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An Investigation Of Effect Of Bio-Medical Waste On Concrete

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CHAPTER – I

Overview of Present Work

Summary:

- By study of literature review we used M25 grade of concrete.
- From the paper we can say that we want compressive strength of M25 grade of concrete for 28 days.
- From the paper we can say that the project is eco-friendly and reduces the cost of construction.
- We use recycled bio medical waste for making concrete cube.

1.1 Introduction

Biomedical waste, a byproduct of medical activities, presents a multifaceted challenge due to its hazardous nature. It comprises materials contaminated with infectious or potentially infectioussubstances, necessitating careful management to prevent public health risks and environmental degradation. In India, where the volume of biomedical waste generated daily is substantial, effective strategies for its management are imperative.

The diverse sources of biomedical waste encompass health clinics, hospitals, laboratories, physicians' offices, dental facilities, veterinary clinics, and providers of home healthcare services. Such establishments collectively contribute to the significant volume of biomedical waste produced each day, estimated at around 405,702 kilograms in India alone.

Despite efforts to address this issue, the proper disposal of biomedical waste remains a challenge. Statistics indicate that only about 72% of biomedical waste is disposed of correctly, leaving over 28% unattended. This gap in management poses serious risks to public health and the environment, potentially leading to the spread of infections and contamination of air, water, and soil.

To mitigate these risks, it is imperative to prioritize the proper management and disposal of biomedical waste. This involves the implementation of effective strategies and protocols at every stage, from generation to final disposal. Key aspects of proper management include:

Segregation at the Source: Healthcare facilities must segregate biomedical waste at the point of generation to separate infectious waste from non-infectious or general waste. This ensures safer handling and facilitates appropriate treatment.

Safe Handling and Transportation: Trained personnel equipped with appropriate protective gear should handle biomedical waste to minimize the risk of exposure. Secure containers and vehicles designed for transporting hazardous materials are essential to prevent spills or leaks during transit.

Treatment and Disposal: Biomedical waste must undergo treatment to inactivate infectious agents and reduce its hazardous nature. Methods such as autoclaving, incineration, chemical treatment, or microwave irradiation are commonly employed. Properly treated waste can then be safely disposed of through landfilling or other approved methods.

Regulatory Compliance: Adherence to national and local regulations governing biomedical waste management is essential. This includes obtaining necessary permits, maintaining records, and regularly auditing waste management practices to ensure compliance with standards and guidelines.

Public Awareness and Education: Educating healthcare workers, waste handlers, and the general public about the risks associated with improper biomedical waste management is crucial. Training programs and awareness campaigns can promote responsible practices and foster a culture of environmental stewardship.

By implementing these measures, the risks associated with biomedical waste can be minimized, protecting both human health and the environment. It is essential for stakeholders, including government agencies, healthcare providers, waste management companies, and the public, to collaborate effectively in addressing this pressing issue. Through concerted efforts, we can ensure the safe and sustainable management of biomedical waste while safeguarding communities and ecosystems for future generations.

1.2 Background of Present Work

The disposal of biomedical waste ash, originating from various medical facilities, poses significant environmental risks. India alone generates 4,05,702 kg of biomedical waste daily, with only 72% of it being properly treated. Incineration is a common method for treating biomedical waste, resulting in ash that is typically disposed of in landfills, requiring extensive land use. To address this issue, the construction industry is evolving through innovative construction techniques and the development of high-performance materials like high-strength concrete.

In recent decades, extensive research has focused on enhancing the strength and durability of concrete, leading to the incorporation of novel ingredients to meet industry demands. In an experimental study, biomedical waste incinerator ash (BMIA) was utilized as a partial replacement for fine aggregate in concrete mixes of M25 grade. Various proportions of BMIA were substituted for fine aggregate, ranging from 0% to 25% by weight, to assess the fresh, mechanical, and durability properties of the resulting concrete.

The primary objective was to investigate the impact of adding 5% biomedical waste ash on the compressive strength properties of concrete, using plain Cement Concrete (PCC) as a reference. The study revealed several advantages, including cost-effectiveness, reduced density, decreased wear, and the potential for recycling with minimal environmental impact. Consequently, alongside improvements in concrete's physical properties, this approach contributes to sustainable waste management practices.

This research initiative delves into a critical issue faced by India: the management of hospital biomedical waste (BMW). BMW presents significant environmental challenges due to its hazardous nature, necessitating innovative solutions for its safe disposal. By exploring the integration of BMW into concrete, this study aims to address both waste management concerns and promote sustainable practices within the construction sector.

The experimental methodology entails incorporating varying proportions of BMW into concrete mixtures and evaluating its impact on several mechanical and durability properties. Key parameters under scrutiny include compressive strength, flexural strength, permeability, and resistance to aggressive environments. By comparing these results with those of conventional concrete, researchers can gauge the feasibility and potential benefits of BMW utilization in concrete production.

This research holds promise for several reasons:

1. Environmental Sustainability: By diverting BMW from traditional disposal methods, such as landfilling or incineration, into a useful construction material like concrete, the study contributes to environmental sustainability. It helps mitigate the adverse impacts of BMW on soil, water, and air quality.

2. Waste Management Innovation: Integrating BMW into concrete offers a novel waste management strategy, potentially reducing the burden on existing disposal infrastructure. It provides an avenue for repurposing a hazardous waste stream into a valuable resource.

3. Enhanced Concrete Performance: The study explores whether incorporating BMW influences concrete's mechanical and durability properties. If successful, it could lead to the development of concrete formulations with improved characteristics, thus enhancing construction quality and longevity.

4. Promotion of Sustainable Construction Practices: By demonstrating the viability of using BMW in concrete production, the research advocates for sustainable practices within the construction industry. It encourages stakeholders to embrace eco-friendly alternatives and reduce their environmental footprint.

5. Addressing Regulatory Compliance: As environmental regulations become increasingly stringent, finding sustainable solutions for BMW disposal becomes imperative. This research aligns with regulatory goals by offering a practical approach to managing hazardous waste while complying with environmental standards.

Ultimately, the research aims to foster a paradigm shift in the construction sector by promoting the adoption of sustainable practices and addressing the multifaceted challenges associated with BMW disposal. By offering insights into alternative waste management strategies and potential enhancements to concrete performance, the study paves the way for a more environmentally conscious and resilient built environment.

1.1 Scope of Present Work

The advantages of Bio-Medical Waste Utilizing concrete as a means to diminish the volume of Bio-Medical Waste (BMW) presents a promising avenue for enhancing strength and reducing costs. Research indicates that incorporating BMW ash as a partial substitute for cement in fresh concrete can effectively mitigate waste management concerns while potentially bolstering the material's mechanical properties. Despite a marginal reduction in compressive strength, BMW-infused concrete maintains a substantial portion of its strength, hinting at its potential as an alternative cementitious material.

Furthermore, the workability of concrete containing BMW ash tends to be lower compared to conventional concrete, and its density may experience a slight decline with higher replacement levels. However, up to a 15% replacement level, the density remains close to that of conventional concrete, offering a viable compromise. Additionally, while the compressive strength may decrease with BMW ash incorporation, the material demonstrates enhanced stability, particularly in bitumen for road construction, suggesting improvements in road infrastructure durability.

In summary, utilizing BMW in concrete production offers numerous benefits, including reducing BMW volumes, enhancing strength, potentially reducing costs, and promoting sustainability. However, considerations such as workability and density variations necessitate careful mix design and construction techniques to optimize performance. The ease of working with concrete containing bio-medical waste ash is inferior to that of conventional concrete. Additionally, the compressive strength of the concrete diminishes with the inclusion of bio-medical ash in comparison to conventional concrete.

Bio-Medical mix exhibits more stability as compared to control mix, that indicate the fact that bio-medical waste improves the properties of bitumen. Use of bio-medical waste in rode construction proves to be one of the safest mechanism to dispose off bio- medical waste plastic.

The utilization of Bio-Medical Waste (BMW) in concrete production offers several advantages, as highlighted by your provided information:

Reducing BMW Levels: By incorporating BMW into concrete, this approach contributes to reducing the overall volume of BMW generated. Instead of disposing of BMW through traditional methods like landfilling or incineration, which can pose environmental and health risks, utilizing it in concrete repurposes the waste material effectively.

Strength Enhancement: The addition of BMW to concrete mixtures can lead to an increase in strength. Despite the reduction in compressive strength compared to conventional concrete, the BMW concrete still maintains a significant portion of its strength. This suggests that BMW can serve as a viable alternative material to enhance the mechanical properties of concrete.

Cost Reduction: Utilizing BMW as a partial replacement for cement in concrete production can potentially reduce costs. This cost-saving aspect is beneficial both economically and environmentally, as it provides a more sustainable and affordable solution for waste management while maintaining concrete performance.

Sustainability: The incorporation of BMW into concrete aligns with sustainability goals by reducing the reliance on conventional raw materials and promoting the circular economy concept. By utilizing waste materials in construction, this approach contributes to resource conservation and reduces the environmental impact associated with traditional construction practices.

Stability in Road Construction: The use of BMW in bitumen for road construction demonstrates improved stability compared to conventional mixes. This indicates that BMW can enhance the properties of bitumen, making it a safer and more sustainable option for disposing of BMW plastic waste while also improving road infrastructure durability.

Density and Workability Considerations: While the density of concrete may decrease slightly with increasing BMW replacement levels, the density remains comparable to conventional concrete at lower replacement levels. Additionally, the workability of concrete may decrease with the incorporation of BMW, but this can be managed through adjustments in mix design and construction techniques.

In summary, the utilization of BMW in concrete production offers a multifaceted solution to address waste management challenges, enhance concrete properties, reduce costs, and promote sustainable construction practices. Through innovative approaches like these, the construction industry can play a significant role in mitigating environmental impacts and advancing towards a more circular and sustainable economy

1.2 Objectives and Scope

This study aims to explore how Bio-Medical Waste ash influences the physical characteristics of concrete. The objectives of this research endeavor are to examine and understand the impact of Bio-Medical Waste ash on concrete's physical properties.The primary aim of this study is to assess the impact of incorporating Bio-Medical Waste (BMW) ash on the physical properties of concrete. To achieve this overarching goal, the research is guided by specific objectives:

Variation in Compressive Strength: The first objective involves examining how the addition of BMW ash affects the compressive strength of concrete. This entails conducting tests to measure the compressive strength of concrete samples containing different proportions of BMW ash and comparing these results with those of conventional concrete mixes. By analyzing the variation in compressive strength, researchers can determine the effectiveness of BMW ash as a supplementary material in concrete production.

Comparison with Conventional Concrete: Another objective is to compare the compressive strength of BMW ash concrete with that of conventional concrete. This comparison provides valuable insights into the performance of BMW ash concrete relative to traditional concrete mixes. It helps evaluate whether BMW ash can serve as a viable alternative or additive in concrete manufacturing without compromising structural integrity or durability.

The scope of the project extends beyond the laboratory tests and analysis to encompass broader environmental and sustainability considerations:

Bio-Medical Waste Reduction: By utilizing BMW ash in concrete production, the project contributes to sustainable waste management practices aimed at reducing the environmental burden of BMW. Instead of disposing of BMW ash through conventional means, such as landfilling or incineration, its incorporation into concrete provides a constructive outlet for waste material, thereby minimizing its impact on the environment.

Sustainable Waste Management Technique: The project aligns with the broader goal of promoting sustainable waste management techniques. By repurposing BMW ash as a construction material, the study advocates for the adoption of innovative and environmentally friendly solutions to address waste management challenges. This approach not only reduces the volume of waste sent to landfills but also maximizes the value extracted from waste materials through their integration into valuable products like concrete.

In summary, this research initiative seeks to not only investigate the technical feasibility of using BMW ash in concrete but also contribute to sustainable waste management practices and environmental conservation efforts. By addressing both technical and environmental objectives, the project aims to pave the way for the adoption of eco-friendly practices in the construction industry while simultaneously mitigating the adverse impacts of BMW on the environment.

The scope of this project is to reduce Bio -Medical Waste from environment by sustainable waste management technique.

Keywords - c

CHAPTER – II

Literature Review

2.1 Earlier Research:

2.1.1 Uma Devi., Prof. R. Rathig.(March 2019) "Effective Utilization of Bio-Medical Waste in Construction Industry". International Journal of Innovative Research in Science Engineering".

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.

2.1.2 Ghulam Mustafa Khanzada, Bashir Ahmed Memon. (JAN–JUN, 2020) "Effect of Bio-Medical Waste on Compressive Strength of Concrete Cylinders''

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.

To mitigate the adverse effects, various strategies could be explored, such as optimizing the proportion of biomedical waste ash in concrete mixtures, investigating different treatment methods to enhance the properties of biomedical waste ash, and exploring the use of additives or admixtures to improve the workability and strength of concrete containing biomedical waste ash. Additionally, rigorous testing and evaluation procedures should be implemented to ensure that the concrete meets the in concrete production can be fully realized, contributing to both environmental sustainability and the efficient utilization of resources in the construction industry.

2.1.3 Udit Kumar, Vikas Srivastava, Amit Kumar Singh.(June 2016)" Appropriateness of Biomedical Waste Ash for Use in Concrete

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**.**

2.1.4 Sathvik S, Suchith. S, Edwin. (April 2019) "Utilizing Biomedical Waste Ash as Partial Replacement in Concrete"

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. These initiatives aim to maximize the utilization Incorporating biomedical waste ash into concrete production while maintaining the necessary properties. and minimizing detrimental effects on both structural performance and environmental sustainability within construction practices. By addressing these concerns comprehensively, the construction industry can effectively harness the benefits of incorporating biomedical waste ash while mitigating associated drawbacks..

2.1.5 Tina Maria Sunny(2018"Utilization of Biomedical Plastic Waste in Asphalt Road Construction." 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.

The improved properties observed in mixes containing biomedical plastic waste suggest several advantages. Firstly, the addition of biomedical plastic waste may contribute to the overall strength and stability of the bituminous mix. This could lead to roads with increased longevity and reduced maintenance requirements, thus offering cost savings over time.

Moreover, incorporating biomedical plastic waste into bituminous mixes could offer environmental benefits. By diverting plastic waste from landfills or incineration, it helps mitigate It helps reduce environmental pollution and preserves natural resources. Furthermore, incorporating biomedical plastic waste into road construction aligns with sustainability goals by promoting circular economy principles, where waste materials are repurposed into valuable resources.

However, while the potential benefits of incorporating biomedical plastic waste into bituminous mixes are significant, several considerations must be addressed. These include ensuring compatibility between the plastic waste and bituminous materials, assessing long-term performance and durability, and complying with regulatory standards for road construction materials.

In conclusion, The application of biomedical plastic waste in bituminous mixes offers a potential solution to tackle waste management issues while enhancing the efficiency and sustainability of road infrastructure.By pursuing further research, conducting rigorous testing, and fostering collaboration between stakeholders, the effective and responsible integration of biomedical plastic waste into bituminous mixes can be realized, contributing to more resilient and eco-friendly road networks. environmentally acceptable way to promote sustainable building is with pervious concrete. Its capacity to retain precipitation and replenish.

Pervious concrete can play a major role in decreasing storm water runoff and preserving ground water. Owing to its ability to decrease runoff, it is frequently utilized as a pavement material. Higher compressive strengths and higher permeability rates should be produced by coarse aggregate with smaller particle sizes. The best infiltration rate and maximum compressive strength are anticipated from the appropriate pervious concrete mix. Pervious concrete stands out as a highly favored material within the concrete industry due to its environmentally friendly characteristics.

CHAPTER – No. **III**

FORMULATION OF PROJECT

CHAPTER – III

Formulation Of Project

3.1 Aim:

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

3.2 Objectives:

- To carried out various physical test on materials.
- To cast the cube by using Biomedical waste ash.
- To design The concrete cube is formed by substituting sand with Bio-Medical Waste Ash..
- To improve workability by using admixtures in concrete.

➢ **Methodology:**

➢ **Collect the material as per requirement**

The materials utilized in this research are...

