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A Fresh Investigation on M35 Solid by Switching Cement with Brick Dust and GGBS by Totaling of Plasticiser

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A B S T R A C T

Particularly because Portland cement manufacture plays such a significant share in world CO2 emissions, the building industry faces significant challenges in trying to reduce carbon emissions. The possibility of partially substituting Ground Granulated Blast Furnace Slag (GGBS) and Brick Dust (BD) for cement in concrete compositions is investigated in this work. To substitute standard Portland cement, concrete samples were produced using varied degrees of brick dust (0% to 15%) and a set mix of GGBS (15%). Mechanical properties including compressive strength, flexural strength, and durability measures were evaluated using a set of exhaustive tests. The results showed that while simultaneously approximating a 35% decrease in carbon emissions, the mix of brick dust and GGBS produced compressive strength levels equivalent to those of normal concrete. These findings suggest that by means of intentional integration of brick dust and GGBS, a feasible, sustainable substitute for conventional cement-based concrete can provide both environmental benefits and similar structural integrity.

The objective is to reduce dependence on Portland cement, and improve the sustainability of concrete. The GGBS & BD both are replaced in place of cement by maintaining GGBS as constant with 15% and BD with ascending follows from 0%, 3%, 6%, 9%, 12% & 15% an expansion of plasticizer with a steady rate 1% within the volume of concrete in M35 Solid.

Furthermore, the comparison is made between the regular Solid and Solid mixed with proxies such as 0%BD+0%GGBS, 3%BD+15%GGBS, 6%BD+15%GGBS, 9%BD+15%GGBS, 12%BD+15%GGBS, and 15%BD+15%GGBS.

Keywords: Portland Cement, Brick Dust (BD), Ground Granulated Blast Furnace Slag(GGBS), Plasticizer & M35 Solid.

1. INTRODUCTION

The construction business is defined by continual evolution, resulting to advancements that increase both the performance and environmental sustainability of building materials. A notable trend in recent years has been the use of alternative materials, such as Brick Dust (BD) and Ground Granulated Blast-furnace Slag (GGBS), as alternatives for regular cement.

Cement serves a critical role in concrete, delivering essential strength and durability to constructions. However, the manufacturing process of regular Portland cement is highly energy-intensive and creates large carbon dioxide emissions, which contribute to global warming. In response to these environmental challenges, academics have researched more sustainable options. Brick dust and GGBS have emerged as viable replacements that not only lower the carbon footprint but also enhance the characteristics of concrete.

Research reveals that the presence of brick dust might boost the compressive strength of concrete while simultaneously reducing its permeability, hence lessening the danger of deterioration over time. Moreover, utilizing this waste material aids to trash reduction in landfills, exemplifying a successful recycling technique within the building business.

Conversely, GGBS is made by rapidly cooling molten iron slag, a byproduct of the iron and steel manufacturing operations. When used as a partial replacement for cement, GGBS has showed considerable improvements in the durability of concrete. This material exhibits pozzolanic qualities, allowing it to react with calcium hydroxide in the presence of moisture to produce additional cementitious compounds, hence boosting overall strength. Furthermore, concrete incorporating GGBS demonstrates a reduced heat of hydration and enhanced resistance to sulfate attack, making it appropriate for a variety of demanding climatic conditions.

1.2 WHAT IS BRICK DUST (BD)?

Brick dust, a byproduct of the masonry sector, is formed from the fragments of broken or abandoned bricks. When mixed into concrete mixtures, it modifies the physical and chemical features of the composite material.

1.2.1 COMPOSITION OF BRICK DUST (BD):

Brick Dust (BD) is generally formed of the following components:

- Silica (SiO_2) – 50-70% (contributes to strength and stability)
- Alumina (Al_2O_3) – 10-20% (enhances plasticity)
- Lime (CaO) – 1-10% (influences structure and coloration)
- Iron Oxide (Fe_2O_3) – 5-10% (imparts color, notably reddish tones)
- Magnesia (MgO) – less than 5% (boosts durability)
- Potash (K_2O) and Soda (Na_2O) – less than 5% (influence fusion and coloration)
- Minor Constituents- trace levels of Titanium Oxide (TiO_2), Phosphorus, Sulfur, among others.

Additionally, brick dust may contain contaminants, and its fine particle size amplifies its reactive qualities.

