

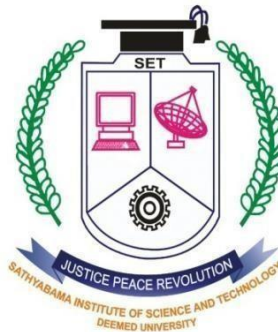
**Behavior of concrete by partial replacing fine aggregate with
tannery sludge**

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Civil Engineering

by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

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APRIL 2023



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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **G. ADITHYA (Reg.No.39200016)** and **CH. SASI KIRAN (Reg. No.39200011)** who carried out the project entitled "**Behaviour of concrete by partial replacing fine aggregate with tannery sludge**" under our supervision from October 2022 to April 2023.

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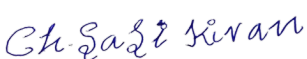
DECLARATION

We, **G. ADITHYA (Reg. No.39200016)** and **CH. SASIKIRAN (Reg. No.39200011)** hereby declare that the Project Report entitled “**Behaviour of concrete by partial replacing fine aggregate with tannery sludge**” done by us under the guidance of **Dr.R PADMA PRIYA** is submitted in fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

DATE: 13.04.2023

PLACE: Chennai

1. 

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SIGNATURE OF THE CANDIDATES

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We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

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ABSTRACT

The tanning industry generates a large amount tannery sludge, which is waste in the form of waste in the form of tannery sludge, which is typically disposed of in landfills. However, this waste material can potentially be utilized in the making of concrete as a partial replacement for fine aggregate. This experiment looked at how concrete that had different amounts of tannery sludge as a substitute for some of the fine aggregate behaved.

The experimental program involved preparing concrete mixes with 0%, 10%, 20%, 30%, and 40% tannery sludge as a replacement for fine aggregate in part. qualities of recently-poured concrete, including workability and slump, were measured, and the breaking strength and durability of hardened concrete were evaluated. The results of the study showed that concrete containing up to 30% tannery sludge as a substitute for fine aggregate in some cases exhibited acceptable workability and met the breaking strength and durability requirements of relevant standards.

The use of tannery sludge in place of some of the fine aggregate in concrete has the potential to provide a sustainable and cost-effective solution for the disposal of tannery waste. However, additional research is required to determine the long-term impact of tannery sludge on the functionality of concrete structures.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

One of the most popular building materials in the world is concrete, although its production requires large amounts of natural resources and energy, resulting in significant environmental impacts. Moreover, the disposal of industrial wastes, such as tannery sludge, poses a major challenge to the tanning industry. Tannery sludge is a by-product of the leather industry, which is typically disposed of in landfills, causing environmental pollution and health hazards.

Partial substitution of trash for natural aggregates materials is a promising strategy for sustainable concrete production. In addition to lowering the environmental effect of concrete production, using industrial wastes as a partial replacement for natural aggregates in concrete can also help with trash disposal.

Tannery sludge is an unwanted item that contains a significant amount of organic matter, such as protein, fat, and collagen, which can affect the properties of concrete. In recent years, researchers have looked into the possibility of using tannery sludge as a partial replacement for fine aggregate in concrete. concrete that has had tannery waste added can improve its workability, reduce its weight, and enhance its thermal insulation properties. However, the features and percentage of the tannery sludge in the concrete will determine how it behaves. sludge used.

Consequently, this project determines how concrete containing will behave various proportions of tannery sludge as a replacement for fine aggregate in part. characteristics of newly-poured and hardened concrete, including workability, breaking strength, and durability, will be evaluated to determine the feasibility of using tannery sludge as a sustainable alternative for the disposal of tannery waste and reducing the environmental impact of concrete production.

1.2 TANNERY SLUDGE

A by-product of the tanning process, which involves processing animal hides with various chemicals to produce leather, is tannery sludge. The method of tanning generates large amounts of wastewater, which contains a variety of both organic and inorganic substances, including proteins, fats, collagen, and salts.

To treat the wastewater, tanneries typically use various methods, including sedimentation, filtration, and chemical treatment, to remove solids and contaminants. The resulting sludge is a mixture of solids and water and contains various organic and inorganic compounds, including heavy metals, salts, and pathogens.

Tannery sludge can be difficult to dispose of due to the presence of and high organic content of heavy metals and other contaminants. Traditionally, tanneries have disposed of sludge in landfills, which can pose environmental risks such as contamination of groundwater and soil.

However, with the increasing concerns about environmental pollution, there has been growing interest in finding beneficial uses for tannery sludge. Some researchers have explored the use of tannery sludge as a potential substitute for natural aggregates in concrete production, as well as its potential as a feedstock for biogas production, fertilizer, or soil amendment.