Cement	**:**	(OPC) Ordinary Portland Cements
M-Sand	**:**	M sand
Bio-Medical Waste Ash	**:**	The material available in Incinerators Treatment Plant
Water	**:**	Gathered from nearby freshwater reservoirs
Coarse Aggregate	:	Aggregates that have been sieved to pass through a 20mm IS sieve

***CHAPTER – No.* IV**

MATERIAL TESTING

CHAPTER – IV

Material Testing

4.1 MATERIAL TESTS

4.1.1 TESTS ON CEMENT

Cement plays a vital role in concrete production. The manufacturing process involves grinding the raw materials, intimately mixing them in specific proportions, and then subjecting them to high temperatures ranging from 1300°C to 1500°C in a kiln. Various tests are conducted to evaluate the properties of cement.

1. Standard Consistency
2. Initial Setting Time
3. Final Setting Time
4. Fineness of Cement
5. Density of Cement
6. Soundness of Cement

4.1.1.1 Standard Consistency

Standard consistency of a cement paste refers to the level of consistency at which the Vicat plunger, measuring 10 mm in diameter and 50 mm in length, can penetrate to a depth of 5 to 7 mm from the base of the Vicat mould, as depicted in Figure 3.1. This experiment was conducted following the guidelines outlined in IS 4031-Part IV.

Figure 4.1 displays the equipment used to determine standard consistency.

4.1.1.2 Initial Setting Time

The initial setting time represents the duration from when water is mixed with the cement until the paste begins to lose its plasticity. This experiment was conducted in accordance with IS -269:1989, clause 6.3.

4.1.1.3 Fineness of Cement

Fineness indicates the total surface area of cement, with finer cements having a larger surface area. This property affects various aspects including the rate of hydration, strength development, shrinkage, and heat evolution. The experiment was conducted following the guidelines outlined in IS 4031-Part I 1996.

4.1.1.4 Density of Cement

The density of cement is determined using Le Chatelier's flask, as illustrated in Figure 3.2. Kerosene, a non-reactive substance with cement, is utilized. The experiment is conducted within the confines of Le Chatelier's flask.

Figure 42 : Le Chatelier's Flask

4.1.1.5 Soundness of Cement

The soundness test for cement aims to verify its resistance to any significant expansion after setting. Cement unsoundness can result from an excess of lime, magnesia, or an excessive proportion of sulfates. The experiment is conducted using the Le Chatelier method, and the acceptable value for soundness is 1mm.

4.1.2 Tests on Coarse Aggregate

Aggregates play a crucial role in concrete by providing structure, minimizing shrinkage, and contributing to cost-effectiveness. They typically constitute 70-80 percent of concrete volume, significantly influencing its properties. Various tests are conducted to assess aggregate properties:

1. Measurement of bulk density for coarse aggregates

2. Determination of specific gravity for coarse aggregates

3. Sieve analysis to assess the particle size distribution of coarse aggregates

4.1.2.1 Bulk Density of Coarse Aggregates

Bulk density refers to the mass of material contained within a specific volume, typically measured in kilograms per liter. Several factors influence the bulk density of an aggregate, such as moisture content and the level of compaction during measurement. It indicates the compactness of the aggregate when filled in a standardized manner, influenced by particle size distribution and shape. The experiment followed the procedure outlined in IS 383.

4.1.2.2 Specific Gravity of Coarse Aggregate

The specific gravity of an aggregate serves as an indicator of its strength or quality, with stones exhibiting lower specific gravity being weaker compared to those with higher values. This property is assessed using a wire basket apparatus, as depicted in Figure 3.3. The experiment adheres to the guidelines outlined in IS. 38 3

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Figure 4.3 : Apparatus for specific gravity of coarse aggregate

4.1.2.3 Grain Size Distribution of coarse aggregate

Sieve analysis is conducted to determine the particle size distribution of coarse aggregate, utilizing a sieve shaker as shown in Figure 4.4. This process involves segregating the aggregate sample into different fractions, each containing particles of similar sizes. The experiment follows the procedures outlined in IS 2386-Part I-1963 and IS:383-1970, and involves plotting a gradation curve.

Figure 4.4 : Sieve shaker

4.1.3 Tests on fine aggregate

1. Bulk density of fine aggregate

2. Specific gravity of fine aggregate

3. Sieve analysis of fine aggregate

4.1.3.1 Bulk density of fine aggregate

Bulk density represents the mass of material contained within a specific volume, typically expressed in kilograms per litre. Numerous factors influence the bulk density of an aggregate, such as moisture content and the degree of compaction during measurement. This parameter reflects the compactness of the aggregate when filled according to standardized methods, and is influenced by both particle size distribution and shape. The experiment adhered to the procedure outlined in IS 383.

4.1.3.2 Specific Gravity of fine aggregate

The specific gravity of an aggregate serves as an indicator of its strength or quality. Specifically, it is defined as the ratio of the weight of the fine aggregate to the weight of an equal volume of distilled water at the same temperature, with both weights measured in air. This measurement is conducted using a pycnometer.

Figure 5.5 : Apparatus for specific gravity

4.1.3.3 Sieve Analysis of Fine Aggregate

Sieve analysis, conducted with a sieve shaker as depicted in Figure 4.7, is the process of separating a sample of aggregate into different fractions, each containing particles of uniform size. Standard sieves used for fine aggregate analysis typically include sizes such as 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, and 150µ. The experiment followed the procedures outlined in IS 2386-Part I-1963 and IS:383-1970, and involved plotting a gradation curve.

Figure 4.6 : Sieve shaker

4.2 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.

4.2.1 MIXING OF CONCRETE

The coarse and fine aggregates were weighed, and the concrete mixture was manually prepared on a water-tight platform. Cement and fine aggregates were mixed thoroughly on the platform until achieving a uniform colour. Subsequently, coarse aggregates were added and thoroughly mixed into the mixture. Water was then added cautiously, ensuring no water loss during mixing. Care was taken to add water gradually to prevent bleeding, which could adversely affect concrete strength and cause water rising to the surface, affecting hydration. Clean and oiled moles were placed on the vibrating table for each category and filled in three layers. Vibrations ceased once cement slurry appeared on the top surface of the Mold.

4.2.2 CASTING AND CURING

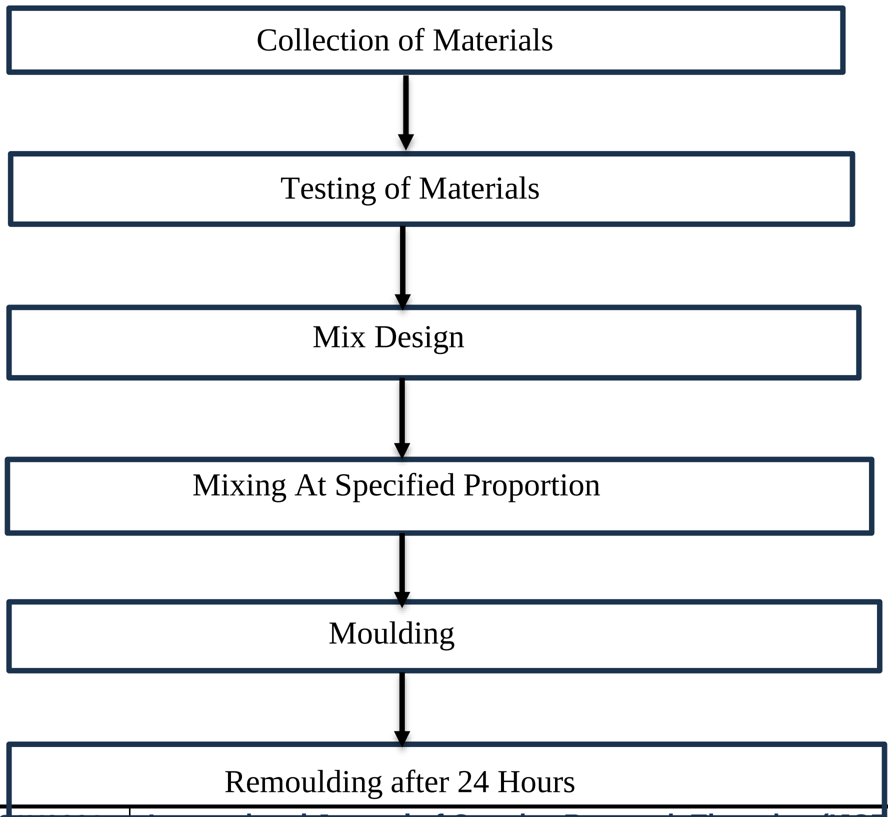
The specimens were left in the steel molds for the initial 24-hour period under ambient conditions. Following this, they were carefully demolded to prevent any breakage of edges and then transferred to a tank at ambient temperature for curing. Upon demolding, the cubes were immersed in water for curing for durations of 7 days, 14 days, and 28 days after loosening the screws of the steel molds.

4.2.3 CASTING OF BIO-MEDICAL WASTE ASH CONCRETE

The predetermined quantities of cement and fine aggregate are thoroughly mixed until a consistent blend is achieved. Bio-Medical waste ash is then incorporated at different proportions, ranging from 15% to 25% of the weight of the fine aggregate. Coarse aggregates are subsequently added to the mixture and mixed thoroughly, after which water is gradually added. Attention must be paid to add water slowly in stages to prevent bleeding, which could compromise the strength development of the concrete. The resulting mixture is placed into molds of standard dimensions, compacted, and finished.

4.2.4 TESTING OF SPECIMEN

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



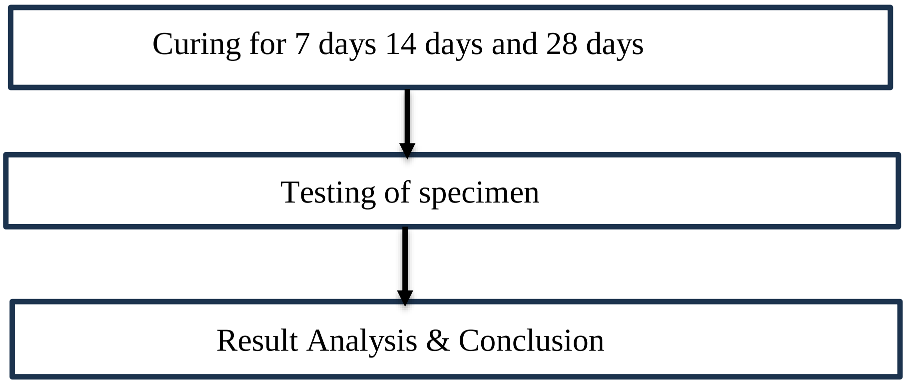


Figure 4.7 : Schematic representation of methodology

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

CHAPTER – No. V

STUDY ON MATERIAL USED

CHAPTER – V

Study On Material Used

5.1 STUDY ON MATERIALS USED

5.1 OVERVIEW

Concrete is a versatile material that can be shaped into various forms when freshly mixed. Unlike other construction materials, concrete is typically produced on-site, and its quality, properties, and performance can vary significantly due to the use of natural materials, with the exception of cement. The properties of the materials are crucial for ensuring the workability and durability of concrete.

The components employed in this investigation include:

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

5.1.1 CEMENT

IS 1489 1991 Part I defines OPC as “An intimately interground mixture of Portland clinker with the possible addition of gypsum (natural or chemical) or an intimate and uniform blending of Portland cement. Ordinary Portland Cement can be produced either by grinding together Portland cement clinker with addition of gypsum or calcium sulphate, or by intimately and uniformly blending Portland cement . The portland materials generally used for manufacture of OPC are calcined clay or fly ash. Ordinary Portland Cement produces less heat of hydration and offers greater resistance to the attack of aggressive waters than normal Portland cement. Moreover, it reduces the leaching of calcium hydroxide liberated during the setting and hydration of cement.

5.1.2 FINE AGGREGATE

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. They occupy about 70-80 percent of the volume of the concrete. Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. They shall be hard, strong, durable, clear and free from veins and adherent coating; and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky and elongated pieces should be avoided. Aggregates can be mainly classified into fine aggregates and coarse aggregates.

IS 383- 1970 defines fine aggregates as “Aggregate most of which passes 4.75mm IS sieve and contains only so much coarser material as permitted.” It may be:

1. Natural sand: Fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies.
2. Crushed stone sand: Fine aggregate produced by crushing hard stone.
3. Crushed gravel sand: line aggregate produced by crushing natural gravel.

In this research work we use Crushed stone sand or M sandFigure4.1

There are four grading zones for fine aggregates such as grading zone I, II, III, and IV. It is recommended that fine aggregate conforming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

Figure 5.1 : M sand

5.1.3 COARSE AGGREGATE

IS 383-1970 defines coarse aggregates as Aggregates most of which is retained on 4.75 mm IS Sieve and containing only so much finer material as is permitted for the various types described in this standardFigure4.2

Coarse aggregates may be described as:

1. Uncrushed gravel or stone which results from natural disintegration of rock,
2. Crushed gravel or stone when it results from crushing of gravel or hard stone, and
3. Partially crushed gravel or stone when it is a product of the blending of uncrushed gravel stone and crushed gravel or stone.

Figure 5.2 : Coarse aggregate

5.1.4 WATER

According to IS 456 : 2000, water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. The pH value of water shall be not less than 6

5.1.5 BIO-MEDICAL WASTE ASH

As it is produced in abundance and therefore cannot be treated or disposed of without special precautions. Generally biomedical waste is burned in incineration plant and produce Incinerated Biomedical Waste Ash (IBWA). It is considered dangerous or lethal because it may contain toxic substances such as heavy metals (hazardous waste).

Incineration produces a residual solid material called biomedical waste ash (BMWA). Incinerated biomedical waste can reduce its environmental impact by being utilized in the construction sector. Numerous studies have shown the detrimental effects of BMWA addition to concrete, which impedes the use of BMWA in the construction industry.

Figure 5.3 : Raw Bio-Medical Waste Ash

5.1.6 PROCEDURE OF GETING BIO-MEDICAL WASTE ASH

Every incinerator is unique, but the most common technique is called “mass burn.” The general process followed in a mass burn incinerator includes five steps

1. **Waste preparation:** Oversized items are removed and certain recyclables like metals are recovered. The remaining waste is often shredded before it enters the incinerator.
2. **Combustion:** Waste is burned in an oxygenated single combustion chamber. Materials are burned at extremely high temperatures of 1,800-2,200 degrees Fahrenheit. At those temperatures, waste should be completely combusted, leaving nothing but gases and ash.
3. **Energy recovery:** The gases released during combustion are cooled with water, generating steam through heat recovery. The steam is used to power electrical generators.
4. **Environmental control:** The cooled gas is treated by scrubbers, precipitators, and filters to remove pollutants. The solids that form during treatment, called residuals, are disposed of in a landfill.
5. **Environmental release:** The treated gas is released into the atmosphere. There should be no visible smoke from the smokestack because the remaining gases should be free from particulates.

As many are quick to point out, incineration still has drawbacks. Not all byproducts of combustion are as beneficial as electricity. Fly ash can be recycled as an ingredient in concrete but is also a hazardous material that contains heavy metals and other pollutants. Incineration can never completely replace landfilling. Waste must be presorted before burning — with oversized and certain hazardous items going to the landfill. But waste also remains after burning. From 15-25% (by weight) of the MSW burned remains as bottom ash that goes to the landfill.

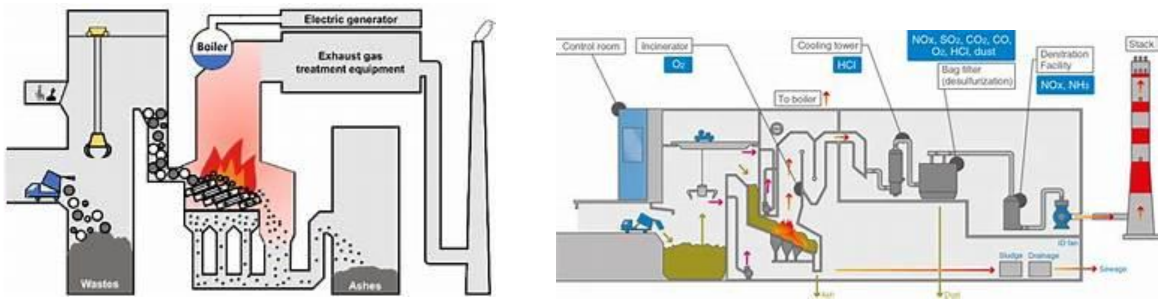


Figure 5.4 : Bio- Medical Waste Ash Incinerator Plant

5.2 TESTS ON MATERIALS– RESULTS AND DISCUSSION

5.2.1 TESTS ON CEMENT

The various tests done on cement are :

1. Standard Consistency
2. Initial Setting Time
3. Final Setting Time
4. Fineness of Cement
5. Density of Cement
6. Soundness of Cement

5.2.1.1 Standard Consistency

The experiment was done as per IS 4031-Part IV and the obtained value of standard consistency is 34 %.