1.2.2 EMPLOYMENTS OF BRICK DUST (BD):

- Partial Cement Replacement: BD can operate as a partial substitute to regular cement in concrete and mortar formulations, hence decreasing the quantity of conventional cement used and reducing total production expenses.
- Enhancement of Compressive Strength: The addition of brick dust into cement can lead to an increase in the compressive strength of the cured cement, hence enhancing its longevity.
- Improved Workability: BD contributes to the workability of the cement mixture, permitting better handling and application during construction processes.
- Pozzolanic Characteristics: Brick dust possesses potential pozzolanic qualities, allowing it to react with calcium hydroxide contained in cement to form compounds that enhance both the strength and durability of the cement.

1.2.3 BENEFITS OF BRICK DUST (BD):

- Utilization of Economical Materials: Incorporating brick dust in the making of cement leads to a decrease in expenses through the repurposing of waste materials, offering a budget-friendly option for standard additives.
- Sustainable Cement Production: The addition of brick dust in cement formulation mitigates environmental consequences by recovering abandoned brick components, hence supporting more sustainable practices in construction.

1.3 WHAT IS GROUND GRANULATED BLAST FURNACE SLAG (GGBS)?

GGBS stands for Ground Granulated Blast-furnace Slag, a byproduct created during the steel production process. This material is made by rapidly cooling molten iron slag from a blast furnace with water or steam, a procedure known as granulation, followed by grinding it into a fine powder. GGBS is often used as a partial replacement for Portland cement in the making of concrete.

1.3.1 MAKEUP OF GGBS:

GGBS largely consists of the following components:

- Silica (SiO_2): Contributes to the development of concrete's strength and durability.
- Alumina (Al_2O_3): Improves workability and increases strength over time.
- Calcium Oxide (CaO): Facilitates the synthesis of cementitious compounds when combined with water.
- Magnesium Oxide (MgO): Plays a function in the long-term strength development.
- Iron Oxide (Fe_2O_3): Boosts the chemical resistance and general performance of concrete.

1.3.2 MERITS & APPLICATIONS OF GGBS

- ✓ Sustainability.
- ✓ Enhanced Workability.

- ✓ Lower Hydration Heat.
- ✓ Long-Term Quality Improvement.
- ✓ Reduction of Carbon Footprint.
- ✓ In Concrete: GGBS is often used as a partial replacement for Portland cement in concrete production, having the ability to substitute up to 70% of the cement content, depending on the specific application.
- ✓ High-Strength Concrete: Utilized in high-performance concrete for major foundation work.
- ✓ Durable Concrete: Perfect for marine constructions, wastewater treatment plants, and numerous applications subjected to severe chemicals or dampness.
- ✓ In Mortar: GGBS can also be included into mortar mixtures to improve workability and strength.

1.4 MANUFACTURING PROCESS OF CONVERTING BRICK INTO DUST:

The process of converting bricks into dust involves the following steps. This process efficiently transforms waste bricks into a fine, usable product for various applications.

1. Collection and Sorting: Old or waste bricks are gathered and sorted to remove any non-brick materials or debris.
2. Crushing: Bricks are fed into a crusher or grinder where they are broken down into smaller pieces. This is typically done using mechanical crushers or hammer mills.
3. Grinding: The crushed brick is then ground into fine particles using mills or grinding machines, producing the dust-like material.
4. Screening: The resulting dust is screened to ensure uniform particle size, separating fine dust from coarser fragments.
5. Storage and Packaging: The processed brick dust is stored in silos or containers and can be packaged for various uses, such as in construction, concrete, or soil improvement.

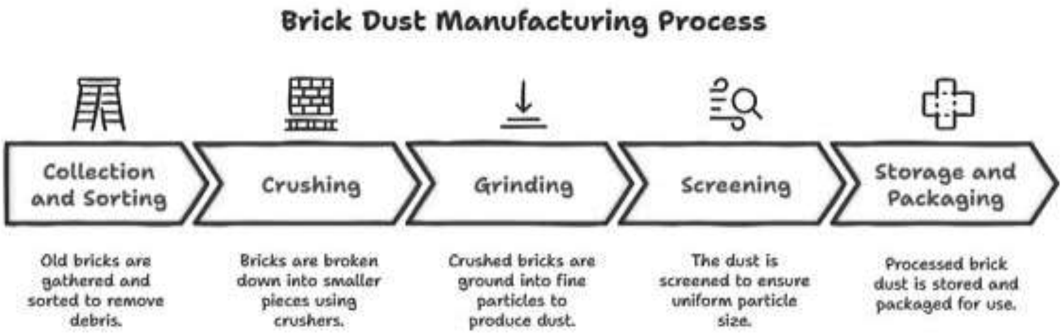


Fig. 1: The procedure of manufacturing Dust from Bricks

1.5 METHODOLOGY:

The Methodology describes the proxies used in place of cement done over this paper:

