



An Investigation of Effect of Bio-Medical Waste On Concrete

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Abstract:

This study investigates the use of treated biomedical waste as a partial replacement in concrete. Concrete specimens with different replacement percentages were tested for compressive strength, workability, and water absorption. Results show that a limited amount of properly treated biomedical waste can be used without significantly affecting concrete performance, while higher replacement levels reduce strength and durability. The study demonstrates that treated biomedical waste can be utilized as an eco-friendly construction material, helping reduce landfill waste and conserve natural resources. Proper segregation, sterilization, and processing are essential for safe and effective utilization.

Keywords: Biomedical Waste, Concrete, Compressive Strength, Sustainable Construction, Waste Management, Environmental Protection.

1. Introduction

Biomedical waste (BMW) generated from healthcare facilities contains potentially infectious and hazardous materials, creating significant environmental and public health concerns. Major sources include hospitals, clinics, laboratories, and dental and veterinary facilities. In India, approximately 405,702 kg/day of biomedical waste is generated, highlighting the need for efficient and sustainable management practices. Conventional treatment methods include incineration, autoclaving, and chemical disinfection. However, improper handling and disposal may lead to environmental contamination and health risks. Therefore, proper segregation, treatment, and safe disposal of BMW are essential, along with exploring sustainable alternatives for its utilization.

Scope of Present Work

The utilization of treated biomedical waste (BMW) in concrete helps reduce waste volume and supports sustainable construction. Partial replacement of cement with BMW ash can provide acceptable compressive strength while reducing material consumption. However, higher replacement levels may reduce workability, density, and strength. Therefore, optimized replacement levels and proper mix design are essential for maintaining concrete performance and ensuring safe BMW disposal.

Objectives and Scope

- To study the effect of treated biomedical waste ash on the compressive strength of concrete.
- To compare BMW ash concrete with conventional concrete and evaluate its potential for sustainable waste management.

Aim:

- Bio-medical waste used as a construction material by recycling it.

2. Literature Review

Udit Kumar, Vikas Srivastava, Amit Kumar Singh (June 2016)

Concrete incorporating biomedical waste ash demonstrates inferior workability and reduced compressive strength compared to traditional concrete. This compromise in performance highlights the need for further research and optimization efforts to address these limitations. Enhancing the utilization of biomedical waste ash in concrete production while maintaining desired properties requires careful consideration. Strategies such as adjusting proportions, exploring treatment methods for biomedical waste ash, and investigating additives or admixtures could be pivotal. Collaborative efforts among researchers, engineers, and policymakers are essential to develop sustainable solutions. These efforts aim to maximize the benefits of biomedical waste ash while mitigating its impact on concrete performance, ensuring both environmental sustainability and efficient resource utilization in construction practices.

Uma Devi., Prof. R. Rathig. (March 2019)

BMW concrete reduces biomedical waste levels by incorporating it into concrete, enhancing strength and lowering costs. This innovative approach not only addresses waste management but also boosts structural integrity and cost-efficiency in construction projects. By repurposing biomedical waste, it offers a sustainable solution while meeting regulatory standards and fostering resource conservation in the building industry.

Ghulam Mustafa Khanzada, Bashir Ahmed Memon. (JAN–JUN, 2020)

Concrete containing biomedical waste ash displays reduced workability and diminished compressive strength when compared to traditional concrete formulations. The incorporation of biomedical waste ash results in a significant decrease in compressive strength relative to conventional concrete mixes. This decline hints at a detrimental influence on the comprehensive performance and long-term durability of concrete structures utilizing biomedical waste ash as a supplementary material. Consequently, it underscores the necessity for meticulous evaluation and extensive research endeavors to effectively address these limitations and enhance the efficiency of biomedical waste ash utilization in concrete production.

Sathvik S, Suchith. S, Edwin. (April 2019)

Concrete incorporating biomedical waste ash presents reduced workability in comparison to conventional concrete, there is a decrease in compressive strength. This decrease in performance raises concerns regarding the attainment of desired structural integrity and durability. Overcoming these challenges requires dedicated research and optimization efforts. Potential strategies encompass adjusting the proportions of ash, exploring various treatment methods for biomedical waste ash, and investigating the efficacy of additives or admixtures. Crucially, collaborative efforts involving researchers, engineers, and policymakers are essential for devising sustainable solutions.

Tina Maria Sunny (2018) The utilization of biomedical plastic waste in bituminous mixes has emerged as a promising avenue, showcasing improved properties compared to conventional mixes. This finding underscores the potential for judicious disposal of biomedical plastic waste through its incorporation into bituminous mixes.