1.3 USES OF TANNERY SLUDGE

Tannery sludge is a by-product of the leather tanning process and is typically composed of organic matter such as protein, fat, and collagen, as well as various inorganic compounds. Historically, tannery sludge has been disposed of in landfills, but with increasing environmental concerns, there has been growing interest in finding beneficial uses for this waste material.

One potential use of tannery sludge is as a substitute for some of the fine aggregate in concrete production. The organic matter in tannery sludge can act as a binding agent, which can increase the strength and workability of concrete. It has been demonstrated that using tannery sludge as a partial replacement for fine aggregate in concrete is feasible and effective in several studies.

In addition to its use in concrete production, tannery sludge has also been employed as a fuel source for the production of energy. The tannery sludge's high level of organic material makes it a potential source of renewable energy through combustion, gasification, or pyrolysis. Tannery sludge can also be used as a fertilizer or soil amendment due to its high nutrient content.

Furthermore, tannery sludge has been used as a substrate for biogas production, where it is anaerobically digested to produce biogas, which can be used as a fuel. Tannery sludge can also be used in the production of biodegradable plastics and as a feedstock for the production of other chemicals.

Overall, tannery sludge has the potential to be a valuable resource, and its use in various applications can provide economic and environmental benefits, reducing the need for disposal in landfills and contributing to a more sustainable future.

1.4 MANUFACTURING PROCESS OF TANNERY SLUDGE

The manufacturing process of tannery sludge can be broken down into various stages:

Soaking: The initial phase of tanning process involves soaking the animal hides in large vats of water to remove dirt, blood, and other impurities.

Liming: The hides are then treated with a lime solution to remove hair and other unwanted materials. The lime solution also helps to loosen the collagen fibers in the hide, making it easier to tan.

Fleshing and splitting: After liming, the hides are mechanically or manually fleshed to remove any remaining flesh and fat. The hides are then split into layers to create a thinner and more uniform product.

Tanning: The tanning process involves treating the hide with various chemicals to stabilize the collagen fibers and create leather. This stage typically involves the use of chromium, which is a common tanning agent used in modern tanneries.

Dyeing and finishing: Once the tanning process is complete, the leather is dyed and finished to create the desired color, texture, and appearance.

Wastewater treatment: During the tanning process, large quantities of wastewater are generated, which contain various contaminants like heavy metals and organic material, and other chemicals. The wastewater is typically treated using sedimentation, filtration, and chemical treatment to remove solids and contaminants. The resulting sludge is a mixture of solids and water and contains various organic and inorganic compounds, including heavy metals, salts, and pathogens.

Sludge disposal: Traditionally, tanneries have disposed of sludge in landfills or incinerators, which can pose environmental risks such as contamination of groundwater and soil. However, with the increasing concerns about environmental pollution, there has been growing interest in finding beneficial uses for tannery sludge.

1.5 ADVANTAGES AND DISADVANTAGES OF TANNERY SLUDGE

Advantages:

Energy Source: Tannery sludge can be used as an energy source. The organic matter present in the sludge can be burned to generate heat and electricity.

Fertilizer: Tannery sludge contains a significant amount of nutrients, such as nitrogen, phosphorus, and potassium, which are essential for plant growth. It can be used as a fertilizer to improve soil fertility and crop productivity.

Raw Material: Tannery sludge contains high levels of collagen, which can be extracted and processed to produce gelatin, a protein-rich material used in food, pharmaceutical, and cosmetic industries.

Disadvantages:

Environmental Pollution: Tannery sludge contains heavy metals, such as chromium, which are toxic and can cause environmental pollution. Disposal of untreated tannery sludge can contaminate soil and groundwater, leading to serious health hazards.

Health Hazard: Tannery sludge can pose a significant risk due to the presence of risks to human health toxic substances. Exposure to tannery sludge can lead to skin irritation, respiratory problems, and even cancer.

Odor: Tannery sludge emits a foul odor that can cause discomfort and annoyance to people living in the vicinity. The odor can also attract insects and rodents, leading to a further health hazard.

In conclusion, while tannery sludge has some advantages, its disadvantages are significant, particularly in terms of environmental pollution and health hazards. Proper treatment and disposal of tannery sludge are necessary to mitigate its harmful effects on the environment and people's health.

