture content (%)	ASTM C	0.89	0.94	0.78
Bulk specific gravity (gr/cm3)	ASTM C127-C128	2.60	2.64	2.02
Apparent specific gravity (gr/cm3)	ASTM C127-C128	2.74	2.72	2.20

3.2 Compressive Strength test on Concrete bricks

A total of 55 number of bricks of size 4 x 8 x 16 inches were casted and tested for 7, 14, 21 and 28 days. The test results are tabulated.

Figure 4: Compressive Strength test

Table 4: Compressive Strength test results of Concrete bricks for different mix ratios

Mix ratio	Compressive Strength in MPa			
	7 days	14 days	21 days	28 days
0%	3.4	5.525	7.65	8.5
25%	2.92	4.745	6.57	7.3
50%	2.84	4.615	6.39	7.1
75%	2.76	4.485	6.21	6.9
100%	2.68	4.355	6.03	6.7

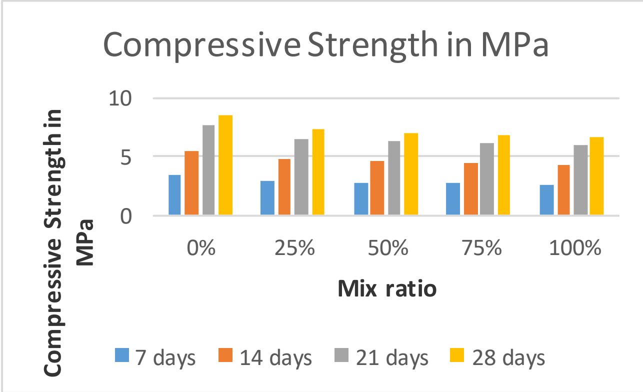

Chart 1: Compressive Strength test results in MPa

Table 5: Water Absorption test on Concrete bricks

Mix ratio	Water absorption in %
0%	2.9
25%	4.2
50%	4.8
75%	5.18
100%	5.44

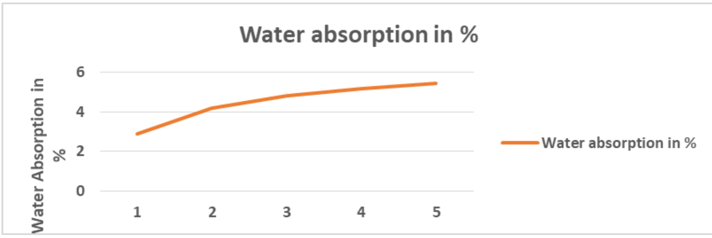

Figure 5: Water absorption test result in %

3.3 Compressive Strength test on paver blocks

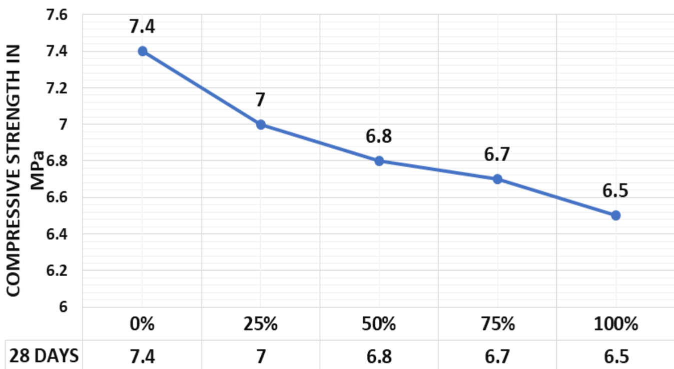

Chart 2: Compressive Strength test results in MPa

4. CONCLUSIONS

The following conclusions are made based on the experimental investigations on compressive strength and water absorption test, also by considering the-environmental aspects:

1. With the increase in percentage of construction and demolition waste (CDW) the compressive strength of concrete bricks and pervious paver blocks decreased and percentage of water absorption increased hence the optimum percentage of CDW can replaced with coarse aggregate from strength and durability point of view was found to be 50%.

2. With 100% replacement of coarse aggregate with CDW, Compressive strength of concrete bricks was found to be in the range of 6MPa and water absorption percentage was found in the range of 5% and such bricks can be utilized for non-load bearing walls.

3. Usage of recycled concrete aggregate can not only preserve the finite raw material, but also reduce energy consumption and overall construction cost.

4. Use of Demolished waste aggregate in the concrete as the recycled aggregate reduces the environmental pollution as well as providing economic value for the waste material.

5. Even it reduces self-weight of the bricks by around 10 to 12%.

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