Bituminous mixes play a vital role in road construction, offering durability and resistance to various environmental factors. By integrating biomedical plastic waste into these mixes, not only can the disposal of such waste be managed effectively, but also the performance of the resulting material can be enhanced.

“Mrs. Priyanka Petkar, Adesh Pawar, (2024) In India hospital bio medical waste (BMW) causing major problem. This research investigates the impact of incorporating biomedical waste (BMW) into concrete, aiming to evaluate its influence on mechanical and durability properties. Biomedical waste, posing significant environmental challenges, necessitates innovative waste management solutions. By integrating BMW into concrete, this study seeks to address both waste disposal issues and promote sustainable construction practices. The experimental approach involves varying proportions of BMW in concrete mixtures, assessing effects on parameters like compressive strength, flexural strength, permeability, and resistance to aggressive environments.

Sandeep Kumar Verma, Vipin Kumar (2024) There is a major problem in India for generation of biomedical waste from health care units, research laboratories, clinics and other medical sources. Generation of waste adversely affect the whole environment for human being. There fore Utilization of medical waste ash is a challenging work for all over India. Some researches revealed the scope for the use of medical waste ash in concrete as partly replacing of cement.

In this paper the study describes the workability, density and compressive strength of concrete after partly replacing of cement with medical waste ash.

Sources of Bio-Medical Waste-

Biomedical waste is generated from various healthcare activities, including patient treatment, diagnostic procedures, laboratory investigations, and surgical operations. The quantity and composition of waste depend on the type, size, and activities of the healthcare facility. Major sources of biomedical waste include:

- Medical and patient-care wards
- Operating and surgical theatres
- Healthcare centres and clinics
- Diagnostic and research laboratories
- Blood banks and pharmacies
- Dental and veterinary facilities

3. Materials Used

Cement: Ordinary Portland Cement (OPC)

Fine aggregate : M-sand

Coarse aggregate : Aggregates that have passed through a 20mm IS sieve

Bio-Medical Waste ash: Washed Bio-Medical waste ash Incinerators Treatment Plant Water : Potable water

Cement

The cement used in this study was 53 Grade Ordinary Portland Cement (OPC), conforming to IS 12269. It was used as the primary binding material for preparing concrete specimens. The cement provides high early-age strength and is suitable for structural concrete applications.

Fine Aggregate



Fine aggregate is an essential constituent of concrete, occupying approximately 30–40% of its volume and improving workability and stability. As per IS 383, fine aggregate is material passing through a 4.75 mm sieve. In this study, crushed stone sand (M-sand) was used as fine aggregate. It was clean, hard, durable, and free from harmful impurities.

Figure no. 1 M sand

Coarse Aggregate

Coarse aggregate is an essential component of concrete that provides strength, stiffness, and dimensional stability. As per IS 383, coarse aggregate is predominantly retained on the 4.75 mm IS sieve. It may consist of natural, crushed, or partially crushed stone or gravel. In this study, clean, hard, and durable coarse aggregate of suitable size was used.



Figure no. 2 Coarse aggregate

Water

Water used for mixing and curing concrete should be clean and free from harmful oils, acids, salts, alkalis, and organic impurities. As per IS 456:2000, potable water is generally suitable for concrete work. The pH value of water should not be less than 6. Clean water helps ensure proper hydration and strength development of concrete. 4.5

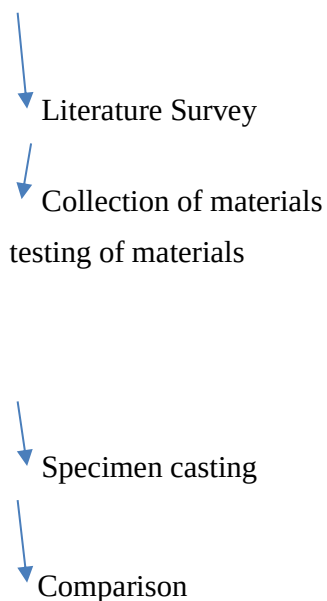
Bio-Medical Waste Ash

Biomedical Waste Ash (BMWA) is a solid residue produced after the incineration of biomedical waste. It may contain hazardous substances such as heavy metals and therefore requires proper treatment and handling. After suitable processing, BMWA can be investigated as a partial replacement material in concrete to reduce waste disposal and environmental impacts.