Tannery sludge can be used in construction in a few different ways, including:

Cement production: Tannery Sludge can be used in place of some of the raw materials used to make cement. The organic and inorganic components in the sludge can contribute to the chemical processes that take place during cement manufacture, and can also help to reduce the amount of energy required for the process. However, the use of tannery sludge in cement production must be carefully controlled to guarantee that the final product matches the necessary strength and quality requirements.

Bricks and blocks: Tannery sludge can be used as a partial substitute for the clay or sand needed to make bricks and blocks. The organic components in the sludge can help to improve the final item's resilience and robustness, while also reducing the amount of raw materials required. However, the use of tannery sludge in bricks and blocks must also be carefully controlled to ensure that the final product meets the necessary strength and quality requirements.

Landfill construction: Tannery sludge can be used in the construction of landfill liners and covers. The organic and inorganic components in the sludge can help to improve the stability and performance of the liner or cover, while also reducing the amount of raw materials required.

It's crucial to remember that the use of tannery sludge in building must be properly regulated to guarantee that it doesn't endanger the environment or human health. The sludge should be properly tested and treated to remove any contaminants or toxins, and its use should be guided by local regulations and standards.

1.6 OBJECTIVE

- To determine the properties of cement, fine aggregate and Coarse aggregate.
- To determine the properties of tannery sludge.
- To determine the behavior of concrete with tannery sludge.
- To determine the compressive strength, bending strength, water absorption, tensile strength and density of concrete. (7 days, 14 days and 28 days).

CHAPTER 2

LITERATURE REVIEW

The earlier research on the is elaborated in this chapter. Tannery Sludge using with concrete by replacing fine aggregate and to understand the importance of study and techniques involved in this study.

S. G. Prabhu et al (2018), By substituting varied percentages of tannery sludge for fine aggregate, the study examined the mechanical characteristics of concrete. The findings demonstrated that when the proportion of tannery sludge grew, the breaking force and splitting strength of concrete dropped.

S. S. Kadam et al (2019), The study looked at how tannery sludge affected the workability and breaking strength of concrete when fine aggregate was substituted. The findings demonstrated that, while concrete's workability increased, its breaking strength reduced as the quantity of tannery sludge increased.

M. A. Al-Ansari et al (2019), By substituting varied percentages of tannery sludge for fine aggregate, the study examined the mechanical characteristics of concrete. The findings demonstrated that as the amount of tannery sludge grew, the splitting durability, tensile strength at splits, the twisting strength of concrete dropped.

N. A. Abas et al (2020), The study looked at how the microstructure and mechanical characteristics of concrete would change if tannery sludge were used in place of fine aggregate. The findings demonstrated that when the amount of tannery sludge grew, the splitting durability, tensile strength when split, and bending durability of concrete dropped, while the inner structure of concrete was unaltered.

A. K. Adegun et al (2018), The study looked at how fine aggregate replacement with tannery waste affected concrete's breaking strength, twisting strength, and water absorption. The findings revealed that while concrete's ability to absorb water decreased, its breaking strength and flexibility declined as the quantity of tannery sludge increased.

S. S. Kadam et al (2019), The investigations that looked into using tannery sludge as an alternative for fine gravel in concrete were summarized in the review paper. The impact of sludge from tanneries on the durability, workability, and breaking strength of concrete was explored in the article.

V. K. Raj et al (2019), The review article covered investigations that looked into the characteristics of concrete when fine aggregate was swapped out for tannery sludge. The focus of the article was on how tannery sludge affects the durability, workability, and breaking strength of concrete.

S. C. Niranjana et al (2019), The studies that looked into using tannery sludge as an alternative for fine gravel in concrete were compiled in the review paper.

S. S. Kadam et al (2020), The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The article concentrated on the impact of sludge from tanneries on the durability, workability, and mechanical characteristics of concrete.

M. A. Al-Ansari et al (2020), The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The discussion in the article was on how tannery sludge affected the mechanical characteristics, microstructure, and environmental effects of concrete.

P. Bhargavi et al (2021), The studies that looked into using sludge from tanneries as an alternative for fine gravel in concrete were compiled in the review paper. The essay covered how tannery waste affects concrete's tensile force, durability, and environmental impact.

V. D. Dhadge et al (2021), The review paper covered studies that looked into how tannery sludge affected the durability and mechanical properties of concrete. The article concentrated on the impact of sludge from tanneries on the concrete's water absorption, chloride ion penetration, breaking courage, tensile strength, and bending strength.

S. S. Kadam et al (2021), The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The article concentrated on the impact of sludge from tanneries on the durability, workability, and mechanical characteristics of concrete.