5.2.1.2 Initial Setting Time

Experiment was done as per IS -269:1989, clause 6.3 and the obtained value of initial setting time is 70 min. According to IS code initial setting time of cement shall not be less than 30 minutes.

5.2.1.3 Final setting time

Experiment was done as per IS -269:1989, clause 6.3 and the obtained value of final setting time is 300 min. According to IS code initial setting time of cement should not exceed 10 hours.

5.2.1.4 Fineness of Cement

Experiment was done as per IS 4031-Part I-1996 and the obtained value of fineness of cement is 7%.According to IS code the weight of residue should not exceed 10% for ordinary cement.

5.2.1.5 Density of Cement

Experiment was done in Le Chatelier’s flask and the obtained value of density of cement is 3.09 g/ml. According to IS 4031-Part II-1988 density of cement is around 3.15 g/ml.

5.2.1.6 Soundness of Cement

Experiment was done by Le Chatelier method and the obtained value of soundness of cement is 1mm.According to IS 269:1989-Clause 6.2, the expansion of cement must not exceed 10 mm for ordinary rapid hardening and low heating portland cement.

5.2.2 TESTS ON COARSE AGGREGATE

The various tests done on aggregate are:

1. Bulk density of coarse aggregates
2. Specific gravity of coarse aggregates
3. Sieve analysis of coarse aggregates

5.2.2.1 Bulk Density of Coarse Aggregates

The experiment was carried out as per IS code 2386 part-III-1963 and IS 383.

Diameter of the metal measure, d=25cm

Height of the metal measure, h=21.5cm

Volume of the metal measure, V= 10.55x103 cm3

Weight of the empty metal measure, W =5.5kg

Weight of compacted aggregate + metal measure, W1=19.95 kg

Bulk density of compacted coarse aggregate = 1.37 kg/lit

Weight of loosely packed aggregate + metal measure, W2= 19.1kg

Bulk density of loosely packed aggregate = 1.29 kg/lit

5.2.2.2 Specific Gravity of Coarse Aggregate

The experiment was carried out as per IS code 2386 part-III-1963 and IS 383.

Weight of saturated aggregate suspended in water with the wire basket,A1=2800g

Weight of empty wire basket suspended in water,A2=1550g

Weight of saturated aggregate in water=A1-A2=2800-1550=1250g

Weight of saturated surface dry aggregate in air,B=1992g

Weight of oven dried aggregate in air,C=1985g

Specific gravity= 2.72

Apparent specific gravity=2.75

Water absorption = 0.04685

5.2.2.3 Grain Size Distribution of coarse aggregate

Experiment was done as per IS 2386-Part I-1963,IS:383-1970 and the results are tabulated in Table 4.1. The gradation curve is shown in Figure 4.5.

Weight of sample taken, W=5000g

Is sieve size in mm	Weight retained on each sieve(g)	Percentage retained on each sieve	Cumulative % retained on each sieve	% finer
80	0	0	0	100
40	0	0	0	100
20	42	0.84	0.84	99.16
10	4705	94.1	94.94	5.06
4.75	16	0.32	95.26	4.74

Table 5.1: Results of sieve analysis conducted on Sample

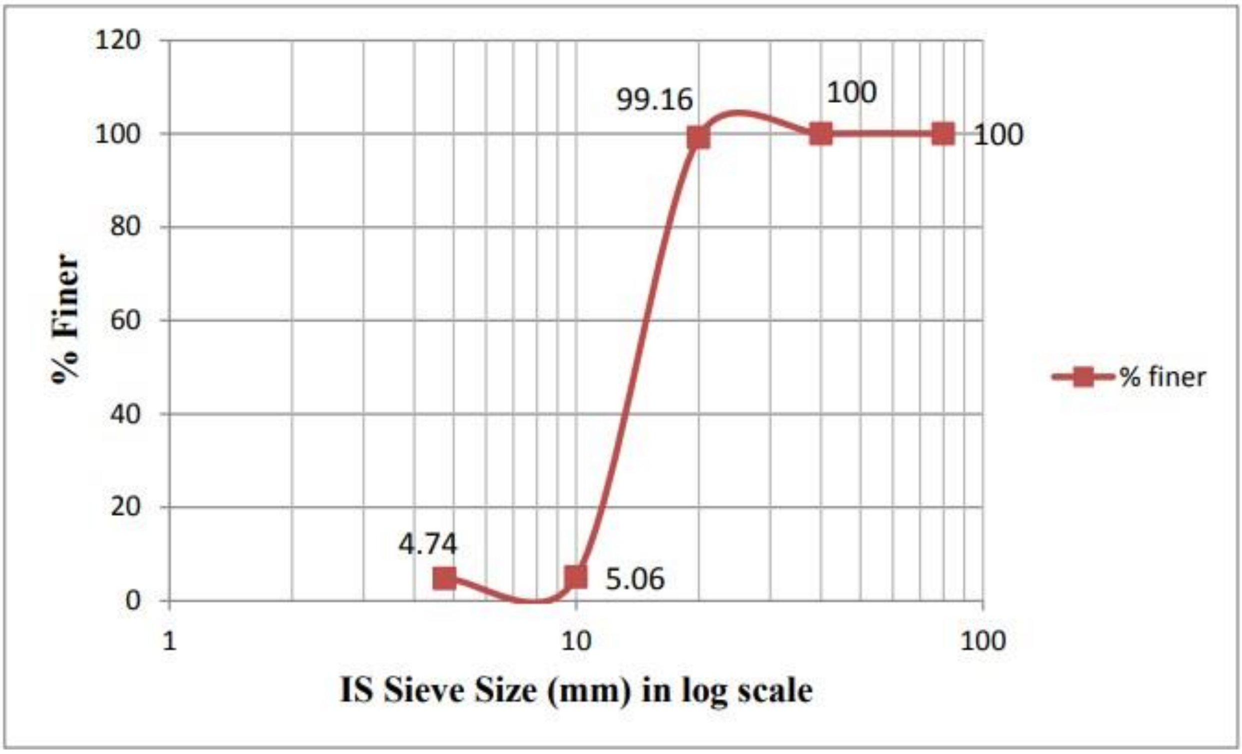


Figure 5.5 : Gradation curve for Coarse Aggregate

5.2.3 TESTS ON FINE AGGREGATE

1. Bulk density of fine aggregate
2. Specific gravity of fine aggregate
3. Sieve analysis of fine aggregate

5.2.3.1 Bulk density of fine aggregate

The experiment was carried out as per IS code 2386 part-III-1963 and IS 383.

Diameter of the metal measure, d=25cm

Height of the metal measure, h=21.5cm

Volume of the metal measure, V= 10.55x103 cm 3

Weight of the empty metal measure, W =5.5 kg

Weight of compacted fine aggregate + metal measure, W1= 24.3kg

Bulk density of compacted coarse aggregate = 1.78 kg/lit

Weight of loosely packed aggregate + metal measure, W2= 23.5 kg

Bulk density of loosely packed aggregate = 1.74 kg/lit

5.2.3.2 Specific Gravity of fine aggregate

The experiment was carried out as per IS code 2386 part-III-1963 and IS 383.

Weight of empty pycnometer =636g

Weight of pycnometer + Msand A =1136g

Weight of pycnometer + aggregate+ water B =1718g

Weight of pycnometer + water C=1395g Specific gravity=2.706

5.2.3.3 Sieve Analysis of Fine Aggregate

Experiment was done as per IS 2386-Part I-1963,IS:383-1970 and the results are tabulated in Table 4.2 and table 4.3 respectively. The gradation curve is shown in Fig 4.6 and Fig 4.7

Sample 1

Weight of sample taken, W = 500g

I.S sieve size	Weight retained on each sieve(g)	Percentage retained on each sieve	Cumulative % retained on each sieve	% finer
4.75 mm	0.680	0.136	0.136	99.864
2.36 mm	0.9	0.18	0.136	99.684
1.18 mm	0.84	0.168	0.484	99.516
600 micron	2.7	0.54	1.024	98.976
300 micron	130	26	27.024	72.976
150 micron	300	60	87.024	12.976
Pan	64.88	12.98	100	0

Table 5.2 : Results of sieve analysis conducted on Sample 1

Fineness modulus = (/ 100) = (116.008/100) = 1.16

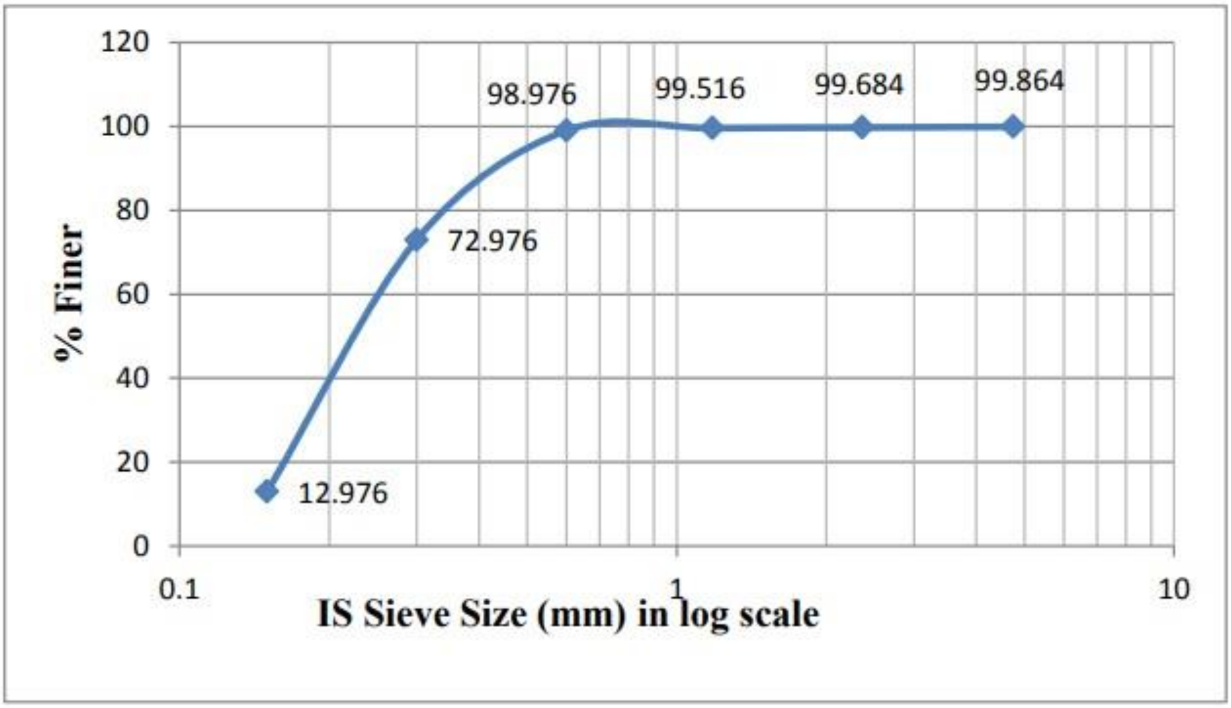


Figure 5.6 : Gradation Curve for Sample 1

Sample 2

Weight of sample taken, W = 1000g

I.S sieve size	Weight retained on each sieve(g)	Percentage retained on each sieve	Cumulative % retained on each sieve	% finer
4.75 mm	23	2.3	2.3	97.7
2.36 mm	205	20.54	22.84	77.16
1.18 mm	185	18.54	41.38	58.62
600 micron	145	14.53	55.91	44.09
300 micron	161	16.13	72.04	27.96
150 micron	149	14.93	86.97	13.03
Pan	130	13.03	100	0

Table 5.3 : Results of sieve analysis conducted on Sample 2

Fineness modulus = (/ 100) = (281.44/100) = 2.814

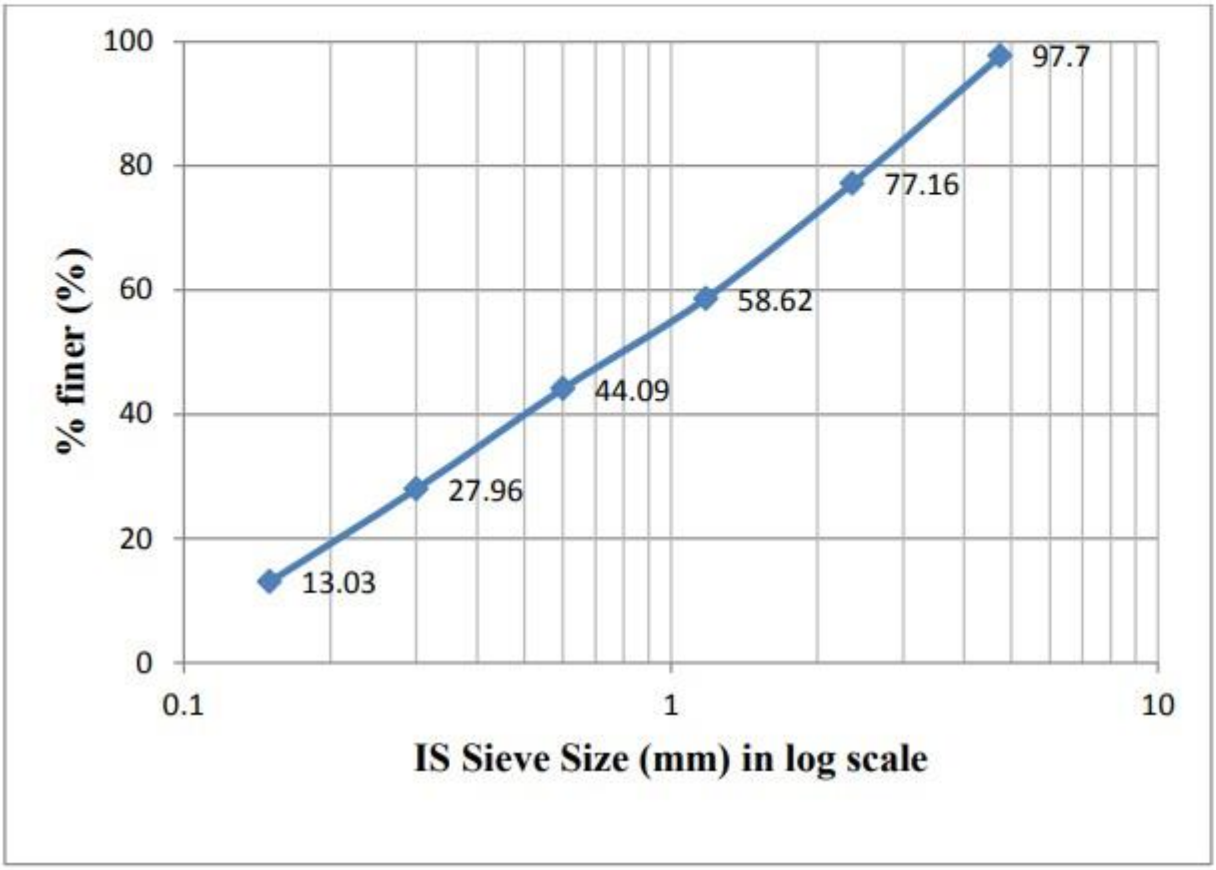


Figure 5.7 : Gradation Curve for Sample 2

5.3 SUMMARY OF MATERIAL PROPERTIES

The physical property of cement, fine aggregate, coarse aggregate and the compressive strength test results of the concrete cube specimens are detailed below.

5.3.1 PROPERTIES OF CEMENT

Properties of Cement is shown in Table 4.4.