Figure no.3 Raw Bio-Medical Waste Ash

METHODOLOGY



Results & Conclusion

Material Testing

Table No. 1 Tests on Cement

PROPERTIES.	OBTAINED RESULT.	REQUIREMENT AS PER IS
Standard Consistency.	34 %.	IS 4031-Part IV.
Initial Setting Time	initial setting time is 70 min.	IS -269:1989, 30 Min .
Final Setting Time	300 min	IS -269:1989 (10 hours)
Fineness of Cement	7%.	IS 4031-Part I 1996. (10%)
Density of Cement	3.09 g/ml	3.15 g/ml.
Soundness of Cement	1 mm	IS 269:1989 10 mm

Properties of Fine Aggregates

Properties	Value Obtained	Limits as per IS 2386
Specific Gravity	2.706	2.6-2.8
Bulk Density	1.78g/cc	1.2-1.8 g/cc
Fineness Modulus	2.814	2.2-2.6 - fine sand 2.6-2.9 – medium sand 2.9-3.2 – coarse sand

Table No. 2 Properties of Fine Aggregate

Properties of Coarse Aggregates

Properties	Value Obtained	Limits as per IS 2386
Bulk Density	1.37g/cc	1.2 -1.8 g/cc
Specific Gravity	2.72	2.6-2.8

Table No. 3 Properties of Coarse Aggregate

Mix Design

Mix design involves the selection of appropriate concrete ingredients and establishing their respective proportions to produce concrete with specified minimum strength and durability, while also aiming for cost- effectiveness. A mix design procedure was carried out according to IS 10262-1982 standards to determine the composition of M25 grade concrete.

Casting of Bio-Medical Waste Ash Concrete

Cement and fine aggregate are thoroughly mixed to obtain a uniform blend. Bio-medical waste ash is added at 15%, 20%, and 25% proportions of fine aggregate. Coarse aggregate is added, followed by water gradually to prevent bleeding. The mixture is placed in standard molds, compacted, and properly finished.

Testing of Specimen

After adequate curing, the remolded specimens are removed and dried in sunlight before being subjected to testing using standard testing equipment.

The subsequent section focuses on the examination of different materials utilized and the testing of these materials.

Stipulations for Proportioning

Grade designation : M25
Type of cement : OPC Max nominal size of aggregate : 20mm
Min cement content : 300 kg/m³
Max water cement ratio : 0.45
Workability : 100mm(slump)
Exposure condition : Mild (for reinforced concrete)
Degree of supervision : Good
Type of aggregate : Crushed angular aggregate
Max cement content : 450 kg/m³

Mix Calculations

The calculation of the mix per unit volume of concrete shall be as follows.

1. The volume of concrete = 1 m³
2. The volume of the cube = 150mm × 150mm × 150mm
= 0.15m × 0.15m × 0.15m
= 0.003375 m³
3. The dry volume of concrete = 1 × 1.54
= 1.54 m³
4. The wet volume of concrete = The product of the dry volume of concrete x volume of the cube
= 1.54 × 0.003375 m³
= 5.1975 × 10⁻³ m³
= 0.005197 m³

Mix Design for M25 Grade Concrete

$$\begin{aligned}
 1) \text{ Volume of Cement} &= \frac{1 \times 1.54}{1+1+2} \times 0.005197 \\
 &= 0.385 \times 0.005197 \text{ m}^3 \\
 &= 0.00200845 \text{ m}^3 \\
 \text{Quantity of Cement in KG} &= 0.00200845 \times 1440 \\
 &= 2.88 \text{ kg} \\
 2) \text{ Volume of Sand} &= \frac{1 \times 1.54}{1+1+2} \times 0.005197 \\
 \text{(Fine Aggregate)} &= 0.385 \times 0.005197 \text{ m}^3 \\
 &=
 \end{aligned}$$

$$= 0.00200845 \text{ m}^3$$

$$\text{Quantity of Sand in KG} = 0.00200845 \times 1600 = 3.20 \text{ kg}$$

=

$$\begin{aligned} 3) \quad \text{Volume of Aggregate} &= \frac{2 \times 1.54}{1+1+2} \times 0.005197 \\ &= 0.77 \times 0.005197 \text{ m}^3 \\ &= 0.00400169 \text{ m}^3 \end{aligned}$$

$$\text{Quantity of Aggregate in KG} = 0.00400169 \times 1800$$

$$= 6.20 \text{ kg}$$

Mix Design for M25 Grade Concrete for 9 Cube

$$\text{Cement} = 25.92 \text{ kg/m}^3$$

$$\text{Water} = 11.66 \text{ kg/m}^3 \quad \text{Fine aggregate (Sand)} = 28.8 \text{ kg/m}^3$$

$$\text{Coarse aggregate} = 55.8 \text{ kg/m}^3$$

$$\text{Admixture} = 3.85 \text{ kg/m}^3 \text{ (1.1 \% of cement)}$$

Cement	Sand (Fine Aggregate)	Coarse Aggregate	Water
25.92	28.8	55.8	11.65
2.88	3.20	6.20	-
1	1.2	2.22	0.45

Table no. 4 The multiplication of the dry volume of concrete and the volume of the cube



Compressive Strength: The compressive strength of concrete is determined by dividing the maximum failure load by the cross-sectional area of the specimen. It is expressed in units such as MPa or N/mm². The test helps evaluate the strength and load-bearing capacity of concrete. It is important for ensuring the structural safety and durability of concrete structures.