- ➢ The study explores the application of ground granulated blast furnace slag (GGBS) at a fixed ratio of 15% to cement and Brick Dust (BD) at proportions of 3%–15%.
- ➢ Compressive strength characteristics for 150 x 150 x 150 mm cubes are evaluated.
- ➢ Tensile strength characteristics for cylinders of 150 mm in diameter and 300 mm in height are examined.
- ➢ Evaluation of 500 x 100 x 100 mm beams' bending strength characteristics.

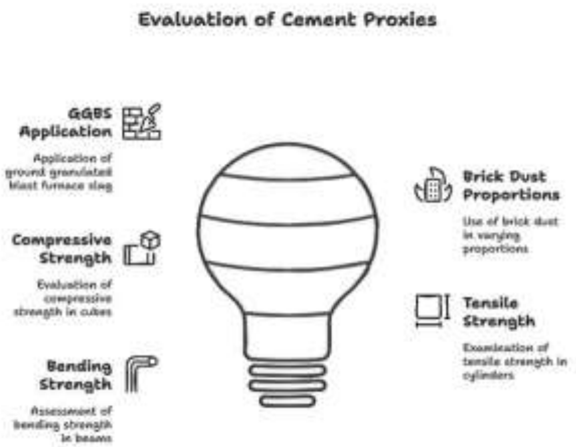


Fig. 2: The procedure of manufacturing Dust from Bricks

2. MATERIALS USED

2.1 Cement:

It is a granular mixture manufactured from different minerals and raw materials that, when combined with water, makes a paste that hardens as it dries. The most often used form of cement is Portland cement, named after the Isle of Portland in England, where its hue mirrored the native stone. Cement functions as a binder, keeping aggregates like sand and gravel together to make concrete, one of the most extensively used construction materials. The cement used is Ultratech Cement, especially Standard Portland Cement (OPC 43 Review).

2.2 Fine Aggregate:

Sand is a naturally occurring granular material made composed of microscopic rock and mineral particles. It is generated by weathering and erosion, when bigger rocks are broken down into tiny bits via mechanical and chemical processes. Composed mostly of silica, or silicon dioxide, sand is typically found in habitats such as beaches, riverbeds, and deserts. The diameter of sand particles generally ranges from 0.0625 mm to 2 mm, placing it separate from both silt and gravel

2.3 Coarse Aggregate:

Coarse aggregate serves a key function in building and civil engineering. This category comprises materials such as gravel, crushed stone, and recycled concrete, all of which have a size bigger than 4.75 mm. Coarse aggregate boosts the strength and stability of concrete and asphalt, hence boosting the overall durability of constructions.

2.4 Water:

Concrete is important since water actively engages in the chemical reaction with cement. Throughout the manufacturing process, tap water mixes and cures are applied. The pH level is 6.8.

2.5 Brick Dust (BD):

Crushed bricks are blended with cement, sand, and gravel to form brick dust for use in concrete. This method boosts the concrete's resilience to cracking and wear, making it particularly beneficial for surfaces such as sidewalks and driveways. Research suggests that concrete with 20% brick dust displays increased compressive strength compared to normal concrete. Overall, brick dust acts as an excellent component in contemporary concrete, fostering creative building techniques while encouraging recycling and sustainable growth.

2.6 Ground Granulated Blast Furnace Flag (GGBS):

Ground Granulated Blast Furnace Slag (GGBS) is an industrial byproduct created mostly from the operation of a blast furnace, where iron ore is combined with coke and limestone. The quick cooling of molten slag by water or steam converts it into a glassy, amorphous material known as "granulated." After this granulated substance is coarsely crushed, it is termed as GGBS. In concrete mixes, GGBS is commonly employed as a supplemental cementing agent, since its inclusion with ordinary Portland cement (OPC) greatly boosts several performance parameters of the concrete.

