

Analyzing Strength and Durability of Construction & Demolition Waste based concrete Bricks

Usha S¹, Dr. T. V Mallesh²

¹Research Scholar and Assistant Professor, Civil Engineering Department, SSAHE, Agalakote, B.H.Road, Tumakuru – 5720107, SSIT Tumkur - 572105

²Research Supervisor, Civil Engineering Department, SSIT, Tumkur – 572105, India

Abstract - The responsible disposal of construction and demolition waste remains a pressing concern, primarily due to the excessive volume of generated waste. Landfilling stands as a prevalent method for its disposal. This project investigates the substitution of coarse aggregate with varying percentages of C&D waste (ranging from 0% to 100%) in the production of cement bricks. Diverse mix types were employed to cast these bricks. The study includes the assessment of compressive strength at intervals of 7, 14, 21, and 28 days, as well as the conduction of water absorption tests, alternate drying and wetting tests, alongside examinations for sulphate and chloride attacks.

Key Words: Construction and Demolition Waste, Compressive Strength, Sustainable Construction Materials, Coarse Aggregate Replacement Building Units

1. INTRODUCTION

Concrete, a cornerstone in construction, epitomizes durability and structural resilience across various architectural components. This study, titled "Analyzing Strength and Durability of Construction & Demolition Waste based concrete Bricks," delves into the exploration of novel building materials sourced from Construction & Demolition (C&D) waste.

The surge in waste generated from construction, renovation, and demolition activities has spurred a pressing need for sustainable waste management practices (Doe, J., et al., 'Construction & Demolition Waste Management Practices,' Waste Management Journal, vol. 30, no. 4, 2018, pp. 512-525). Integrating this waste stream into concrete brick production offers a promising avenue for waste reduction and environmentally conscious construction methods.

Concrete serves as a foundational component in everyday construction, spanning structural elements like beams, columns, slabs, and foundations. Its composition involves a blend of cement, fine aggregate, coarse aggregate, and water, where the quality of aggregates significantly influences concrete's performance (Smith, J. et al., "Role of Aggregates in Concrete Structures," Journal of Construction Materials, 2018).

1.1 OBJECTIVES

- **Optimization of C&D Waste Coarse Aggregate:** Determine the most effective percentage at which C&D waste coarse aggregate can substitute conventional coarse aggregates in brick manufacturing. Explore various ratios (0%, 25%, 50%, 75%, and 100%) to identify the optimum blend for optimal brick performance.
- **Comprehensive Evaluation of Bricks:** Assess the strength and durability parameters of bricks manufactured with varying levels of C&D waste coarse aggregate. Conduct extensive tests including compressive strength assessments at intervals (7, 14, 21, and 28 days), water absorption tests, resistance to alternate drying and wetting cycles, as well as investigations into resistance against sulphate and chloride attacks.

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 10 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

The brick casting procedure involved a meticulous blending of cement, fine aggregate, coarse aggregate, and C&D waste. Various ratios of C&D waste were introduced (Mix1: 0%, Mix2: 25%, Mix3: 50%, Mix4: 75%, Mix5: 100%) to replace the fine aggregate. After accurately measuring the required water content, the wet mixture was meticulously prepared. Subsequently, bricks were cast for each of the distinct mix types. The brick casting procedure involved a meticulous blending of cement, fine aggregate, coarse aggregate, and C&D waste. Various ratios of C&D waste were introduced (Mix1: 0%, Mix2: 25%, Mix3: 50%, Mix4: 75%, Mix5: 100%) to replace the coarse aggregate. After

accurately measuring the required water content, the wet mixture was meticulously prepared. Subsequently, bricks were cast for each of the distinct mix types.

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

$$\text{Brick Size} = 101.6 \times 203.2 \times 406.4 \text{ mm} = 0.00839 \text{ m}^3$$

Materials required per Brick

$$1/10 \times 0.00839 = 0.000839 \times 1440 = 1.280 \text{ kg (cement)}$$

$$4/10 \times 0.00839 = 0.003556 \times 1600 = 5.36 \text{ kg (fine aggregate)}$$

$$5/10 \times 0.00839 = 0.004195 \times 1800 = 7.55 \text{ kg (coarse aggregate)}$$

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

3. EXPERIMENTAL WORK

3.1 Physical properties of aggregates

Table 2: 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/cm ³)	ASTM C127-C128	2.60	2.64	2.02
Apparent specific gravity (gr/cm ³)	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 3: 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%	1.194	4.91	6.79	8.46
25%	1.162	4.81	6.56	7.72
50%	1.134	4.64	6.36	7.12
75%	1.106	4.51	6.18	6.91
100%	1.064	4.39	6.01	6.70

Table 4: Water Absorption test on Concrete bricks

Mix ratio	Water absorption in %
0%	4.2
25%	5.3
50%	5.9
75%	6.24
100%	6.98

Table 8: Compressive strength after Chloride attack test

SI No	Mix Ratio %	28 days Compressive strength in MPa
1	0	4.23
2	25	4.14
3	50	3.88
4	75	3.45
5	100	3.12

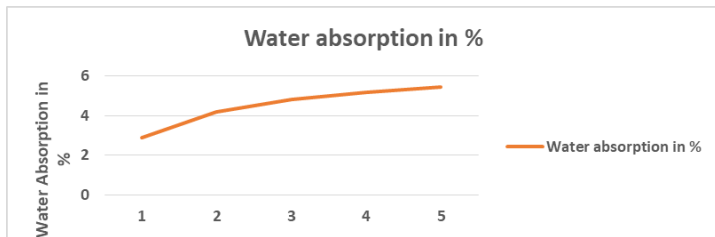


Figure 5: Water absorption test result in %

Table 5: Compressive strength of bricks after water absorption test

SI No	Mix Ratio %	28 days Compressive strength in MPa
1	0	8.12
2	25	7.56
3	50	5.98
4	75	5.64
5	100	4.54

4. CONCLUSIONS

The investigation examined the specific gravity of materials and the compressive strengths of bricks (Mix-1 to Mix-5) over varying curing durations. Notable findings include cement having the highest specific gravity followed by fine aggregate, C&D waste, and coarse aggregate. The compressive strengths exhibited an increasing trend with prolonged curing periods for all mixes.

Mix-1 showed respective compressive strengths of 1.198, 4.96, 6.89, and 8.50 for 7, 14, 21, and 28 days of curing. Mixes 2 through 5 demonstrated similar trends in strength improvements over time.

Additionally, an average water absorption rate of 4.64% was observed across the bricks. Post-test analyses indicated varied effects on compressive strength: water absorption test and alternative drying and wetting test led to slight strength gains (0.54% and 0.98% respectively), while the sulphate and chloride attack tests resulted in reduced strengths (-1.94% and -2.94% respectively).

These findings underline the influence of curing duration and the impact of environmental challenges on the compressive strength of bricks. Further research could focus on optimizing mix compositions and refining manufacturing processes to enhance the bricks' durability and performance against different environmental stressors.

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Table 6: Compressive strength of bricks after alternative drying and wetting test

SI No	Mix Ratio %	28 days Compressive strength in MPa
1	0	8.12
2	25	7.56
3	50	5.98
4	75	5.64
5	100	4.54

Table 7: Compressive strength of bricks after Sulphate attack test

SI No	Mix Ratio %	28 days Compressive strength in MPa
1	0	6.74
2	25	6.02
3	50	4.98
4	75	4.56
5	100	3.76

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