Figure no. 4 Oiling of Molds Figure no. 5 Filing of concrete in molds

Age in Days	Percentage of Strength
1 Day	16%
3 Day	40%
7 Day	65%
21 Day	94%
28 Day	99%

Table No. 5 Tentative Strength in days

Calculation of Compressive Strength

- Size of the Cube = 15cm×15cm×15cm
- **Compressive Strength Formula**
- Compressive Strength = Load / Cross-Sectional area Kilonewton = 1000 Newton
1 kN = 1000 N
- Load by Machine = kN
- Load in Newton = Load by Machine × 1000
- Area of Cube in mm² = 150 × 150
= 22500 mm²



Figure no 6. Marking on Cube



Figure no. 7 Placing of Cube On Machine



Figure no. 8 Crushing of Cube

Water Absorption test of concrete cube block: -

The process you've described involves assessing the water absorption of concrete cubes at different curing periods (7 days, 14 days, and 28 days) by immersing them in water for 24 hours. Here's a more detailed explanation of the procedure:

- 14 days, and 28 days. During each period, the cubes are kept in a controlled environment to allow for proper curing.

$$\text{Percent Water Absorption} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100\%$$

A) Water Absorption of Conventional Concrete Cube (M25)

Cube	Without Absorption	With Absorption
Cube 1 (7 days)	6.720	6.760
Cube 2 (7 days)	6.680	6.730
Cube 3 (7 days)	6.640	6.710
Cube 4 (14 days)	6.450	6.500
Cube 5 (14 days)	6.600	6.660
Cube 6 (14 days)	6.540	6.600
Cube 7 (28 days)	6.670	6.610
Cube 8 (28 days)	6.700	6.560
Cube 9 (28 days)	6.610	6.220

Table No. 6 Water Absorption of Conventional Concrete Cube

B) Water Absorption of Added 15% Bio-Medical Waste Ash Concrete Cube (M25)

Cube	Without Absorption	With Absorption
Cube 1 (7 days)	6.520	6.560
Cube 2 (7 days)	6.450	6.550
Cube 3 (7 days)	6.450	6.550
Cube 4 (14 days)	6.620	6.740
Cube 5 (14 days)	6.550	6.660
Cube 6 (14 days)	6.650	6.760
Cube 7 (28 days)	6.420	6.530
Cube 8 (28 days)	6.620	6.730

Cube 9 (28 days)	6.630	6.740
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Table No. 7 Water Absorption of Added 15% Bio-Medical Waste Ash Concrete Cube

Result and Analysis

Slump Test

Trial	w/c ratio	Slump Value(mm)	Remarks
Trial 1	0.4	30	Target Slump not achieved
Trial 2	0.45	50	Target Slump not achieved
Trial 3	0.5	120	Desired Slump value is obtained (Slump >100mm)

Table No. 8 Slump test on Trial Mixes

Compressive Strength of Conventional Concrete Cubes

- The compressive strength of ordinary concrete with different water cement ratio was tested.
- Material taken for making cubes

Material	Quantity For 1 Cube (in Kg)	Quantity For 9 Cubes (in Kg)
Cement	2.88	25.92
Fine Aggregate (sand)	3.20	28.8
Coarse Aggregate	6.20	55.8

Table No. 9 Material taken for making 9 cubes

- Reading taken in Compressive Testing Machine

M25 Conventional Cube	Number of Days	Value in Compressive Testing Machine (in KN)
Cube 1	7 days	460 KN
Cube 2	7 days	400 KN
Cube 3	7 days	430 KN
Cube 4	14 days	480 KN
Cube 5	14 days	440 KN
Cube 6	14 days	470 KN
Cube 7	28 days	450KN
Cube 8	28 days	470KN
Cube 9	28 days	490KN

Table No. 10 Reading taken in Compressive Testing Machine

➤ Calculation of Value (in KN) by Compressive Testing Machine 1 Kilonewton = 1000 Newton, 1 KN = 1000 N

➤ Compressive Strength = Load / Cross-Sectional Area

where, Load = Load by Compressive Testing Machine × 1000

➤ Area of Cube in mm² = 150mm × 150mm, = 22500 mm²

➤ Reading for Compressive Strength (in N/mm²)