Properties	Value Obtained	Limits as per IS 4031
Initial Setting Time	70 minutes	>30
Soundness (expansion)	1mm	<10mm
Density	3.09 g/cc	3.15
Fineness	7%	<10%

Table 5.4 : Properties of Cement

5.3.2 PROPERTIES OF FINE AGGREGATES

Sieve analysis of fine aggregate is done using standard set of IS sieves. The results of tests conducted on Sample are tabulated in Table 4.5

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 5.5 : Properties of Fine Aggregate

5.3.3 PROPERTIES OF COARSE AGGREGATES

The properties of coarse aggregate is shown in Table 4.6

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 5.6 : Properties of Coarse Aggregate

5.4 CASTING AND TESTING OF CONCRETE SPECIMEN

5.4.1 TESTS ON FRESH CONCRETE

5.4.1.1 SLUMP TEST

Slump test is the most commonly used method of measuring consistency of concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of frustum of a cone having the internal dimensions of bottom diameter 20 cm, top diameter 10 cm and a height of 30 cm as shown in Figure 5.1

Figure 5.8 : Slump Testing Apparatus

5.5 TESTS ON HARDENED CONCRETE

5.5.1 COMPRESSIVE STRENGTH TEST

Compressive strength is the capacity of a material or structure to withstand axial loads tending to reduce the size. It is measured using the Universal Testing machine. Concrete can be made to have high compressive strength, e.g. many concrete structures have compressive strengths in excess of 50 MPa. Here the compressive strength of concrete cubes for the plain concrete and fibre reinforced concrete are found out using Compression testing machine. Three cubes were cast for each percentage of fibres and the average of the two compressive strength values was taken. A Compression testing machine is shown in Figure 5.2.

Figure 5.9 : Compression Testing Machine

***CHAPTER – No.* VI**

MIX DESIGN

CHAPTER – VI

Mix Design

6.1 Mix Design

Mix design is defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The mix design must consider the environment that the concrete will be in exposure to sea water, trucks, cars, forklifts, foot traffic or extremes of hot and cold. A Mix design was conducted as per IS 10262-1982 to arrive at M 20 mix concrete.

6.1.1 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

6.1.2 TEST DATA FOR MATERIALS

Cement used : OPC

Standard consistency of cement : 34%

Initial setting time of cement : 70 min

Final setting time of cement : 300 min

Specific gravity of cement : 3.09 g/cc

6.1.3 Specific gravity of

Coarse aggregate : 2.72

Fine agggregate : 2.706

6.1.4 Water absorption of

Coarse aggregate : 0.5%

Fine aggregate : 1%

6.1.5 Free surface moisture of

Coarse aggregate : Nil

Fine aggregate : Nil

6.1.6 Bulk density of

Coarse aggregate : 1.37 kg/l

Fine aggregate : 1.78 kg/l

6.1.7 Sieve analysis

Coarse aggregate : Fineness modulus = 6.91

Fine aggregate : Fineness modulus = 2.814 and Conforming to grading zone 2, Table 4 of IS 383

6.2 TARGET STRENGTH FOR MIX PROPORTIONING

Where,

f'ck = fck+ 1.65 s

f'ck= target average compressive strength at 28 days

f"ck= characteristic compressive strength at 28 days = 20 N/mm2

s = standard deviation = 4 N/mm2 (from Table 1, IS 10262 : 2009)

t = statistical value dependent on expected results

As per IS:456-2000 and IS 1343-1980, the characteristic strength represents the value below which it is anticipated that not more than 5 percent of results will fall. Consequently, the formula simplifies to: Thus, the target strength equals 20 plus 1.65 times 4, resulting in 26.6 N/mm2.

6.3 CHOOSING THE WATER TO CEMENT RATIO

Various parameters like type of cement, aggregate, maximum size of aggregate, surface texture of aggregate etc are influencing the strength of concrete, when water cement ratio remain constant, hence it is desirable to establish a relation between concrete strength and free water cement ratio with materials and condition to be used actually at site.

From Table 5 of IS 456, maximum water cement ratio for M20mix = 0.45

From the trial mixes, water cement ratio is fixed as 0.50

0.50>0.45 hence OK

6.4 SELECTION OF AIR CONTENT

The air content for 20mm aggregate is determined to be 2% of the concrete volume, as specified in Table 4.4 of IS 10262-1982.

Maximum Size of Aggregate(mm)	Entrapped Air, as Percentage of Volume of Concrete
10	3
20	2
40	1

Table 6.1 : Approximate Entrapped Air Content

6.5 SELECTION OF WATER CONTENT

The water content and the proportion of sand in the total aggregate by absolute volume are obtained from Table 2 of IS 10262 : 2009.

The maximum water content for 20mm aggregate is specified as 186 liters for a slump range of 25 to 50 mm.

Estimated water content for 100mm slump = 186 + (6/100*186) = 197 litres

6.6 CALCULATION OF CEMENT CONTENT

The cement content per unit volume of concrete can be determined by dividing the quantity of water per unit volume of concrete by the free water-cement ratio. Given a water-cement ratio of 0.5, the cement content is calculated as 394 kg/m3 from a water quantity of 197 liters. Referring to Table 5 of IS 456, the minimum cement content for severe exposure conditions is 320 kg/m3. Since 394 kg/m3 exceeds 320 kg/m3, the requirement is met.

6.7 RATIO OF VOLUME BETWEEN COURSE AGGREGATE AND FINE AGGREGATE

From Table 3 of IS 10262 : 2009, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (zone 2) for water cement ratio of 0.50 = 0.62

Therefore proportion of volume of fine aggregate = 1 – 0.62 = 0.38

6.8 MIX CALCULATIONS

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

1. The volume of concrete = 1 m^3

2. The volume of the cube = 150mm × 150mm × 150mm
   = 0.15m × 0.15m × 0.15m
   = 0.003375 m^3

3. The dry volume of concrete = 1 × 1.54
   = 1.54 m^3

4. The wet volume of concrete = The product of the dry volume of concrete x volume of the cube
   = 1.54 × 0.003375 m^3
   = 5.1975 × 10^{-3} m^3
   = 0.005197 m^3

6.8.1 Mix Design For M25 Grade Concrete

1) Volume of Cement = $\frac{1\times1.54}{1+1+2} \times 0.005197$

= 0.385 × 0.005197 m^3

= 0.00200845 m^3

Quantity of Cement in KG = 0.00200845 × 1440

= 2.88 kg

2) Volume of Sand (Fine Aggregate) = $\frac{1 \times 1.54}{1+1+2} \times 0.005197$

= 0.385 × 0.005197 m^3

= $0.00200845\ m^3$

Quantity of Sand in KG = 0.00200845×1600

= 3.20 kg

3) Volume of Aggregate = $\frac{2 \times 1.54}{1+1+2} \times 0.005197$

= $0.77 \times 0.005197\ m^3$

= $0.00400169\ m^3$

Quantity of Aggregate in KG = 0.00400169×1800

= 6.20 kg

6.8.2 Mix Design For M25 Grade Concrete For 9 Cubes

a) Quantity of Cement for 9 Cubes (in kg)

= 2.88×9

= 25.92 kg

b) Quantity of Sand (Fine Aggregate) for 9 Cubes (in kg)

= 3.20×9

= 28.8 kg

c) Quantity of Aggregate for 9 Cubes (in kg)

= 6.20×9

= 55.8 kg

d) Quantity of Water = Quantity of Cement % 45

= 25.92 % 45

= 11.66 kg

Summery

Cement = 25.92 kg/m^3

Water = 11.66 kg/m^3

Fine aggregate (Sand = 28.8 kg/m^3

Coarse aggregate = 55.8 kg/m^3

Admixture = 3.85 kg/m3 (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 6.2 : The multiplication of the dry volume of concrete and the volume of the cube

6.8.3 Methodology of Compressive Testing for Strength and Water Absorption

The compressive strength test is a crucial aspect of assessing the quality of concrete in construction projects. Let's delve into the significance of this test and the factors influencing concrete strength:

- **Indian Standard and Methodology:** In India, the method for conducting the compressive strength test is outlined in IS 456:2000, titled "Method of Test for Strength of Concrete." This standard provides guidelines for using a compression testing machine To ascertain the concrete's strength specimens.

- **Importance of Compressive Strength:** The compressive strength test is instrumental in evaluating various characteristics of concrete. It serves as a single indicator to ascertain whether concreting has been executed correctly. The test results provide insights into The capacity of concrete to resist loads and pressures, essential for ensuring the structural stability and longevity of buildings and infrastructure.

- **Range of Strength:** Concrete compressive strength varies based on the intended application. For general construction applications, concrete strength typically falls within the range of 15 MPa (2200 psi) to 30 MPa (4400 psi). However, in commercial and industrial buildings, concrete with higher strength is often required., exceeding 30 MPa, is often required to meet specific project demands and safety standards.

- **Factors Influencing Strength:** Several factors influence the compressive strength of concrete:

- **Water-cement ratio:** The ratio of water to cement in the concrete mixture greatly influences its strength. Generally, reducing the water-cement ratio leads to increased strength..

- **Cement strength:** The quality and type of cement used play a crucial role in determining concrete strength. Different types of cement possess varying degrees of strength.

- **Quality of concrete materials:** The quality of aggregates, admixtures, and other constituents used in concrete directly affects its strength and overall performance.

- **Quality control during production:** Stringent quality control measures during the batching, mixing, and curing stages are essential to ensure the uniformity and consistency of concrete, which ultimately influences its strength.

- **Testing Specimens:** The compressive strength test can be carried out using either concrete cubes or cylinders. Different standard codes suggest either form as the preferred specimen for the test.. Both cube and cylinder specimens have their advantages and are used based on project requirements and testing standards.

In summary, the compressive strength test is a pivotal quality assurance measure in the construction industry, providing valuable insights into concrete performance and ensuring the safety and durability of structures. Through adherence to standards, meticulous testing procedures, and attention to influencing factors, engineers and construction professionals can reliably assess and optimize concrete strength for diverse applications.

6.8.4 **Compressive Strength Definition**

Compressive strength is indeed a critical parameter in materials science and structural engineering. Let's delve deeper into its definition and the formula for calculation:

- **Definition of Compressive Strength:** Compressive strength refers to the ability of a material or structure to withstand external forces that tend to decrease its volume or size. or volume without experiencing significant deformation, cracking, or failure. When subjected to compressive forces, materials tend to decrease in size, exhibiting resistance to compression.

- **Formula for Compressive Strength:** The The formula for calculating compressive strength entails finding the ratio of the maximum load exerted on the material at the moment of failure to the cross-sectional area of the surface upon which the load was applied. This relationship can be expressed mathematically as

- Compressive Strength = P/A

  Where,

  P - represents the maximum load or force applied to the material at the point of failure.

A - denotes the cross-sectional area of the surface on which the load was applied.

Compressive strength is commonly represented in pressure units like Pascals (Pa), megapascals (MPa), or pounds per square inch (psi), which are determined by the load and area units utilized..

In summary, compressive strength is a fundamental mechanical property that characterizes a material's ability to withstand compressive forces. By applying the appropriate formula and conducting compressive strength tests, engineers can evaluate the structural integrity and performance of materials used in various applications, ranging from construction materials like concrete and masonry to metal alloys and polymers.

Compressive strength = Load / Cross-sectional area

6.8.5 Procedure :- Compressive Strength test of Concrete Cube

The cube test is a commonly employed technique for assessing the compressive strength of concrete samples. Below is a detailed outline of the procedure:

- **Selection of Specimen Size:** Depending on The dimensions of the aggregate employed in the concrete mix, two types of cube specimens are commonly employed: 15cm × 15cm × 15cm or 10cm × 10cm × 10cm. For most construction works, cubes measuring 15cm × 15cm × 15cm are preferred.

- **Preparation of Specimens:** The concrete mix is placed into the cube molds and thoroughly compacted to eliminate any voids.. After filling the molds, the surface is leveled and smoothed using a trowel. The molds are Then, it is left undisturbed for a period of 24 hours to permit the concrete to solidify.

- **Curing Process:** Following the 24-hour period, the molds are taken off, and the test specimens are immersed in water for curing.. Curing helps in maintaining adequate moisture levels within the concrete, promoting hydration and ensuring optimal strength development. The specimens are cured for different durations, typically At intervals of 7 days, 14 days, and 28 days, the specimens are tested to evaluate their strength. gain over time.

- **Surface Preparation:** Before testing, the top surface of each specimen is made even and smooth to ensure uniform loading during the compression test. This is achieved by applying a thin layer of cement paste and spreading it evenly across the surface.

- **Compression Testing:** After the specified curing period The specimens undergo testing with a compression testing apparatus. A gradual and constant load is applied, usually at a rate of 140 kg/cm^2 per minute, until the specimen reaches failure. The maximum load achieved at failure is documented.

- **Calculation of Compressive Strength:** The compressive strength of the The compressive strength of a concrete specimen is calculated by dividing the maximum load at failure by the cross-sectional area of the specimen. in units of pressure, such as MPa or psi.

By following these standardized procedures, engineers and technicians can accurately assess the compressive strength of concrete, which is essential for ensuring the structural integrity and durability of construction projects.

Figure 6.1 : Oiling of Molds

Figure 6.2 : Filing of concrete in molds

Figure 6.3 : Concrete Cube

6.8.6 Compressive strength of Concrete and its Importance

Certainly! Concrete is a versatile and fundamental material in construction, and its strength is crucial for ensuring the integrity and longevity of structures. Let's delve deeper into how various factors influence concrete strength and how compressive strength testing plays a vital role in assessing concrete quality:

- **Composition of Concrete:** Concrete consists primarily of cement, sand, and aggregate. The individual compressive strengths of these constituents significantly impact the overall strength of the concrete. High-quality materials with strong compressive strengths contribute to higher concrete strength.

- **Quality of Materials:** The quality of materials used in concrete construction is paramount. Any impurities, contaminants, or inconsistencies in cement, sand, or aggregate can weaken the concrete and compromise its strength. Therefore, ensuring the use of high-quality materials is essential.

- **Air Entrainment:** Air entrainment involves incorporating tiny air bubbles into the concrete mix, which enhances its durability and resistance to freeze-thaw cycles. However, excessive air entrainment can reduce compressive strength. Thus, controlling the air content within optimal ranges is crucial.

- **Mix Proportions:** The proportions of cement, sand, aggregate, and water in the concrete mix significantly influence its strength. Proper mix design, with appropriate proportions of each component, is essential for achieving the desired compressive strength.

- **Water-Cement Ratio:** The water-to-cement ratio is an essential aspect parameter affecting concrete strength. Higher water-cement ratios generally result in weaker concrete, as excess water can increase porosity and reduce strength. Thus, maintaining an optimal water-cement ratio is vital for maximizing compressive strength.

- **Curing Methods:** Proper curing is essential for allowing concrete to realize its maximum strength capability. Curing techniques, including moist curing, steam curing, or chemical curing, help maintain adequate moisture levels and temperature conditions for hydration to occur, thereby enhancing concrete strength.

- **Temperature Effects:** Temperature significantly influences the rate of concrete hydration and strength development. Extreme temperatures can adversely affect concrete strength if not controlled during mixing, placing, and curing. Therefore, proper temperature control is crucial for optimal strength.

Compressive strength testing serves as a reliable method for assessing the quality and strength of concrete. By subjecting concrete specimens to compression tests at various curing durations (e.g., By testing concrete at different intervals (such as 7 days, 14 days, and 28 days), engineers can assess its strength and detect any shortcomings or areas that require enhancement in the construction procedures..

In summary, understanding the factors influencing concrete strength and conducting compressive strength tests are essential steps in ensuring the production of high-quality concrete and the successful completion of durable and resilient construction projects.

6.8.7 We Test Concrete for 7 days , 14 days and 28 days

Testing the compressive strength of concrete at early ages, such as 7 days and 14 days, can indeed provide valuable insights into its potential strength and suitability for construction purposes. Let's explore why early strength testing is beneficial and how concrete strength develops over time:

- **Significance of Early Strength Testing:** Early strength testing allows engineers and construction professionals to assess the performance of concrete at critical stages of construction. By obtaining strength measurements at 7 days and 14 days, stakeholders can make informed decisions regarding formwork removal, loading, and further construction activities.

- **Concrete Strength Development:** Concrete typically gains strength gradually over time as hydration reactions occur between cement and water. While concrete achieves its maximum strength at around 28 days, significant strength development occurs within the first few days after casting. Here's a general overview of concrete strength development:

- **24 Hours:** Concrete gains approximately 16% of its ultimate strength within the first 24 hours after casting. This initial strength gain is crucial for ensuring early formwork stability and handling.

- **7 Days:** By the 7th day, concrete typically achieves around 65% to 70% of its ultimate strength. This early strength gain allows for early removal of formwork and accelerates construction progress.

- **14 Days:** At 14 days, concrete generally reaches about 90% of its ultimate strength. This high percentage of strength attainment indicates that the concrete has matured significantly and is suitable for a wide range of construction activities.

