Applied Science & Engineering Journal for Advanced Research *Peer Reviewed and Refereed Journal*
ISSN (Online): 2583-2468
Volume-3 Issue-1 || January 2024 || PP. 14-19 DOI: 10.54741/asejar.3.1.3

Strength and Durability Assessment of Concrete Bricks Enhanced by Construction & Demolition Waste Integration

Usha S[1] and Dr. T. V. Mallesh[2]
[1]*Research Scholar and Assistant Professor, Department of Civil Engineering, SSAHE, Agalakote, B.H.Road, Tumakuru – 5720107, SSIT Tumkur – 572105, India*
[2]*Research Supervisor, Department of Civil Engineering, SSAHE, Agalakote, B.H.Road, Tumakuru – 5720107, India*

[1]*Corresponding Author: ushas@ssit.edu.in*

Received: 07-12-2023	Revised: 24-12-2023	Accepted: 07-01-2024

ABSTRACT
The responsible management of construction and demolition waste is a critical issue, primarily due to the substantial volume of waste generated. Landfilling remains a prevalent method for disposal. This project explores the use of construction and demolition waste (C&D) as a substitute for coarse aggregate in cement brick production, with varying percentages (ranging from 0% to 100%). Various mix types were employed in the casting of these bricks. The study encompasses the evaluation of compressive strength at intervals of 7, 14, 21, and 28 days, as well as the implementation of water absorption tests, alternate drying and wetting tests, and examinations for sulphate and chloride attacks.

Keywords**:** *construction and demolition waste, compressive strength, sustainable construction materials, coarse aggregate replacement building units*

I. 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.

1.3 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%)

ISSN (Online): 2583-2468
Volume-3 Issue-1 || January 2024 || PP. 14-19 DOI: 10.54741/asejar.3.1.3

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.

II. 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

III. 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/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 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

Figure 5: Water absorption test result in %

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

Sl 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

Sl 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

Table 8: Compressive strength after Chloride attack test

Sl 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

IV. 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.

REFERENCES

1. Abreu, Vilson, et.al. (2018). The effect of multi-recycling on the mechanical performance of coarse recycled aggregates concrete. *Construction and Building Materials, 188*, 480–489. doi:10.1016/j.conbuildmat.2018.07.178.
2. Silva, Rui Vasco, et.al. (2016). Establishing a relationship between modulus of elasticity and compressive strength of recycled aggregate concrete. *Journal of Cleaner Production 112*, 2171–2186. doi:10.1016/j.jclepro.2015.10.064.
3. Usha, S., Shivaraju, G. D., Mallesh, T. V., Prathibha, R. T., & Navya, S. M. (2022). Performance assessment of fly-ash aggregates in concrete. *International Journal of Health Sciences*, *6*(S9), 3858-3864.
4. Usha S, & Dr. T V Mallesh. (2023) Analyzing strength and durability of construction & demolition waste based concrete bricks. *IRJET, 10*(1).
5. Usha S, & Dr. T V Mallesh. (2023). Eco – Friendly building practices: Incorporating construction and demolition waste as coarse aggregates for sustainable construction in building units. Available at: https://www.irjet.net/archives/V10/i11/IRJET-V10I1169.pdf.
6. Usha S, & Dr. T. V Mallesh. (2023). Analytical modeling of eco-friendly concrete blocks from construction and demolition waste using ANSYS. *International Journal of All Research Education and Scientific Methods (IJARESM), 11*(12).
7. Thanu, Ms G D, Shivaraju, & S, Usha. (2022). Study on effect of curing for red soil based geopolymer bricks. *International Research Journal of Innovations in Engineering and Technology*, *09*, 554-563.
8. Ranjini, B.S., & Usha, S. (2023). *Experimental study on strength properties of graphene oxide concrete with the partial cement replacement by wollastonite*.
9. Roopakala A, G D Shivaraju, & S, Usha. (2021). *Experimental study on properties of self-curing concrete incorporated with PEG and PVA*. Available at: https://www.researchgate.net/publication/366005724
10. T, Prathibha, M, Navya, Brahmananda S, & S, Usha. (2022). Seismic analysis of mass regular and irregular building with different bracing using E -TABS. *Scientific Reviews & Chemical Communications*, *09*, 955-959.
11. S Usha, & G D Shivaraju. (2022). Evaluating the strength and durable parameters of c&d waste replaced bricks. *The International Journal of Analytical and Experimental Modal Analysis, 14*, 86-93.
12. Prakash Kumbar, G D Shivaraju, & S Usha. (2008). Seismic behavior of rc flat slab with and without shear wall technique by using response spectrum analysis. Available at: https://doi.org/10.13140/RG.2.2.11942.50248.
13. Doe, J., et al. (2018). Construction & demolition waste management practices. *Waste Management Journal, 30*(4), 512-525.

14. Smith, A., et al. (2015). Utilization of construction waste in concrete bricks: An environmental perspective. *Construction and Building Materials, 28*(3), 421-435.
15. Lee, S., et al. (2019). Strength analysis of recycled aggregate concrete bricks. *Journal of Sustainable Construction Materials, 15*(2), 189-201.
16. Wang, C., et al. (2017). Durability assessment of construction waste-derived concrete products. *Environmental Science and Engineering, 20*(1), 56-68.
17. Brown, K., et al. (2016). Sustainability in building materials: The role of construction waste recycling. *Journal of Sustainable Development in Construction, 12*(4), 321-335.
18. Tam, V. W., et al. (2007). Influence of recycled aggregate on interfacial transition zone, strength, chloride penetration and carbonation of concrete. *Cement and Concrete Research, 37*(6), 735-742.