M25 Conventional Cube	Number of Days	Value in Compressive Testing Machine (in KN)	Compressive Strength (in N/mm ²)
Cube 1	7 days	460 KN	20.45 N/mm ²
Cube 2	7 days	400 KN	17.78 N/mm ²
Cube 3	7 days	430 KN	19.12 N/mm ²
Cube 4	14 days	480 KN	21.34 N/mm ²
Cube 5	14 days	440 KN	19.56 N/mm ²
Cube 6	14 days	470 KN	20.89 N/mm ²
Cube 7	28 days	470 KN	20.89 N/mm ²
Cube 8	28 days	480 KN	21.33 N/mm ²
Cube 9	28 days	460 KN	20.44 N/mm ²

Table No. 11 Reading for Compressive Strength (in N/mm²)

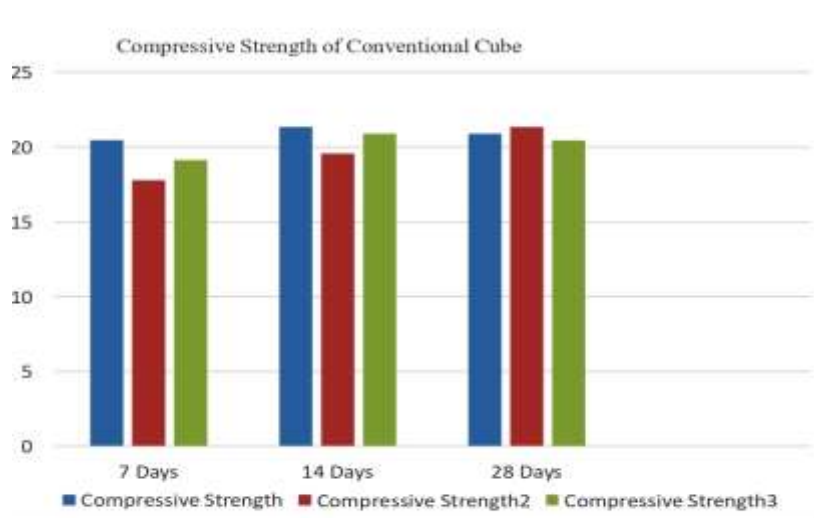


Fig. No. 1 Compressive Strength of Conventional Cube

Fig. No. 9

Add 15% of Bio-Medical Waste Ash by Partial Replacement of (Sand) for Concrete Cube of Grade (M25)

➤ Material taken for making 9 cubes

Material	Quantity For 1 Cube (in Kg)	Quantity For 9 Cubes (in Kg)
Cement	2.88	25.92
Fine Aggregate (sand)	3.20	28.8-4.32 = 24.48
Coarse Aggregate	6.20	55.8
Add 15% Bio-Medical Waste Ash	0.48	4.32

Table No. 12 Material taken for making 9 cubes

➤ Add 15% of Bio-Medical Waste Ash by Partial Replaced by Fine Aggregate (Sand)

$$= 28.8 / 100 \times 15 = 4.32 \text{ kg}$$

➤ kg of Bio-Medical Waste Ash has Added and Rest is Fine Aggregate (Sand)

➤ Reading taken in Compressive Testing Machine

M25 Add 15% Bio-Medical Waste Ash Cube	Number of Days	Value in Compressive Testing Machine (in KN)
Cube 1	7 days	530 KN
Cube 2	7 days	560 KN
Cube 3	7 days	590 KN
Cube 4	14 days	430 KN
Cube 5	14 days	400 KN
Cube 6	14 days	460 KN
Cube 7	28 days	450 KN
Cube 8	28 days	480 KN
Cube 9	28 days	490 KN

Table No.13 Reading taken in Compressive Testing Machine

➤ Now, Calculation of Value (in KN) by Compressive Testing Machine 1 Kilonewton = 1000 Newton , 1 KN = 1000 N

➤ Compressive Strength = Load / Cross-Sectional Area Where, Load = Load by Compressive Testing Machine × 1000

$$\text{Area of Cube in mm}^2 = 150\text{mm} \times 150\text{mm}, = 22500 \text{ mm}^2$$

➤ Reading for Compressive Strength (in N/mm²)

M25 Add 15% Bio-medical waste Ash Cube	Number of Days	Value in Compressive Testing Machine (in KN)	Compressive Strength (in N/mm ²)
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Cube 1	7 days	530 KN	23.56 N/mm ²
Cube 2	7 days	560 KN	24.89 N/mm ²
Cube 3	7 days	590 KN	26.23 N/mm ²
Cube 4	14 days	430 KN	19.12 N/mm ²
Cube 5	14 days	400 KN	17.78 N/mm ²
Cube 6	14 days	460 KN	20.45 N/mm ²
Cube 7	28 days	450 KN	20.00 N/mm ²
Cube 8	28 days	480 KN	21.33N/mm ²
Cube 9	28 days	490 KN	21.78N/mm ²