Fig. 3: Cement, Sand, Aggregate, Brick Dust & GGBS

Table .1. Physical properties of Brick Dust (BD)

S.No	Physical Property	Brick Dust
1	Appearance	Uniform & Bright
2	Size of Particle	Material Passed through IS Sieve 90 micron
3	Color	Class Red
4	Density	1600-1800 Kg/m^3
5	Water absorption	0.36 %
6	Specific Gravity	2.69

Table 2. Chemical properties of Brick Dust (BD) & Ordinary Portland Cement (OPC)

S.No	Chemical Composition	OPC (%)	BD (%)
1	CaO	40.83	0.62
2	Sio2	38.13	41.89
3	Al2O3	8.76	38.95
4	MgO	1.55	-
5	SO3	2.25	1.46
6	Fe2O3	2.67	12.13
7	Misc	5.81	4.95

Table 3. Physical properties of Ground Granulated Blast Furnace Flag (GGBS)

S.No	Physical Property	Ground Granulated Blast Furnace Flag (GGBS)
1	Size of Particle	Typically finer than 45 microns (usually around 30–50 microns)
2	Color	Light grey to off-white
3	Density	1.1 to 1.3 g/cm^3
4	Water absorption	Less than 1%
5	Specific Gravity	2.92.

Table 4. Chemical properties of Ordinary Portland Cement (OPC) & Ground Granulated Blast Furnace Flag (GGBS)

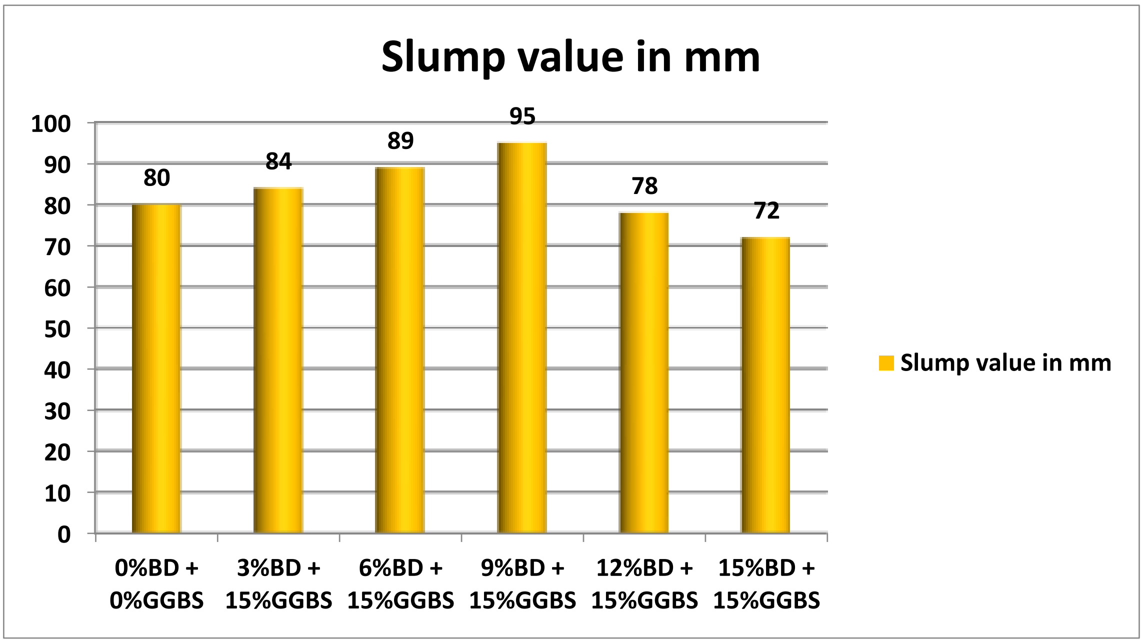
S.No	Chemical Composition	OPC (%)	GGBS (%)
1	CaO	62.15	47.25
2	Sio2	22.5	35.17
3	Al2O3	7.76	11.57

4	MgO	1.67	3.57
5	SO3	2.40	0.82
6	Fe2O3	2.57	0.84
7	K_2O	0.95	0.78

3. RESULTS

Table 5 Slump Cone values

Mix % Replacement	**Slump value in mm**
0%BD + 0%GGBS	80
3%BD + 15%GGBS	84
6%BD + 15%GGBS	89
9%BD + 15%GGBS	95
12%BD + 15%GGBS	78
15%BD + 15%GGBS	72