- **28 Days:** Concrete achieves its maximum design strength at around 28 days, reaching approximately 99% of its ultimate strength. Testing at this age provides confirmation of the concrete's strength and durability for long-term performance.

- **Benefits of Early Strength Prediction:** By extrapolating strength data from early age testing (7 days and 14 days), engineers can predict the concrete's potential strength at later ages, such as 28 days. This predictive approach enables proactive decision-making and adjustments to construction schedules, optimizing project timelines and resource utilization.

In summary, conducting compressive strength tests at early ages, particularly at 7 days and 14 days, offers valuable insights into concrete strength development and aids in predicting the concrete's target strength for construction projects. This proactive approach enhances project management, minimizes risks, and ensures the timely completion of high-quality structures.

We can’t Assessing the strength of concrete until it stabilizes is important, and waiting for 28 days to evaluate its suitability for construction may not always be feasible. To maintain balance, concrete is tested at different intervals..

Age in Days	Percentage of Strength
1 Day	16%
3 Day	40%

7 Day	**65%**
21 Day	**94%**
28 Day	**99%**

Table 6.3 : Tentative Strength in days

6.8.8 Procedure For Testing The Compressive Strength of Concrete Cubes

The process for assessing the compressive strength of concrete cubes as per IS 456:2000:

- **Apparatus for Concrete Cube Test:** Utilize a compression testing machine.
- **Preparation of Concrete Cube Specimen:**

1. Use the same concrete proportion and materials as those employed in the actual construction.
2. Prepare 9 cubes of 15cm size each, with a mix grade of M25.

- **Mixing of Concrete for Cube Test:**

➢ Concrete mixing can be done either manually or by using a laboratory batch machine.

Hand Mixing:

1. Place the concrete and fine aggregate on a watertight, non-absorbent platform.
2. Mix them thoroughly until the mixture achieves a uniform color

.

- **Sampling of Cubes for Test:**

1. Thoroughly clean the cube moulds and apply a thin layer of oil to prevent adhesion.
2. Fill the concrete into the moulds in layers, approximately 5cm thick each.
3. After adding each layer, use a steel tamping rod, 16mm in diameter and 60cm long, with a bullet point at the lower end, to compact the concrete.
4. Ensure proper compaction by administering no less than 35 strokes per layer.
5. Repeat this process until the mould is completely filled.
6. Smooth and level the top surface of the concrete using a trowel to ensure uniformity.

- **Filling the Cube Moulds:**

1. Fill the cube moulds with the prepared concrete mix.
2. Compact the concrete properly to ensure there are no voids or air pockets.

- **Curing of Concrete Cubes:**

1. After filling, cover the moulds with a damp cloth and keep them in a shaded area to prevent moisture loss.
2. Allow the cubes to cure for a minimum of 7 days.

- **Removing the Cube Specimens:**

After the curing period, cautiously extract the cubes from the moulds, taking care to avoid any damage.

- **Testing Procedure:**

1. Place the cube specimen in the compression testing machine with its axis aligned centrally.
2. Apply Gradually apply the load uniformly at a consistent rate until the cube fails.
3. Record the maximum load applied and compute the compressive strength utilizing the prescribed formula. specified in IS 456:2000.

- **Recording Results**:

1. Record the compressive strength of each cube tested.
2. Calculate the mean compressive strength of the set of cubes tested.

- **Reporting:**

➢ Report the compressive strength findings appropriate format, mentioning the mix grade used and any relevant details of the testing procedure.

- **Safety Precautions:**

1. Ensure proper safety measures are followed during the testing procedure, especially when operating the compression testing machine.
2. Use appropriate personal protective equipment (PPE) as necessary.

- **Quality Control:**

➢ Maintain proper quality control measures throughout the testing process to ensure accurate and reliable results.

- **Documentation:**

➢ Maintain records of the test results, including details of the concrete mix, curing conditions, and testing parameters, for future reference and analysis.

Figure 6.4 : Weight of Material

Figure 6.5 : Ingredients Mixing Dry Form

Figure 6.6 : Filing of concrete in molds

- **Procedure for Concrete cube Test**

1. After the specified curing time, remove the concrete cube specimens from the curing environment, ensuring excess water is wiped off from the surface. Take accurate dimensions of the specimens, rounding to the nearest 0.2mm for precise measurements.

2. Next, prepare the compression testing machine for the test. Clear the bearing surface of the machine to ensure proper contact with the specimen. Place the specimen in the machine with the load applied to the opposite side of the cube cast. Align the specimen centrally on the base plate of the machine.

3. Carefully rotate the movable portion of the machine by hand until it gently touches the top surface of the specimen. Apply the load gradually and continuously, without any shock, at a rate of 140kg/cm2 per minute until the specimen fails.

4. During the testing process, record the maximum load applied and note any unusual features observed during the failure of the specimen. These observations could include the type of failure, such as crushing, splitting, or shear failure, and any other relevant details.

5. Following the completion of the test, carefully remove the specimen from the testing machine and clean the machine's surfaces. Document the test results, including the maximum load applied and any observations made during the test, for further analysis and reporting.

***CHAPTER – No.* VII**

CASTING PROCEDUR

CHAPTER – VII

Casting Procedure

7.1 CASTING PROCEDURE

7.1.1 Casting of Concrete Cubes

Concrete is mixed either by hand Fig 5.4. In this casting process is used. Concrete is a mixture of Cement, Water, Coarse and Fine Aggregates and Admixtures. The proportion of each material in the mixture affects the properties of the final hardened concrete. These proportions are best measured by weight. Measurement by volume is not as accurate, but is suitable for minor projects. The dry ingredients are mixed and water is added slowly until the concrete is workable. This mixture may need to be modified depending on the aggregate used to provide a concrete of the right workability. The mix should not be too stiff or too sloppy. It is difficult to form good test specimens if it is too stiff. If it is too sloppy, water may separate (bleed) from the mixture

Figure 7.1 : Ingredients Mixing Dry Form **Figure 7.2 : Ingredient Mixing Wet Form**

For casting, all the moulds were cleaned and oiled properly. There were securely tightened to correct dimension before casting. Care was taken that there is no gaps left, where there is any possibility of leakage of slurry. Careful procedure was adopted in the batching, mixing and casting operation. The coarse aggregate and fine aggregate were weighed first. The concrete mixture was prepared by hand mixing on a water tight platform. On the water tight platform cement and fine aggregates are mixed thoroughly until a uniform colour is obtained, to this mixture coarse aggregate was added and mixed thoroughly. Then water is added carefully making sure no water is lost during mixing. While adding water care should be taken to add it in stages so as to prevent bleeding which may affect the strength formation of concrete rising of water required for hydration to the surface. Clean and oiled mould for each category was then placed on the vibrating table respectively and filled in three layers. Vibrations were stopped as soon as the cement slurry appeared on the top surface of the mould. Fig 5.5 shows cube specimen placed on table vibrator.

Figure 7.3 : Filing of concrete in molds **Figure 7.4 : Smoothing of top Surface**

These specimens were allowed to remain in the steel mould for the first 24 hours at ambient condition. After that these were demoulded with care so that no edges were broken and were placed in the tank at the ambient temperature for curing. After demoulding the specimen by loosening the screws of the steel mould, the cubes were placed in the water for 7 days,14 days and 28 days.

- **NOTE** :- Minimum three specimens should be tested at each selected age .If the strength of any specimen varies by more than 15 % of average strength ,the results of such specimens should be rejected of three specimens given the crushing strength of concrete . The strength requirements of concrete.

7.1.2 Calculation of Compressive Strength

- Size of the Cube = 15cm×15cm×15cm
- **<u>Compressive Strength Formula</u>**
- Compressive Strength = Load / Cross-Sectional area

Kilonewton = 1000 Newton

1 kN = 1000 N

- Lode by Machine = kN
- Lode in Newton = Lode by Machine × 1000
- Area of Cube in mm^2 = 150 × 150

= 22500 mm^2

7.1.3 Reports of Cube Test

1. Identification Mark

2. Date of Test
3. Age of specimen
4. Curing conditions , including date of manufacture of specimen.
5. Appearance of fracture faces of concrete and the type of fracture if they are unusual.

Figure 7.5 : Marking on Cube

Figure 7.6 : Placing of Cube On Machine

Figure 7.7 : Compressive Test Machine

Figure 7.8 : Rotating Movable Part of Machine

Figure 7.9 : Crushing of Cube

Figure 7.10 : Reading of Compressive Lode

7.1.4 Water Absorption by specimens

- **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:

- **Initial Weighing:**

- Initially, the weight of each concrete cube specimen is recorded before any curing period begins. This serves as the baseline weight.
- **Curing Periods:**
- The concrete cubes are subjected to different curing periods: 7 days, 14 days, and 28 days. During each period, the cubes are kept in a controlled environment to allow for proper curing.
- **Water Immersion:**
- After each curing period, the cubes are immersed in water for a duration of 24 hours. This immersion allows for the measurement of water absorption by the concrete.
- **Measurement of Water Absorption:**
  1. After the 24-hour immersion period, the cubes are removed from the water and their weights are recorded again.
  2. The difference between the initial weight and the weight after water immersion represents the amount of water absorbed by the concrete cubes.
- **Calculation and Comparison:**
  1. The amount of water absorbed by the cubes is calculated by subtracting the initial weight from the weight after immersion.
  2. This process is repeated for cubes that were air-dried and cubes that underwent self-curing.
  3. The water absorption rates of air-dried cubes and self-cured cubes are compared to assess the effectiveness of the curing methods in preventing water ingress into the concrete.
- **Data Analysis:**
  1. The collected data on water absorption is analyzed to understand the curing effectiveness and the performance of the concrete mix.
  2. Any significant differences in water absorption between the curing methods are noted and investigated.
- **Conclusion:**
  1. Based on the results, conclusions are drawn regarding the curing methods' effectiveness in controlling water absorption and maintaining the concrete's durability.
  2. Recommendations for improvements in curing practices or concrete mix formulations may be made based on the findings.

This process helps in evaluating the quality of the concrete mix and the efficacy of the curing methods employed, which is crucial for ensuring the long-term durability and performance of concrete structures.

- **Date** :- Water absorption is expressed as increase in weight percent

Percent Water Absorption = Wet Weight – Dry Weight / Dry Weight × 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 7.1 : 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

Table 7.2 : Water Absorption of Added 15% Bio-Medical Waste Ash Concrete Cube

C) Water Absorption of Added 20% Bio-Medical Waste Ash Concrete Cube (M25)

Cube	Without Absorption	With Absorption

Cube 1 (7 days)	6.550	6.700
Cube 2 (7 days)	6.610	6.690
Cube 3 (7 days)	6.570	6.680
Cube 4 (14 days)	6.570	6.660
Cube 5 (14 days)	6.760	6.800
Cube 6 (14 days)	6.620	6.710
Cube 7 (28 days)	6.630	6.720
Cube 8 (28 days)	6.760	6.920
Cube 9 (28 days)	6.550	6.710

Table 7.3 : Water Absorption of Added 20% Bio-Medical Waste Ash Concrete Cube

D) Water Absorption of Added 25% Bio-Medical Waste Ash Concrete Cube (M25)

Cube	Without Absorption	With Absorption
Cube 1 (7 days)	8.640	8.730
Cube 2 (7 days)	8.670	8.800
Cube 3 (7 days)	9.090	9.220
Cube 4 (14 days)	8.730	8.930
Cube 5 (14 days)	8.605	8.780
Cube 6 (14 days)	8.700	8.740
Cube 7 (28 days)	8.740	8.880
Cube 8 (28 days)	8.660	8.750
Cube 9 (28 days)	8.645	8.860

Table 7.4 : Water Absorption of Added 20% Bio-Medical Waste Ash Concrete Cube

E) Water Absorption of Added 05% Bio-Medical Waste Ash Concrete Cube (M25)

Cube	Without Absorption	With Absorption
Cube 1 (7 days)	8.690	8.700
Cube 2 (7 days)	8.420	8.490
Cube 3 (7 days)	8.740	8.830
Cube 4 (14 days)	8.540	8.680
Cube 5 (14 days)	8.410	8.600
Cube 6 (14 days)	8.730	9.100
Cube 7 (28 days)	8.670	8.720
Cube 8 (28 days)	8.390	8.640
Cube 9 (28 days)	8.570	8.930

Table 7.5 : Water Absorption of Added 05% Bio-Medical Waste Ash Concrete Cube

CHAPTER – No. VIII

TEST RESULT AND ANALYSIS

CHAPTER – VIII

Test Result And Analysis

8.1 TEST RESULTS AND ANALYSIS

8.1.1 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 8.1 : Slump test on Trial Mixes

8.1.2 COMPRESSIVE STRENGTH

8.1.2.1 COMPRESSIVE STRENGTH OF CONVENTIONAL CONCRETE CUBES

- The compressive strength of ordinary concrete with different water cement ratio was tested. The results are as shown in Table 5.4.

  Conventional 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
Coarse Aggregate	6.20	55.8

Table 8.2 : 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 8.3 : 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

- Area of Cube in mm^2 = 150mm × 150mm

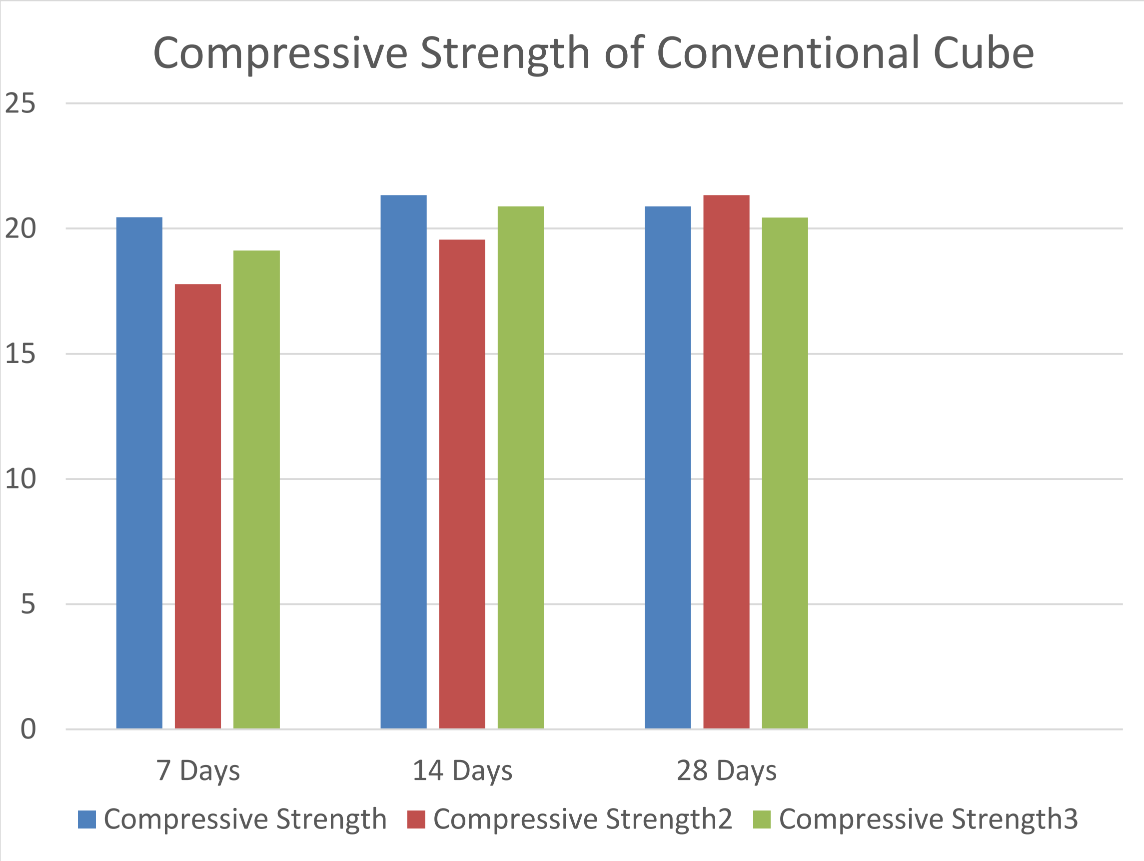
  = 22500 mm^2

- Reading for Compressive Strength (in N/mm^2)