Table No. 14 Reading for Compressive Strength (in N/mm²)

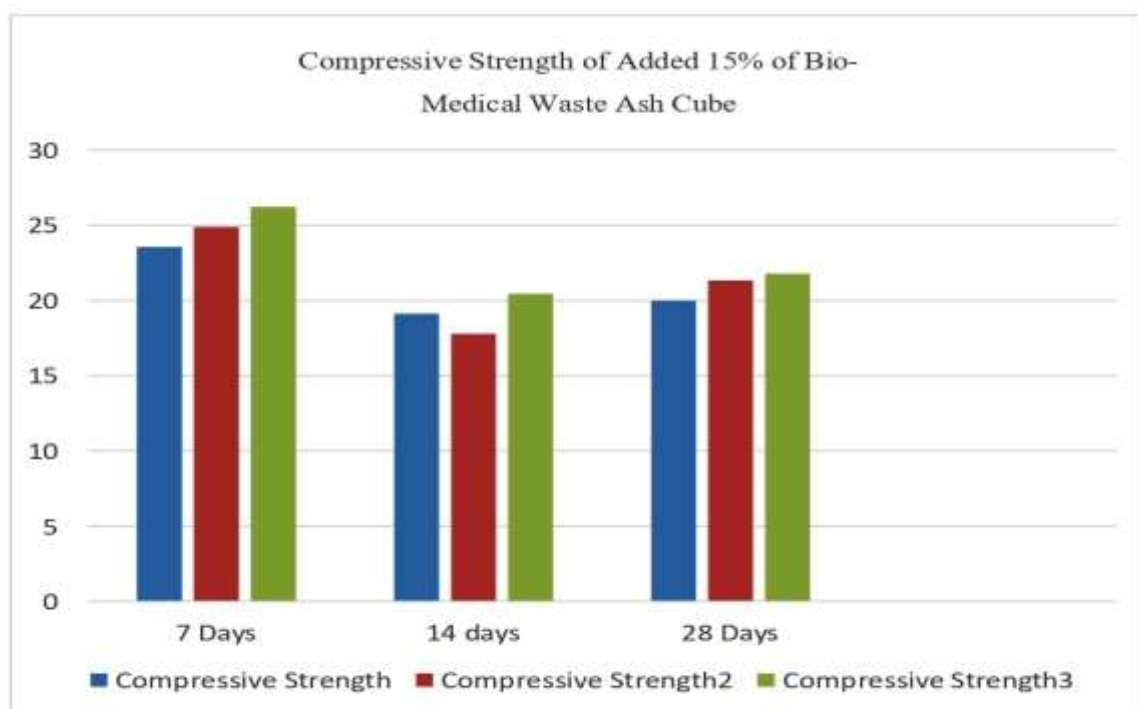


Fig. No. 2 Compressive Strength of Added 15% of Bio -Medical Waste Ash Cube

Fig. No. 10

Compression Between Concrete Cube

Comparing Conventional Concrete Cube with 15% Add Bio-Medical Waste Concrete Cube

Days	Conventional Cube (M25)	Add 15% Bio-Medical Waste Cube
7 Days	19.12 N/mm ²	24.23 N/mm ²

14 Days	20.89 N/mm ²	19.12 N/mm ²
28 Days	20.89 N/mm ²	21.33 N/mm ²

Table No. 15

Comparing Conventional Concrete Cube with 15% Add Bio-Medical Waste Concrete Cube

Comparing Conventional Concrete Cube with 20% Add Bio-Medical Waste Concrete Cube

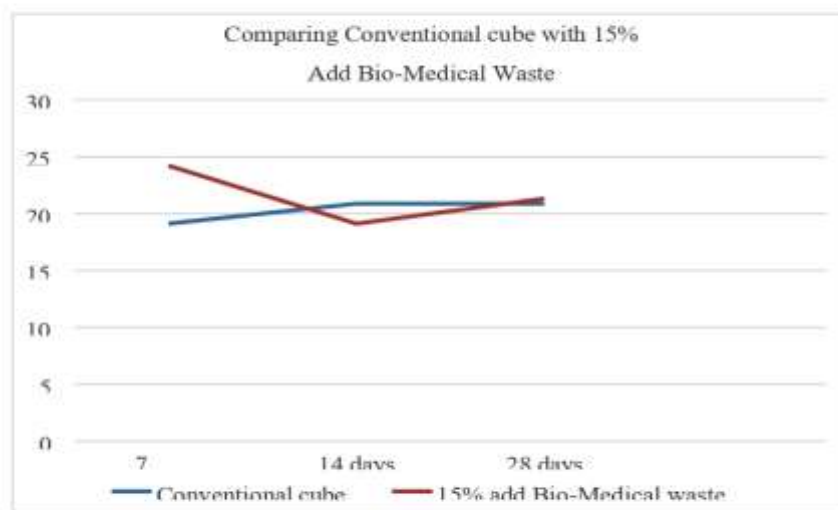


Fig. No. 3 Comparing Conventional cube with 15% Add Bio-Medical Waste

Comparing Conventional Concrete Cube with 20% Add Bio-Medical Waste Concrete Cube