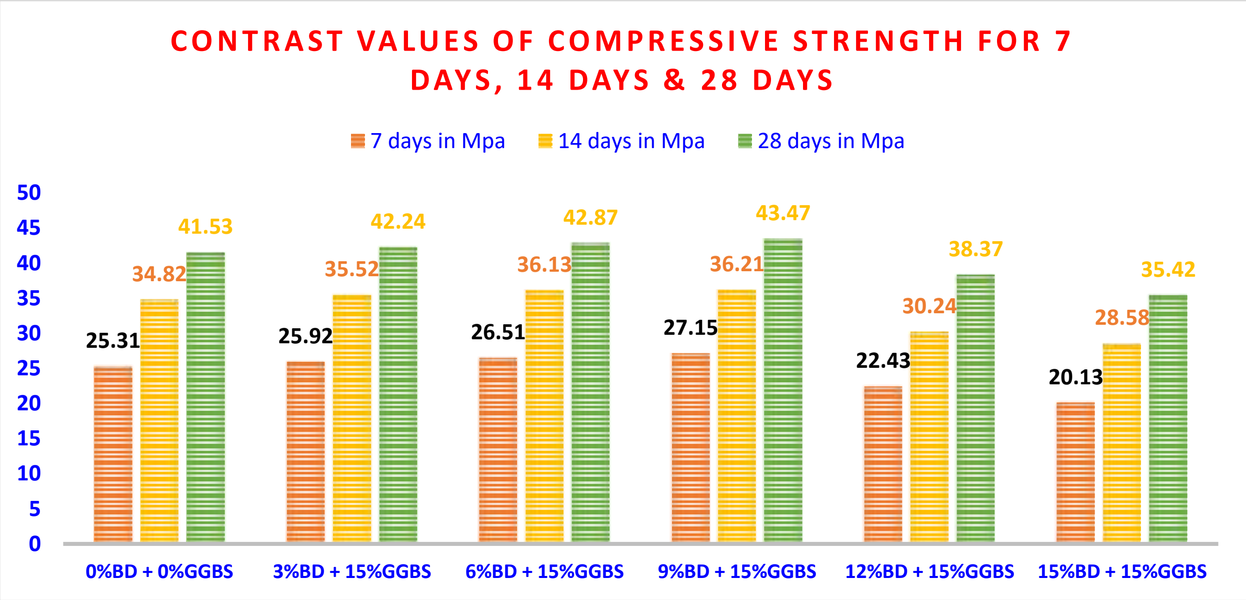
Graph 1: Slump Cone values

Table 6: Mix proportion of M35

Grade	**M35**
Proportion	**1:1.97:2.75**
W/C ratio	**0.41**
Cement	**375.24**
Fine Aggregate	**742.15**
Coarse Aggregate	**1034.88**
Water	**172.61**