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	20.89N/mm^2
Cube 8	28 days	480 KN	21.33N/mm^2
Cube 9	28 days	460 KN	20.44N/mm^2

Table 8.4 : Reading for Compressive Strength (in N/mm^2)

- **GRAPH**



8.1.1.2 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 8.5 : Material taken for making 9 cubes

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

  = 28.8 / 100 × 15 = 4.32 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 8.6 : 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

- Area of Cube in mm^2 = 150mm × 150mm

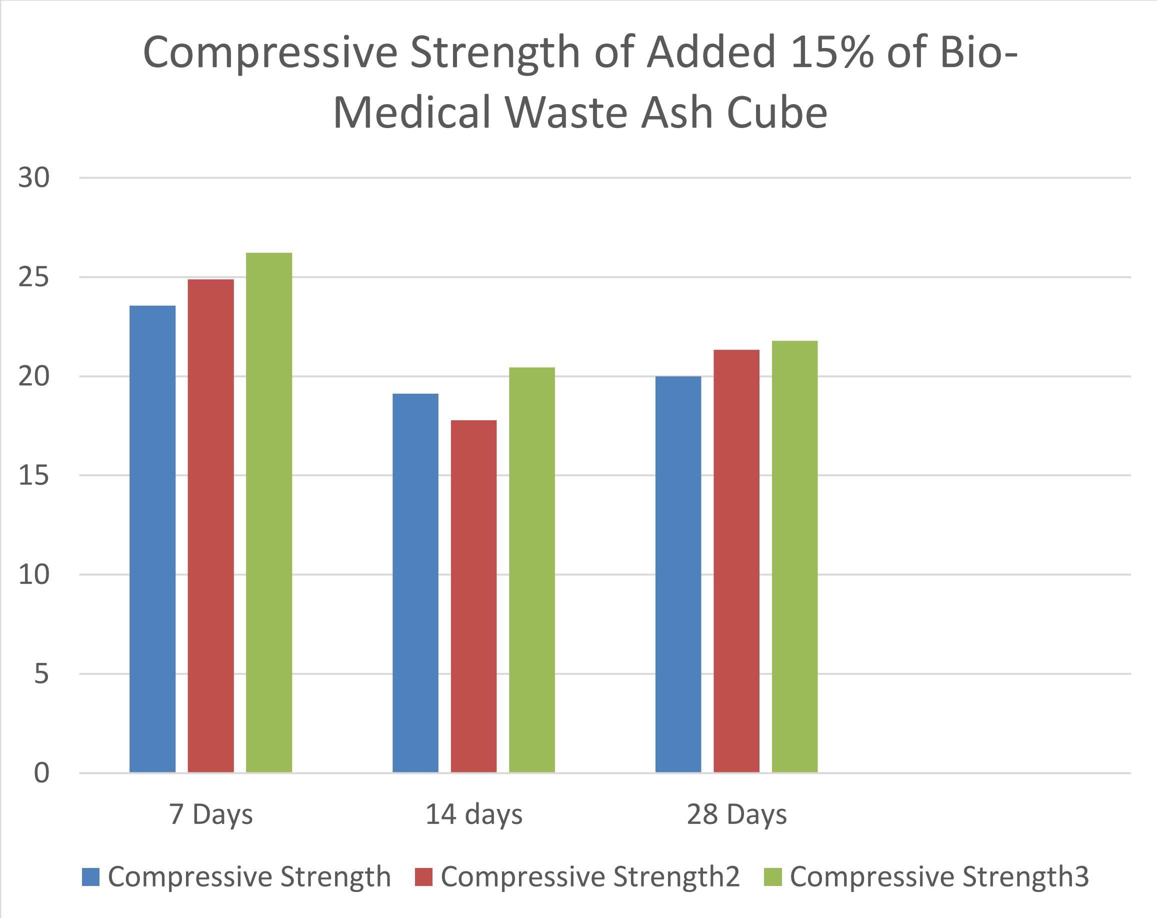
= 22500 mm^2

- Reading for Compressive Strength (in N/mm^2)

M25 Add 15% Bio-medical waste Ash Cube	**Number of Days**	**Value in Compressive Testing Machine (in KN)**	**Compressive Strength (in N/mm^2)**
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 8.7 : Reading for Compressive Strength (in N/mm^2)

- **GRAPH**



8.1.2.3 Add 20% 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	28.8-5.76 = 23.04
Coarse Aggregate	6.20	55.8
Add 20% Bio-Medical Waste Ash	0.64	5.76

Table 8.8 : Material taken for making 9 cubes

- Add 20% of Bio-Medical Waste Ash by Partial Replaced by Fine Aggregate (Sand)

$= 28.8 / 100 \times 20 = 5.76$ kg

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

- Reading taken in Compressive Testing Machine

M25 Add 20% Bio-Medical Waste Ash Cube	**Number of Days**	**Value in Compressive Testing Machine (in KN)**
Cube 1	7 days	590 KN
Cube 2	7 days	560 KN
Cube 3	7 days	520 KN
Cube 4	14 days	540 KN
Cube 5	14 days	490 KN
Cube 6	14 days	510 KN
Cube 7	28 days	540 KN
Cube 8	28 days	560 KN
Cube 9	28 days	570 KN

Table 8.9 : 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

- Area of Cube in mm^2 = 150mm × 150mm
  = 22500 mm^2

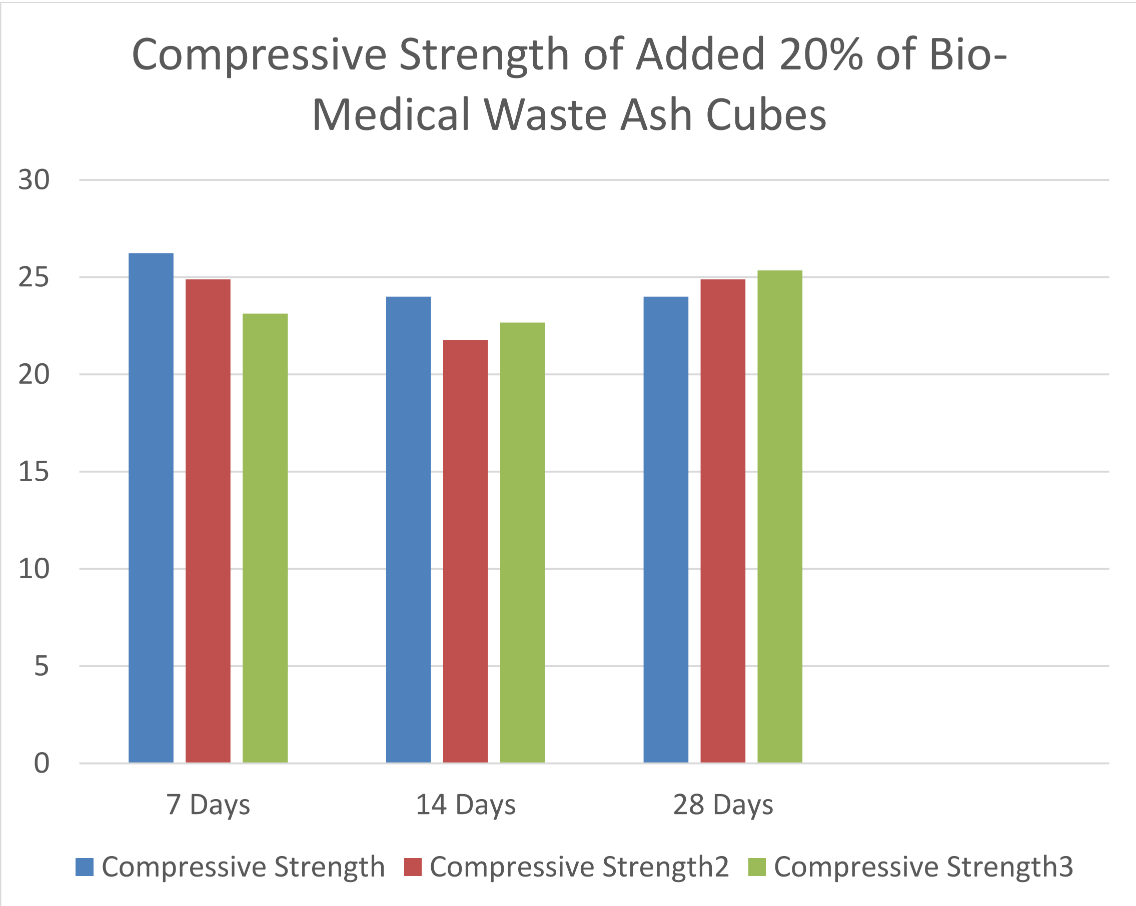
- Reading for Compressive Strength (in N/mm^2)

M25 Add 20% Bio-medical waste Ash Cube	**Number of Days**	**Value in Compressive Testing Machine (in KN)**	**Compressive Strength (in N/mm^2)**
Cube 1	7 days	590 KN	26.23 N/mm^2
Cube 2	7 days	560 KN	24.89 N/mm^2

Cube 3	7 days	520 KN	23.12 N/mm^2
Cube 4	14 days	540 KN	24.00 N/mm^2
Cube 5	14 days	490 KN	21.78 N/mm^2
Cube 6	14 days	510 KN	22.67 N/mm^2
Cube 7	28 days	540 KN	24.00 N/mm2
Cube 8	28 days	560 KN	24.89 N/mm2
Cube 9	28 days	570 KN	25.34 N/mm2

Table 8.10 : Reading for Compressive Strength (in N/mm^2)

- **GRAPH**



8.1.2.4 Add 25% 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	28.8-7.2 = 21.6
Coarse Aggregate	6.20	55.8
Add 25% Bio-Medical Waste Ash	0.80	7.2

Table 8.11 : Material taken for making 9 cubes

- Add 25% of Bio-Medical Waste Ash by Partial Replaced by Fine Aggregate (Sand)

$= 28.8 / 100 \times 25 = 7.2$ kg

- 7.2 kg of Bio-Medical Waste Ash has Added and Rest is Fine Aggregate (Sand)
- Reading taken in Compressive Testing Machine

M25 Add 25% Bio-Medical Waste Ash Cube	Number of Days	Value in Compressive Testing Machine (in KN)
Cube 1	7 days	320 KN
Cube 2	7 days	390 KN
Cube 3	7 days	380 KN
Cube 4	14 days	410 KN
Cube 5	14 days	360 KN
Cube 6	14 days	300 KN
Cube 7	28 days	360 KN
Cube 8	28 days	310 KN
Cube 9	28 days	330 KN

Table 8.12 : 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

- Area of Cube in mm^2 = 150mm × 150mm

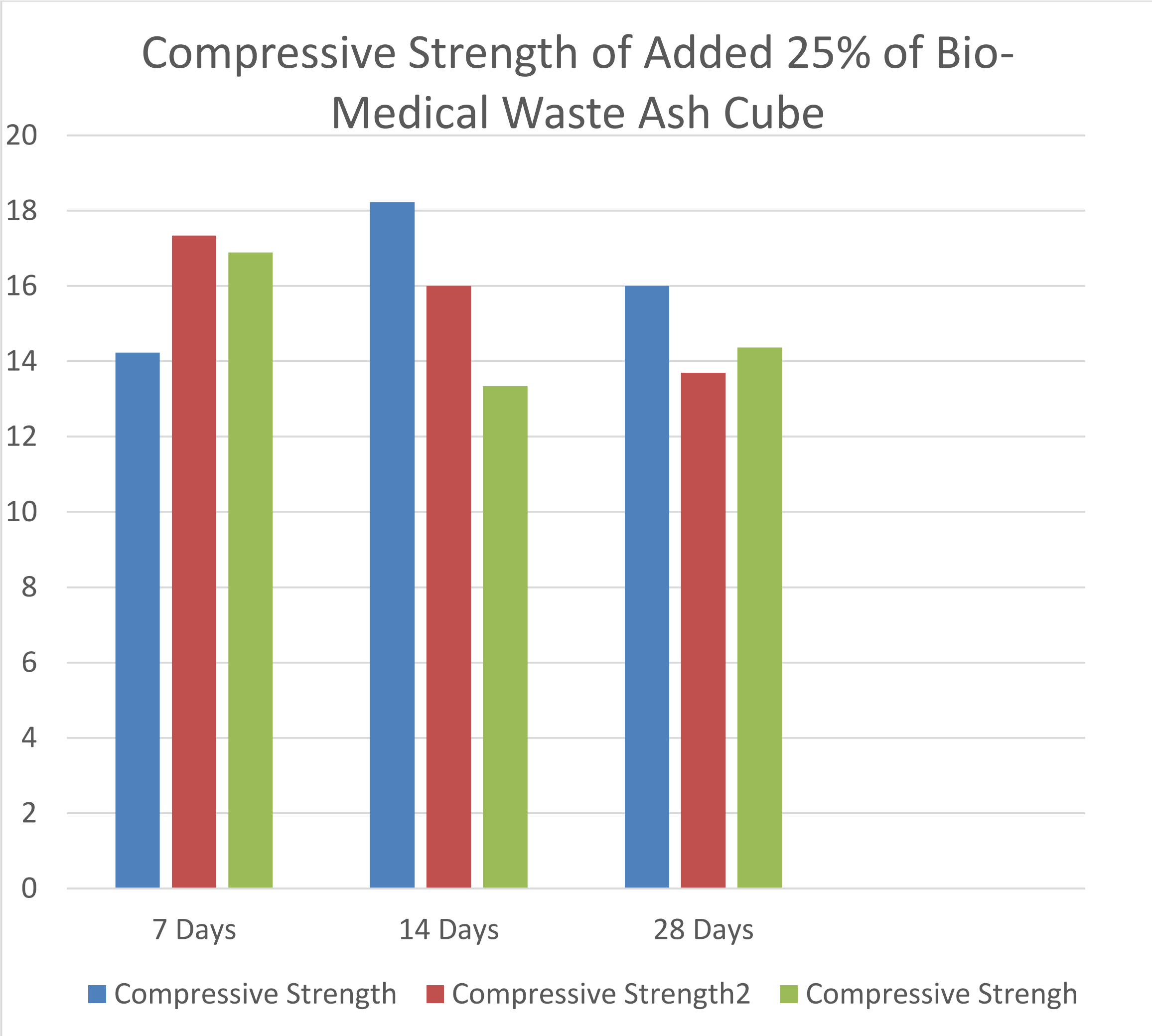
  = 22500 mm^2

- Reading for Compressive Strength (in N/mm^2)

M25 Add 25% Bio-medical waste Ash Cube	**Number of Days**	**Value in Compressive Testing Machine (in KN)**	**Compressive Strength (in N/mm^2)**
Cube 1	7 days	320 KN	14.23 N/mm^2
Cube 2	7 days	390 KN	17.34 N/mm^2
Cube 3	7 days	380 KN	16.89 N/mm^2
Cube 4	14 days	410 KN	18.23 N/mm^2
Cube 5	14 days	360 KN	16.00 N/mm^2
Cube 6	14 days	300 KN	13.34 N/mm^2
Cube 7	28 days	360 KN	16.00 N/mm^2
Cube 8	28 days	310 KN	13.70 N/mm^2
Cube 9	28 days	330 KN	14.67 N/mm^2

Table 8.13 : Reading for Compressive Strength (in N/mm^2)

- **GRAPH**



8.1.2.5 Add 5% of Bio-Medical Waste Ash as a Material 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
Coarse Aggregate	6.20	55.8
Add 5% Bio-Medical Waste Ash	0.16	1.44

Table 8.14 : Material taken for making 9 cubes

➢ Add 5% of Bio-Medical Waste Ash as a Ingredient

= 28.8 / 100 × 5 = 1.44 kg

- 1.44 kg of Bio-Medical Waste Ash has Added and Rest is Fine Aggregate (Sand)
- Reading taken in Compressive Testing Machine

M25 Add 25% Bio-Medical Waste Ash Cube	**Number of Days**	**Value in Compressive Testing Machine (in KN)**
Cube 1	7 days	410 KN
Cube 2	7 days	420 KN
Cube 3	7 days	440 KN
Cube 4	14 days	480 KN
Cube 5	14 days	460 KN
Cube 6	14 days	440 KN
Cube 7	28 days	400 KN
Cube 8	28 days	450 KN
Cube 9	28 days	470 KN