Fig.No. 10

Days	Conventional Cube (M25)	Add 20% Bio-Medical Waste Cube
7 Days	19.12 N/mm ²	24.89 N/mm ²
14 Days	20.89 N/mm ²	22.78 N/mm ²
28 Days	20.89 N/mm ²	24.89 N/mm ²

Table No. 16 Comparing Conventional Concrete Cube with 20% Add Bio-Medical

Waste Concrete Cube

Comparing Conventional Concrete Cube with 25% Add Bio-Medical Waste Concrete Cub

Days	Conventional Cube (M25)	Add 25% Bio-Medical WasteCube
7 Days	19.12 N/mm ²	16.89 N/mm ²
14 Days	20.89 N/mm ²	16.00 N/mm ²
28 Days	20.89 N/mm ²	14.67 N/mm ²

Table No. 17 Comparing Conventional Concrete Cube with 25% Add Bio-Medical

Waste Concrete Cube

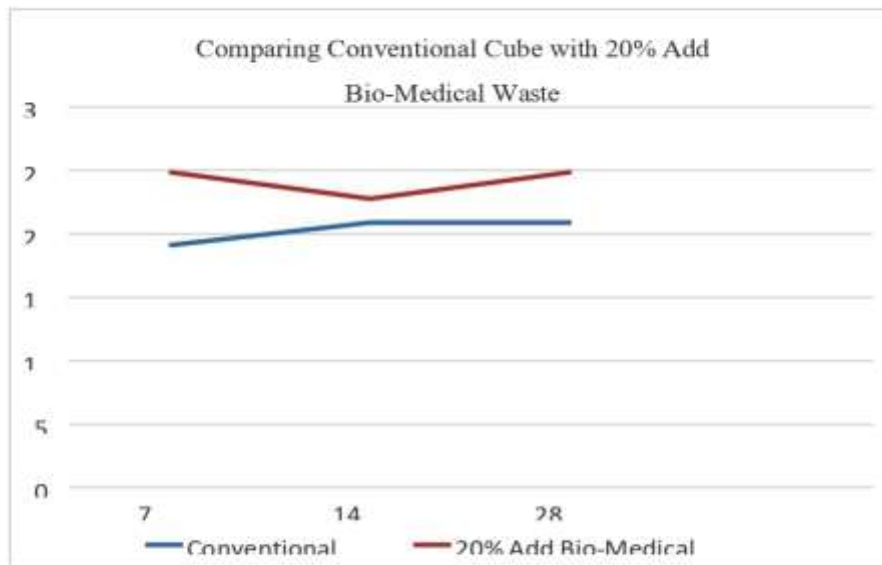


Fig. No.4 Comparing Conventional Cube with 20% Add Bio-Medical Waste

Comparing Conventional Concrete Cube with 25% Add Bio-Medical Waste Concrete Cub

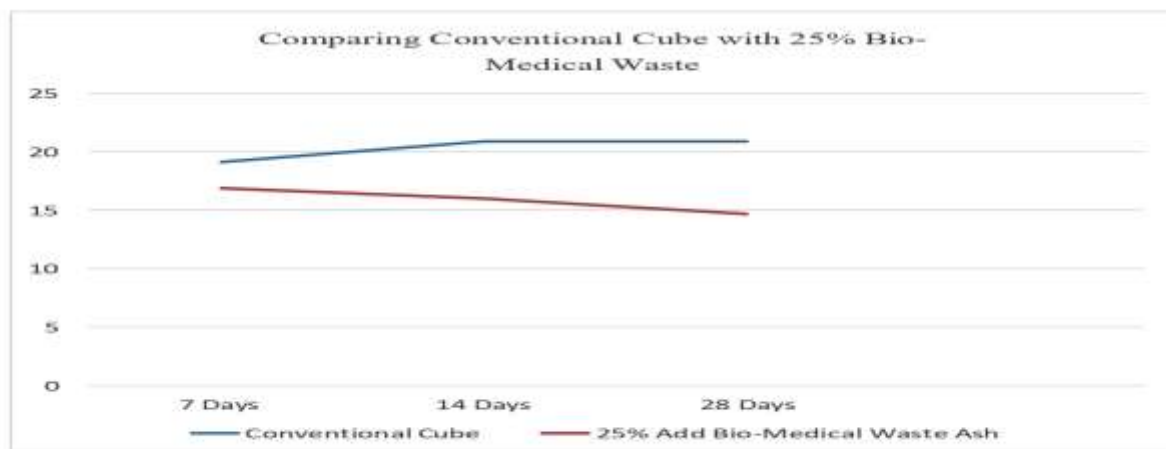


Fig. No. 5 Comparing Conventional Cube with 25% Bio- Medical Waste

Comparing Conventional Concrete Cube with 5% Add Bio-Medical Waste Concrete Cube

Days	Conventional Cubes (M25)	Add 5% Bio-Medical Waste Cube
7 Days	19.12 KN	18.67N/mm ²
14 Days	20.89 KN	20.44N/mm ²
28 Days	20.89 KN	20.00N/mm ²

Table No. 19 Comparing Conventional Concrete Cube with 05% Add Bio-Medical Waste Concrete Cube
Comparing Conventional Concrete Cube with 15%,20%,25% Add Bio-Medical Waste Concrete Cub

Bio-Medical Waste Ash					
Days	Conventional Cubes (M25)	15%	20%	20%	25%
7 Days	19.12 N/mm ²	24.23 N/mm ²	24.89 N/mm ²	24.89 N/mm ²	16.89 N/mm ²