Table 7: Test results of Compressive Strength at 7 days, 14 days & 28 days

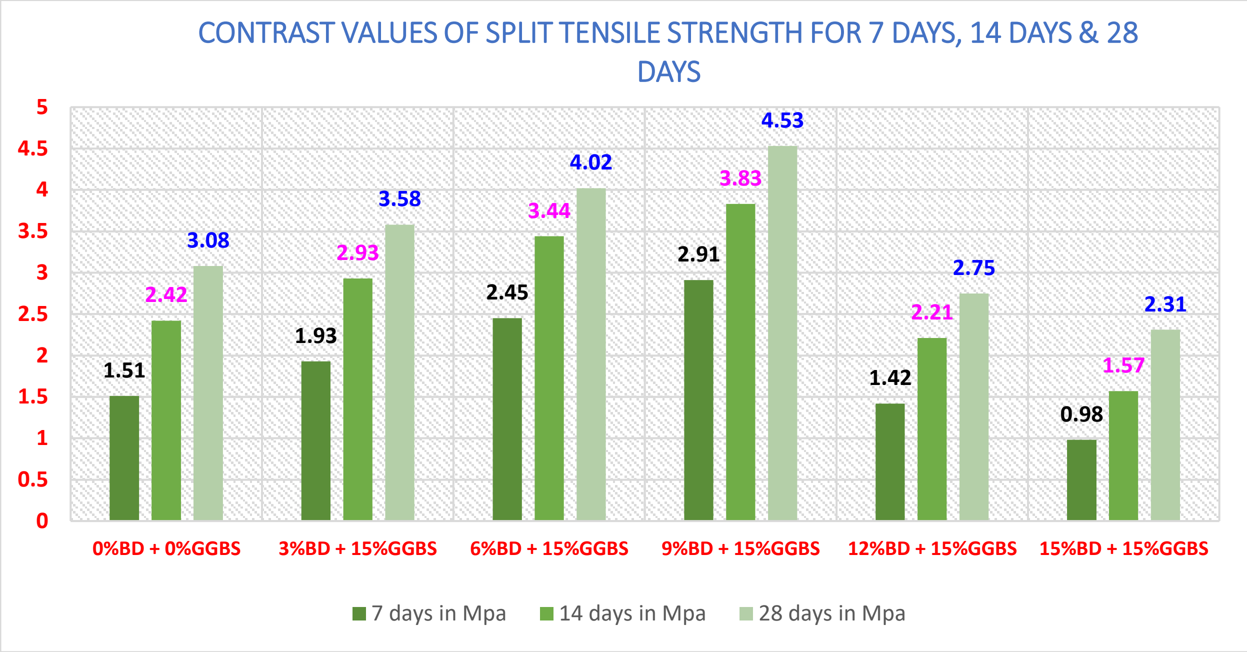
Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0%BD + 0%GGBS	25.31	34.82	41.53
3%BD + 15%GGBS	25.92	35.52	42.24
6%BD + 15%GGBS	26.51	36.13	42.87
9%BD + 15%GGBS	27.15	36.21	43.47
12%BD + 15%GGBS	22.43	30.24	38.37
15%BD + 15%GGBS	20.13	28.58	35.42



Graph 2: Contrast values of Compressive strength for 7 days, 14 days & 28 days

Table 7: Test results of Split Tensile Strength at 7 days, 14 days & 28 days

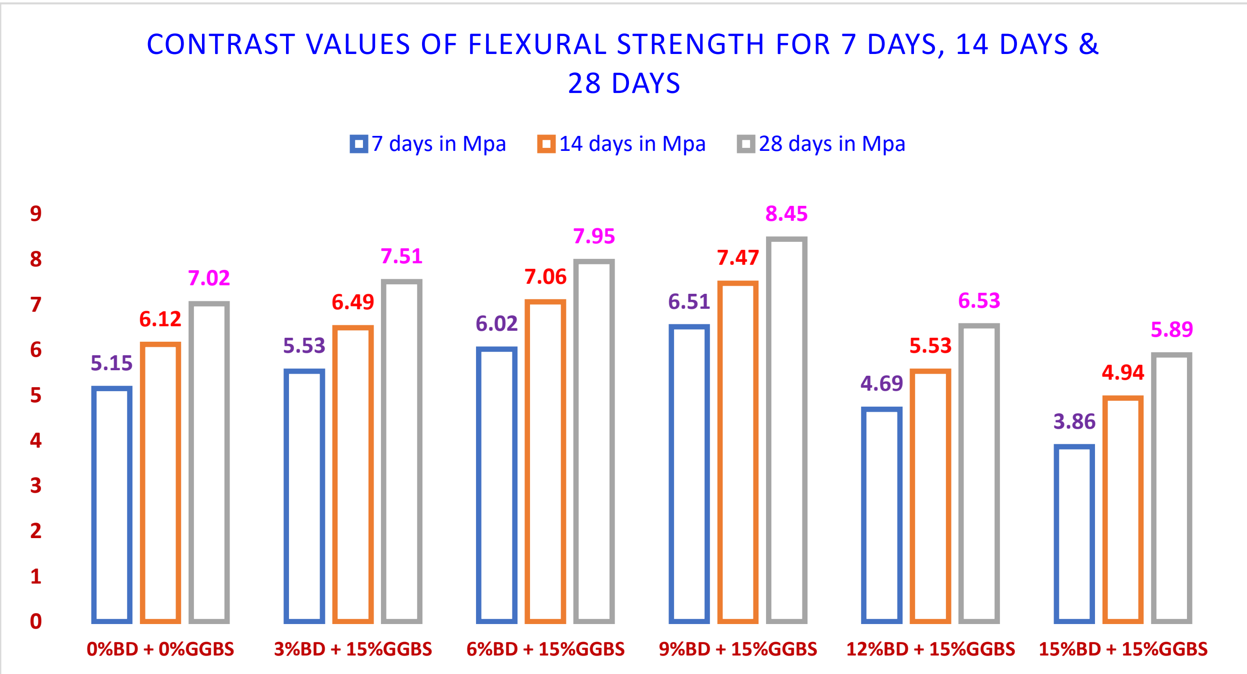
Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0%BD + 0%GGBS	1.51	2.42	3.08
3%BD + 15%GGBS	1.93	2.93	3.58
6%BD + 15%GGBS	2.45	3.44	4.02
9%BD + 15%GGBS	2.91	3.83	4.53
12%BD + 15%GGBS	1.42	2.21	2.75
15%BD + 15%GGBS	0.98	1.57	2.31