Table 8.15 : 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

- Area of Cube in mm^2 = 150mm × 150mm

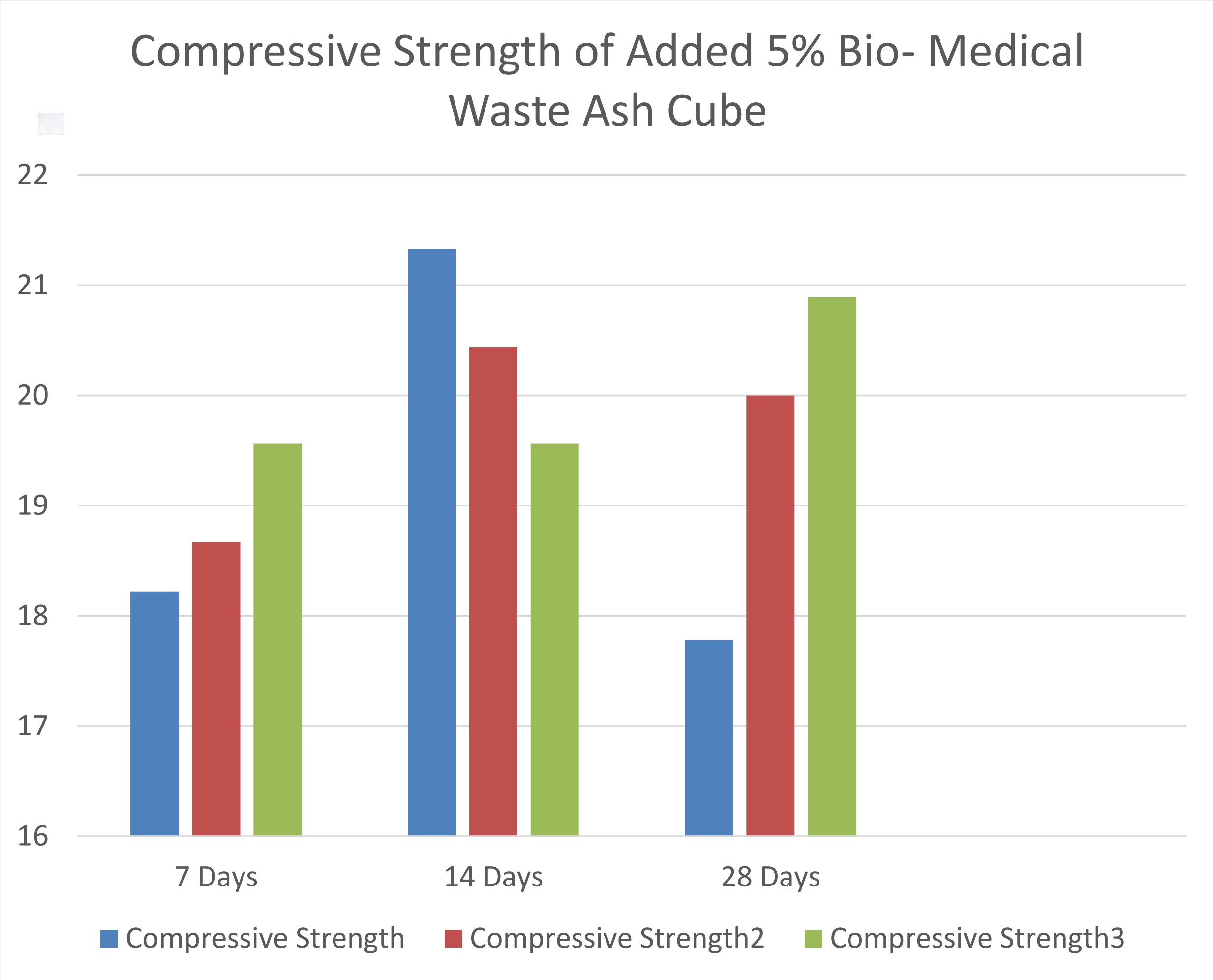
= 22500 mm^2

- Reading for Compressive Strength (in N/mm^2)

M25 Add 5% Bio-medical waste Ash Cube	Number of Days	Value in Compressive Testing Machine (in KN)	Compressive Strength (inN/mm^2)
Cube 1	7 days	410 KN	18.22N/mm^2
Cube 2	7 days	420 KN	18.67N/mm^2
Cube 3	7 days	440 KN	19.56N/mm^2
Cube 4	14 days	480 KN	21.33N/mm^2
Cube 5	14 days	460 KN	20.44N/mm^2
Cube 6	14 days	440 KN	19.56N/mm^2
Cube 7	28 days	400 KN	17.78N/mm^2
Cube 8	28 days	450 KN	20.00N/mm^2
Cube 9	28 days	470 KN	20.89N/mm^2

Table 8.16 : Reading for Compressive Strength (in N/mm^2)

- **GRAPH**



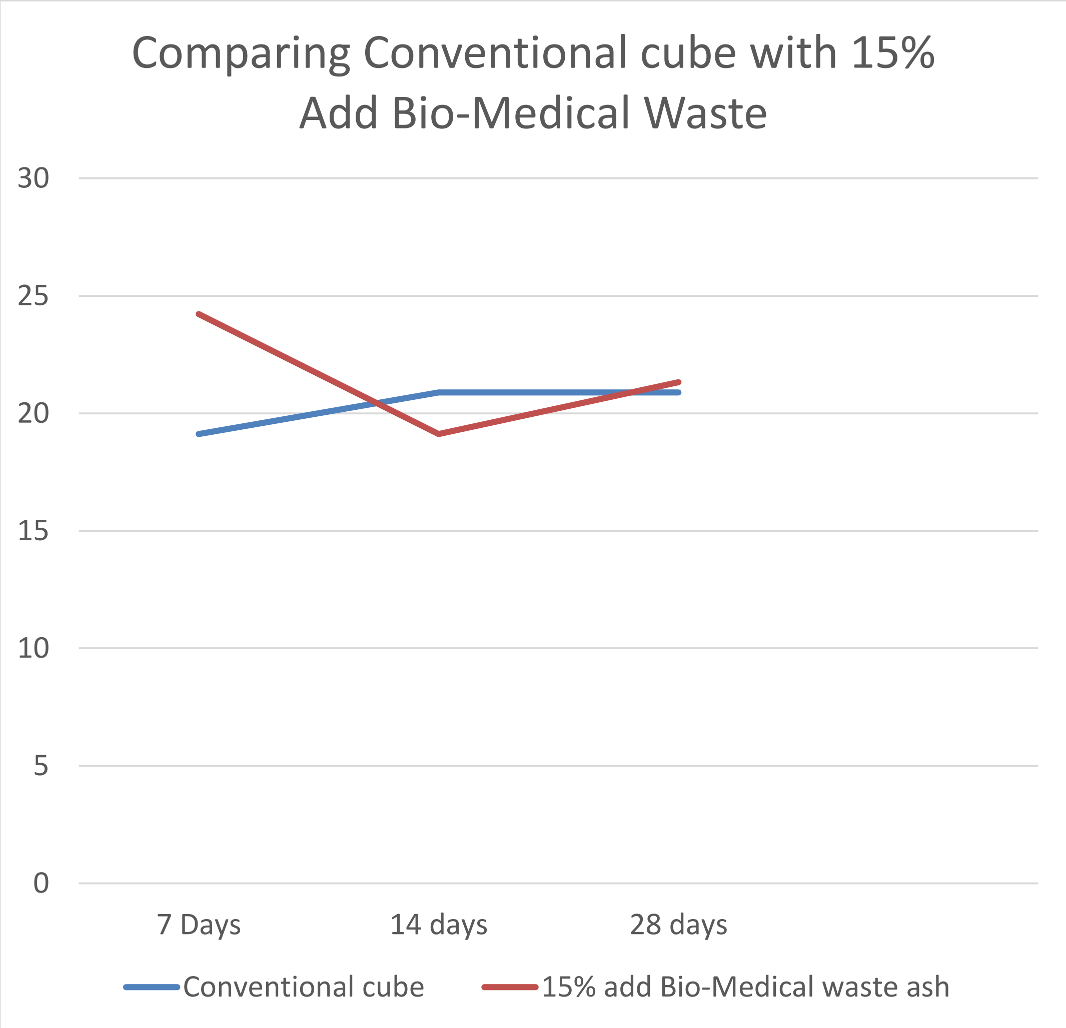
8.1.3 Compression Between Concrete Cube

8.1.3.1 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/mm2	24.23 N/mm2
14 Days	20.89 N/mm2	19.12 N/mm2
28 Days	20.89 N/mm2	21.33 N/mm2

Table 8.17 : Comparing Conventional Concrete Cube with 15% Add Bio-Medical Waste Concrete Cube

➢ **GRAPH**

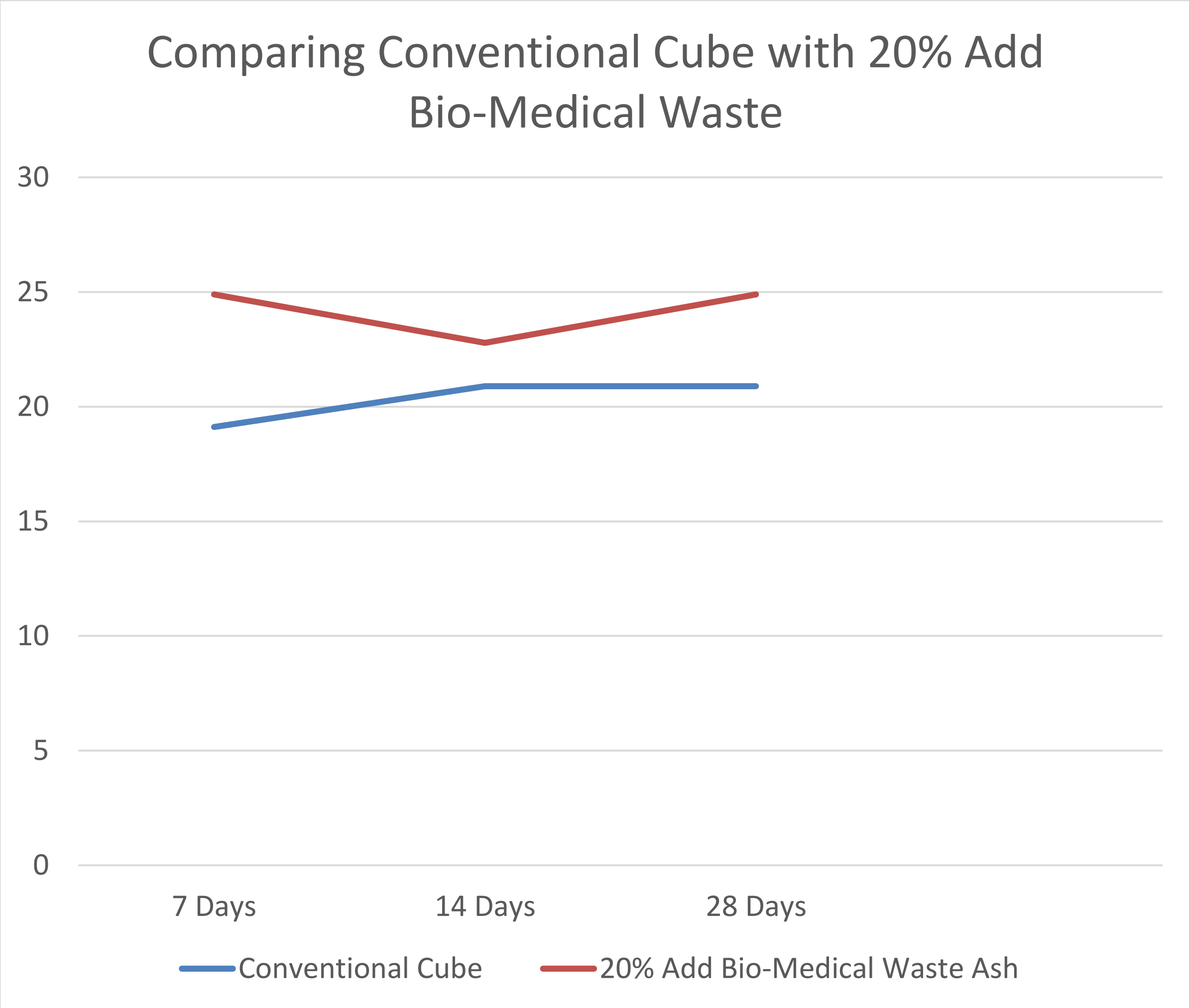


8.1.3.2 Comparing Conventional Concrete Cube with 20% Add Bio-Medical Waste Concrete Cube

Days	Conventional Cube (M25)	Add 20% Bio-Medical Waste Cube
7 Days	19.12 N/mm2	24.89 N/mm2
14 Days	20.89 N/mm2	22.78 N/mm2
28 Days	20.89 N/mm2	24.89 N/mm2

Table 8.18 : Comparing Conventional Concrete Cube with 20% Add Bio-Medical Waste Concrete Cube

- **GRAPH**



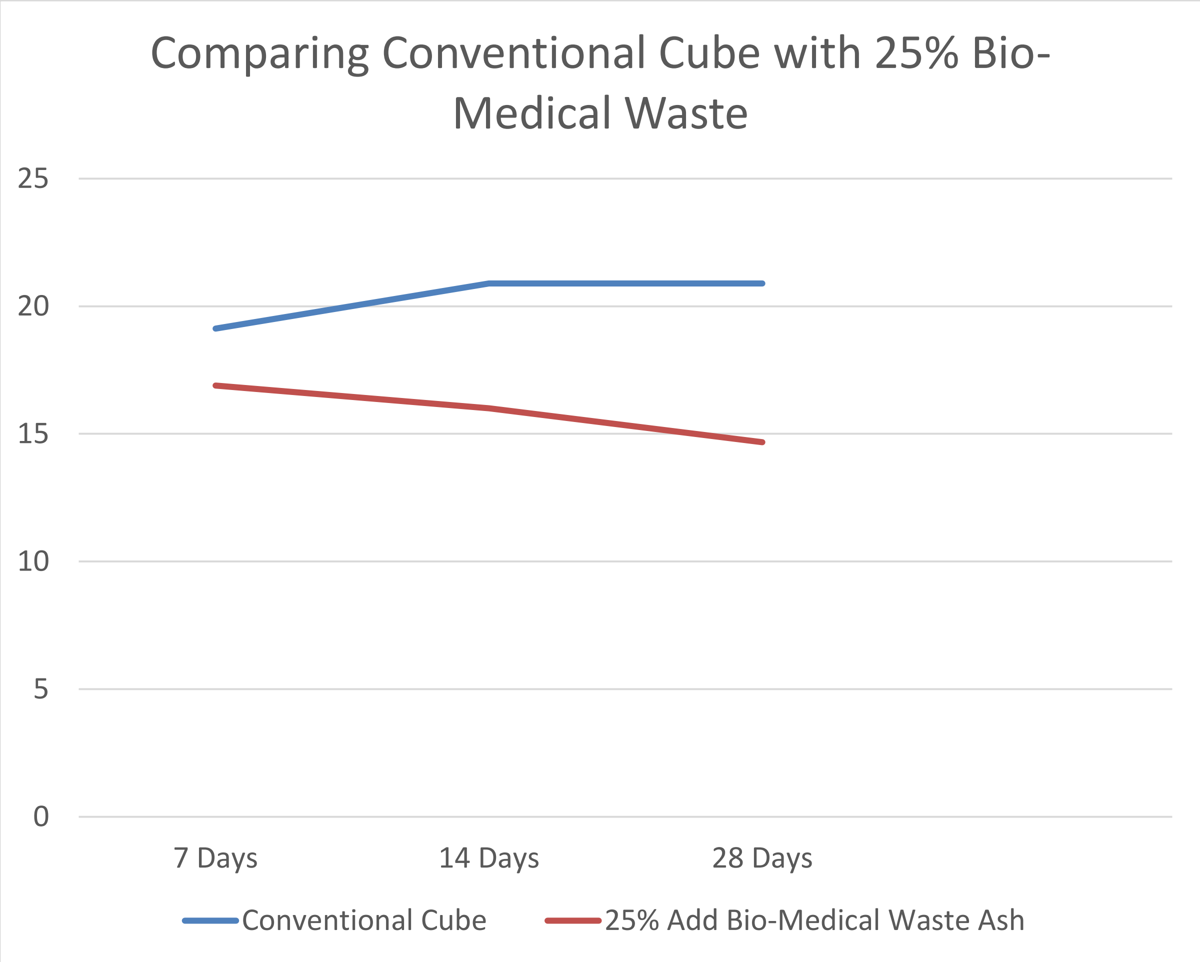
8.1.3.3 Comparing Conventional Concrete Cube with 25% Add Bio-Medical Waste Concrete Cub