14 Days	20.89 N/mm ²	19.12 N/mm ²	22.78 N/mm ²	22.78 N/mm ²	16.00 N/mm ²
28 Days	20.89 N/mm ²	21.33 N/mm ²	24.89 N/mm ²	24.89 N/mm ²	14.67 N/mm ²

Table No.20

Comparing Conventional Concrete Cube with 15%,20%and 25% Add Bio-Medical Waste Concrete Cube

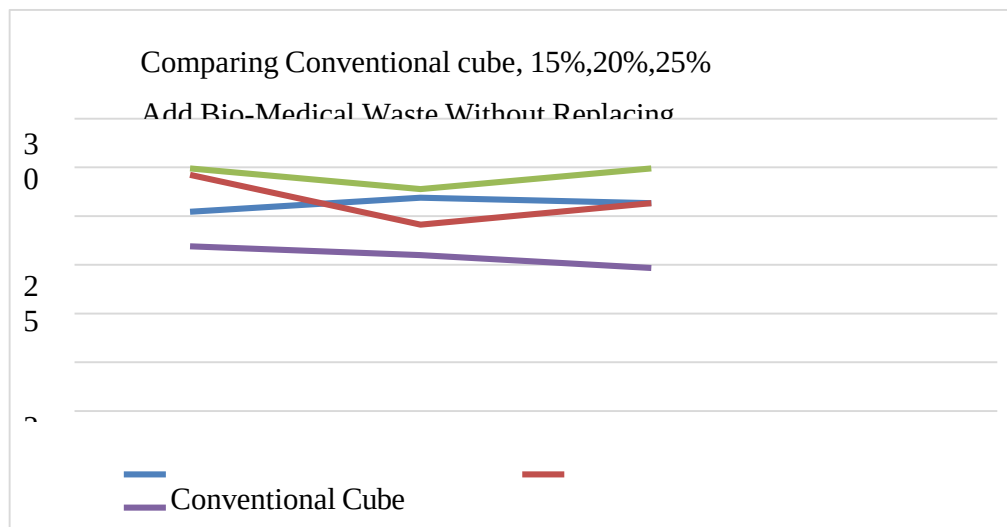


Fig. No. 14

Comparing Conventional cube, 15%,20%,25% Add Bio-Medical Waste Without Replacing

5. Conclusion

1. Treated biomedical waste ash can be used as a partial replacement material in concrete for sustainable waste management.
2. Increasing BWA content may reduce the workability and density of concrete.
3. Properly optimized BWA replacement can provide satisfactory mechanical strength and durability.
4. Its utilization helps reduce biomedical waste disposal and conserve natural construction resources.
5. Further studies are required to determine optimum replacement levels and ensure long-term safety and performance.

Limitation of Bio-Medical waste on Concrete

Concrete has limitations in biomedical waste management due to its potential for contamination, chemical degradation, and environmental risks. It may also involve high transportation and maintenance costs and may not satisfy strict biomedical waste regulations. Therefore, specialized treatment methods such as sterilization, autoclaving, and controlled incineration are generally preferred. Concrete may be used only as secondary containment with suitable protective liners or coatings.

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