Graph 3: Contrast values of Split Tensile strength for 7 days, 14 days & 28 days

Table 8: Test results of Flexural Strength at 7 days, 14 days & 28 days

Mix % Replacement	**7 days in Mpa**	**14 days in Mpa**	**28 days in Mpa**
0%BD + 0%GGBS	5.15	6.12	7.02
3%BD + 15%GGBS	5.53	6.49	7.51
6%BD + 15%GGBS	6.02	7.06	7.95
9%BD + 15%GGBS	6.51	7.47	8.45
12%BD + 15%GGBS	4.69	5.53	6.53
15%BD + 15%GGBS	3.86	4.94	5.89



Graph 4: Contrast values of Flexural strength for 7 days, 14 days & 28 days

5. Conclusions

- Emphasizing the following important elements will help this essay to be summed up in view of the past debates and results:
- The results imply that both materials effectively replace cement when GGBS is kept at 15% and BD is progressively substituted in the M35 Solid mix at levels of 0%, 3%, 6%, 9%, 12%, and 15%.
- Combining 9% BD with 15% GGBS yields the optimal compressive, ductile, and flexural strengths according to the analysis of the data.
- The highest compressive strength seen after 28 days is 43.47 MPa.
- The peak tensile strength is 4.53 MPa and the flexural strength comes out to 8.45 MPa.
- The presence of recovered demolition waste BD helps one to classify this mix as green concrete.

References

1. Vandanapu, R., Mohanan, V., & Selvan, C. P. (2019b). Understanding the influence of replacing cement with GGBS on compressive and flexural strengths of concrete at medium workability conditions. 2022 Advances in Science and Engineering Technology International Conferences (ASET), 1–4. https://doi.org/10.1109/ICASET.2019.8714522
2. An Escalation Over Mechanical Attributes in M30 Type Solid Using Qualified Fill-In by Brick Dust to Cement & Saw Dust to Sand. (2024d). INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT, 08(05), 1–5. https://www.doi.org/10.55041/IJSREM34914.
3. Karri, S. K., Rao, G., & Raju, P. (2015b). Strength and Durability Studies on GGBS Concrete. International Journal of Civil Engineering, 2(10), 34–41. https://doi.org/10.14445/23488352/ijce-v2i10p106.
4. M. Pavan Kumar and Y. Mahesh (2015) The Behaviour of Concrete by Partial Replacement of Fine Aggregate with Copper Slag and Cement with GGBS - An Experimental Study IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. III (May. - Jun. 2015), PP 51-56
5. Mary, V. & Kishore, C.H.. (2015). Experimental investigation on strength and durability characteristics of high performance concrete using GGBS and msand. ARPN Journal of Engineering and Applied Sciences. 10. 4852-4856.
6. Familusi, Ayokunle & Adewumi, Babatunde & Oladipo, F & Ogundare, Damilola & Olusami, Joel. (2017). EFFECTS OF BLAST FURNACE SLAG AS A PARTIAL REPLACEMENT FOR CEMENT IN CONCRETE.
7. Arif, Rehan & Khitab, Anwar & Kirgiz, Full Professor Dr & Tayyab, Seemab & Khan, Riaz & Anwar, Waqas & Arshad, Muhammad. (2021). Experimental analysis on partial replacement of cement with brick powder in concrete. Case Studies in Construction Materials. 15. e00749. 10.1016/j.cscm.2021.e00749.