Days	Conventional Cube (M25)	Add 25% Bio-Medical Waste Cube
7 Days	19.12 N/mm2	16.89 N/mm2
14 Days	20.89 N/mm2	16.00 N/mm2

28 Days	**20.89 N/mm2**	**14.67 N/mm2**

Table 8.19 : Comparing Conventional Concrete Cube with 25% Add Bio-Medical Waste Concrete Cube

- **GRAPH**



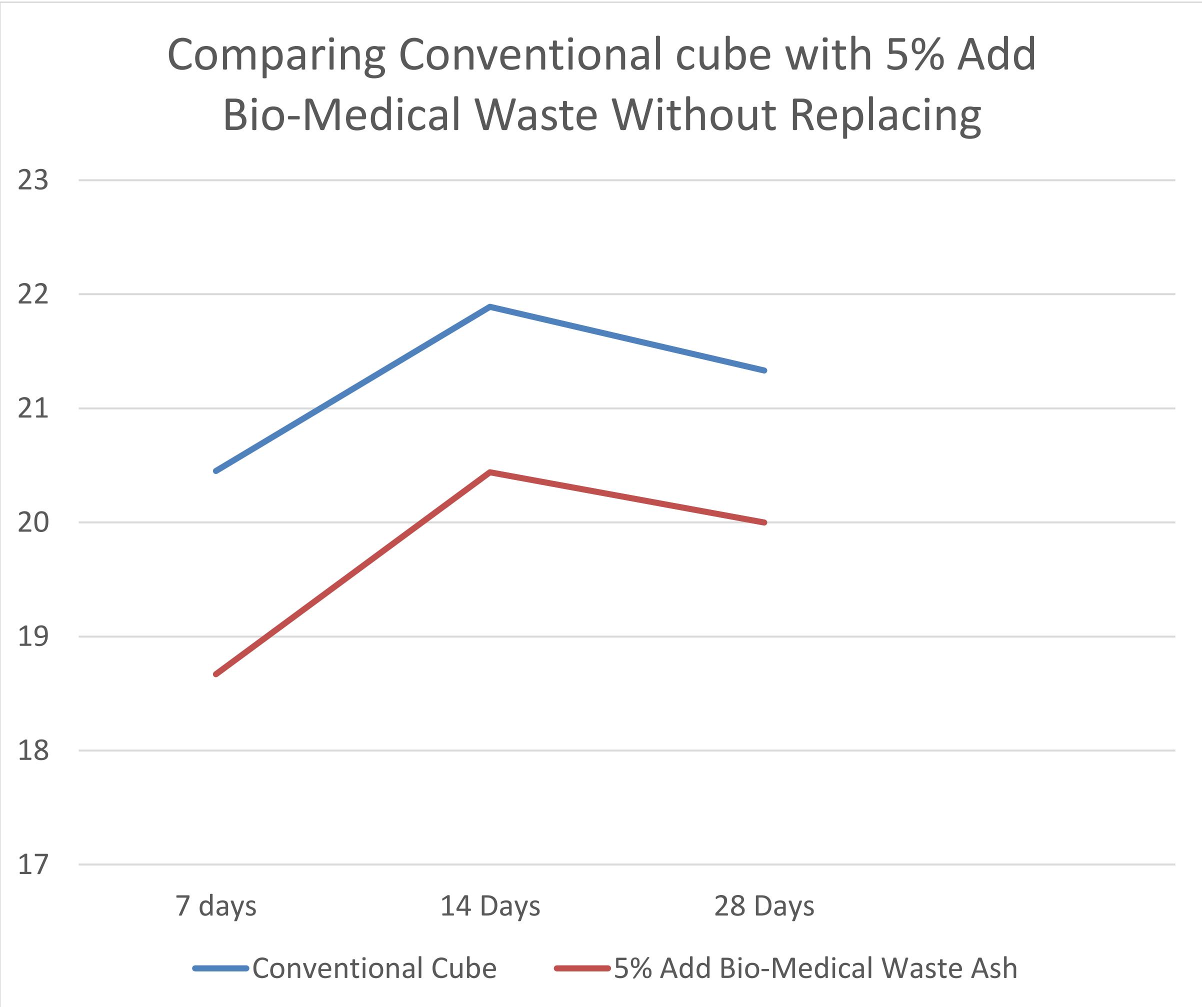
8.1.3.4 Comparing Conventional Concrete Cube with 5% Add Bio-Medical Waste Concrete Cube

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 8.10 : Comparing Conventional Concrete Cube with 05% Add Bio-Medical Waste Concrete Cube

- **GRAPH**



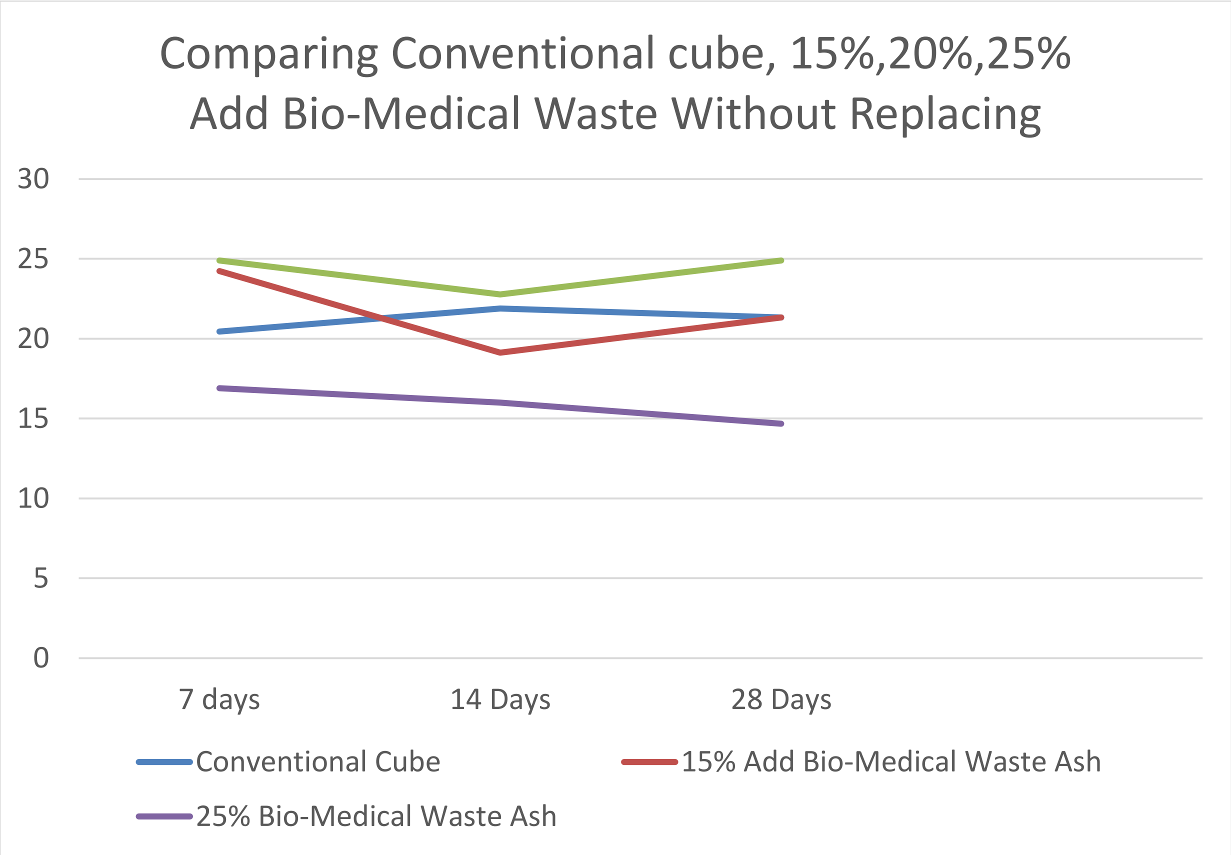
8.1.3.5 Comparing Conventional Concrete Cube With 15%,20%,25% Add Bio-Medical Waste Concrete Cub

		Bio-Medical Waste Ash

Days	Conventional Cubes (M25)	15%	20%	25%
7 Days	19.12 N/mm2	24.23 N/mm2	24.89 N/mm2	16.89 N/mm2
14 Days	20.89 N/mm2	19.12 N/mm2	22.78 N/mm2	16.00 N/mm2
28 Days	20.89 N/mm2	21.33 N/mm2	24.89 N/mm2	14.67 N/mm2

Table 8.21 : Comparing Conventional Concrete Cube with 15%,20%and 25% Add Bio-Medical Waste Concrete Cube

- **GRAPH**



CHAPTER – No. IX

CONCLUSION AND SUGGESTED FURTHER WORK

CHAPTER – IX (TNR, Bold, 20)

Conclusion & Suggested Further Work

9.1 Conclusion

Based on the research on concrete containing Incinerated Bottom Ash Mixed With Water (IBMW) and its mechanical properties, as well as its durability aspects including water absorption, sorptivity, and leaching characteristics, several conclusions can be drawn:

The utilization of biomedical waste ash (BWA) in concrete construction presents a promising avenue for sustainable waste management and enhanced material properties. Based on research findings, the following conclusions can be drawn:

Lower Workability:

1. The workability of concrete refers to its ease of placement and compaction during construction.
2. Concrete made using biomedical waste ash (BWA) may exhibit lower workability compared to conventional concrete due to factors such as particle shape, size distribution, and surface characteristics of the ash.
3. The irregular shape and finer particle size of BWA may increase friction between particles, leading to higher viscosity and decreased workability.

Density Variation with Replacement Level:

1. The density of concrete is an important property that influences its strength, durability, and thermal performance.
2. Studies indicate that the density of concrete decreases slightly with an increase in the replacement level of conventional aggregates with BWA.
3. This decrease in density can be attributed to the lighter weight of BWA compared to conventional aggregates, which results in a lower overall density of the concrete mix.
4. However, up to a certain replacement level, typically around 15%, the density of BWA concrete remains approximately 99% of that of conventional concrete.

Enhanced Mechanical Properties:

The inclusion of IBMW in concrete has shown to positively influence its mechanical properties. This could include improvements in compressive strength, flexural strength, or other relevant mechanical parameters. The specific enhancements would need to be outlined based on the study's findings.

Improved Durability:

Concrete with IBMW exhibits improved durability characteristics compared to conventional concrete mixes. This can be inferred from lower water absorption and sorptivity rates. Lower water absorption suggests reduced susceptibility to moisture-related degradation processes such as freeze-thaw cycles or chemical attacks.

Environmental Benefits:

The utilization of IBMW in concrete not only enhances its performance but also offers environmental benefits by recycling waste materials. This contributes to sustainable construction practices and reduces the environmental impact associated with waste disposal.

Leaching Characteristics:

The study of leaching characteristics provides insights into the environmental impact of concrete containing IBMW. Understanding the leaching behavior of elements or compounds from the concrete matrix is crucial for

assessing potential environmental risks and ensuring compliance with regulatory standards.

Waste Reduction:

1. Incorporating biomedical waste (BMW) into concrete significantly reduces the volume of biomedical waste that would otherwise require specialized disposal methods.
2. This reduction in biomedical waste helps alleviate environmental concerns associated with its disposal, such as contamination risks and landfill space usage.
3. By repurposing BMW as a valuable construction material, BMW concrete contributes to sustainable waste management practices and promotes environmental stewardship.

Strength Enhancement:

1. BMW concrete offers tangible improvements in the mechanical properties of concrete, including compressive strength, flexural strength, and durability.
2. The unique properties of biomedical waste ash (BWA) can enhance the bonding matrix within the concrete, resulting in stronger and more resilient structures.
3. This strength enhancement makes BMW concrete particularly suitable for load-bearing applications, infrastructure projects, and high-performance concrete requirements.

Cost Reduction:

1. Utilizing BMW in concrete production offers significant cost advantages compared to traditional construction materials.
2. BMW is often available at lower or even zero cost, as it is a byproduct of biomedical waste treatment processes.
3. By reducing the reliance on costly raw materials such as aggregates and cement, BMW concrete lowers overall production costs for construction projects.
4. Additionally, the use of BMW concrete can lead to long-term cost savings through reduced maintenance and repair requirements, thanks to its enhanced durability and structural integrity.

In summary, BMW concrete presents a win-win solution by simultaneously addressing waste management challenges, enhancing construction material performance, and reducing costs. By harnessing the potential of biomedical waste in concrete production, stakeholders in the construction industry can promote sustainability, efficiency, and innovation while meeting the demands of modern infrastructure development.

While concrete made using biomedical waste ash may exhibit lower workability compared to conventional concrete, adjustments to the mix design can help mitigate this issue. Additionally, the density of concrete decreases slightly with increasing replacement levels of conventional aggregates with BWA, but up to a certain threshold, the density remains comparable to that of conventional concrete. These findings underscore the feasibility of utilizing BWA in concrete production while considering both workability and density considerations

Overall, the findings suggest that concrete containing IBMW holds promise as a sustainable and durable construction material, offering both environmental and performance benefits. However, continued research and development efforts are necessary to fully understand its properties and optimize its use in practical applications.

Limitation of Bio-Medical waste on Concrete

Using concrete as a means to handle biomedical waste presents various limitations stemming from its properties, environmental concerns, regulatory standards, and practical considerations. While concrete is a versatile material known for its strength and durability, it may not be the most suitable option for managing biomedical waste due to several factors.

Firstly, concrete's porous nature poses a significant limitation when it comes to containing biomedical waste effectively. Biomedical waste often contains bodily fluids, pathogens, and other hazardous materials that can seep into the concrete's pores, leading to contamination. Once absorbed, these substances can be difficult to remove, potentially posing health risks to individuals handling the waste or coming into contact with contaminated concrete surfaces.

Moreover, the environmental impact of using concrete to handle biomedical waste is a pressing concern. Biomedical waste contains a wide range of hazardous substances, including chemicals, pharmaceuticals, and infectious agents. If these substances leach into the soil or groundwater from concrete surfaces, they can pollute the environment and pose risks to ecosystems and public health. Given the stringent regulations governing the disposal of biomedical waste, any method that risks environmental contamination is deemed unsuitable and may not meet regulatory standards.

In addition to environmental considerations, the durability of concrete must be taken into account. While concrete is renowned for its strength and longevity, it can degrade over time, especially when exposed to harsh chemicals or biological substances present in biomedical waste. Degradation of concrete can compromise its structural integrity, potentially leading to leaks or breaches that allow hazardous materials to escape into the surrounding environment.

Furthermore, regulatory compliance is a critical factor to consider when evaluating the use of concrete for biomedical waste management. Local, national, and international regulations dictate strict standards for the handling, storage, and disposal of biomedical waste to protect public health and the environment. These regulations often prescribe specific methods and materials for containing biomedical waste, and the use of concrete may not always align with these requirements. Failure to comply with regulatory standards can result in legal consequences and pose significant liabilities for healthcare facilities and waste management organizations.

Practical considerations also come into play when assessing the feasibility of using concrete for biomedical waste containment. Transporting, handling, and disposing of concrete structures designed for waste management can be logistically challenging and costly. Moreover, maintaining and cleaning concrete surfaces to prevent contamination requires specialized equipment and resources, which may not be readily available or cost-effective for all facilities.

Despite these limitations, there may be instances where concrete can be used effectively in conjunction with other waste management methods. For example, concrete can be used to construct secondary containment structures, such as storage bins or containment vaults, to supplement primary waste disposal systems. In such cases, additional measures, such as chemical-resistant coatings or liners, may be implemented to mitigate the risk of contamination and ensure compliance with regulatory standards.

In conclusion, while concrete offers certain advantages in terms of strength and durability, its use for handling biomedical waste is subject to significant limitations. Concerns related to contamination, environmental impact, durability, regulatory compliance, and practicality must be carefully considered when evaluating the suitability of concrete for biomedical waste management. Alternative methods and materials, such as specialized containers, autoclaving, or incineration, may offer more effective and environmentally sustainable solutions for managing biomedical waste in compliance with regulatory standards.