S. R. Mallick et al (2021), The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The article's main focus was on how tannery waste affected the durability, mechanical qualities, and environmental effects of concrete.

K. H. Praveen et al (2022), The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The focus of the article was on how tannery muck affected concrete's breaking durability, divided tensile strength, bending strength, and water absorption.

P. Manikandan et al (2022), The review article gave a summary of the investigation into the effects of replacing some of the smaller particles in concrete with tannery sludge on the properties of the material. The focus of the article was on the effects of tannery sludge on the water adsorption, chloride ion penetration, breaking tensile force, durability in bending, and breaking strength of concrete.

R. Bhuvaneshwari et al (2022). The summary of the research into how the properties of concrete were impacted when sludge from tanneries was used for the replacement of some of the smaller particles was given in the review paper. The focus of the article was on how tannery sludge affected the concrete's ability to absorb water, allow chloride ions to penetrate, split under tension, withstand bending, and shatter.

K. Vijayakumar et al (2022) The characteristics and prospective uses of sludge from tanneries in concrete were covered in the review article. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

N. N. Mariappan et al (2022) The review paper covered studies that looked into using sludge from tanneries as a substitute for some of the finest gravel in concrete. The article concentrated on the impact of sludge from tanneries on the concrete's water absorption, chloride ion penetration, splitting tensile force, bending strength, and breaking strength.

R. V. Veeraragavan et al (2022) The review article covered how tannery waste affects the characteristics of concrete. The article concentrated on the impact of sludge from tanneries on concrete's water absorption, durability, splitting strength, tensile strength at splits, and breaking strength.

R. Z. B. Ahmed et al (2022) The usage of tannery waste in the creation of concrete was covered in the review paper. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

M. P. Manoharan et al (2022). The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The article concentrated on the impact of sludge from tanneries on concrete's water absorption, durability, splitting strength, tensile strength at splits, and breaking strength.

P. Bhuvaneswari et al (2021) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The article was primarily concerned with how tannery waste affected the mechanical characteristics, resilience, and long-term viability of concrete.

N. N. Mariappan et al (2021) The use of tannery waste in the creation of concrete was covered in the review paper. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

R. Vaishnavi et al (2021) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The article concentrated on the impact of sludge from tanneries on concrete's water absorption, durability, splitting strength, tensile strength at splits, and breaking strength.

M. C. Nataraja et al (2020) The durability of concrete employing tannery sludge as an alternative for fine aggregate was covered in the review article. The article's main focus was on how tannery waste affected the durability, mechanical qualities, and environmental effects of concrete.

S. Kumar et al (2020) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The research on the impact of sludge from tanneries on the durability, long-term viability and environmental effects of concrete was summarized in the article.

A. B. Elmaghraby et al (2020) The review study covered the characteristics of concrete using tannery sludge in place of some of the fine aggregate. The article concentrated on the impact of sludge from tanneries on concrete's water absorption, durability, splitting strength, tensile strength at splits, and breaking strength.

V. K. Jain et al (2019) The review article covered how tannery waste affects the characteristics of concrete. The research on tannery sludge's impact on concrete's breaking strength, tensile strength when split, bending strength, absorption of water, and durability was summarized in the article.

S. S. Singh et al (2018) The review study covered the characteristics of concrete using tannery sludge in place of some of the fine aggregate. In the article, the effects of tannery waste on the durability, sustainability, and ecological impact of concrete was highlighted.

R. G. D. Silva et al (2018) The usage of tannery waste in concrete was covered in the review article. The research on the impact of sludge from tanneries on the durability, long-term viability and environmental effects of concrete was summarized in the article.

M. A. Shobana et al (2017) The review study covered the characteristics of concrete using tannery sludge in place of some of the fine aggregate. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

M. P. Carmona-Quiroga et al (2016) The research on using sludge from tanneries as a mixture in concrete was covered in the review article. The research on the impact of sludge from tanneries on the durability, long-term viability and environmental effects of concrete was summarized in the article.

Z. He et al (2014) The usage of tannery waste in cement-based materials was covered in the review article. The study on the impact of tannery waste on the strength, sustainability, and environmental effects of materials made from cement, including concrete, was summarized in the article.

M. H. Alshaaer et al (2014) The research on the impact of sludge from tanneries on the durability, mechanical characteristics, and environmental effects of concrete was summarized in the article.

M. Arif et al (2013) The use of tannery waste in cement-based materials was covered in the review article. The study on the impact of tannery waste on the resilience, sustainability, and environmental effects of materials made from cement, including concrete, was summarized in the article.

P. S. Raja et al (2012) The use of sludge from tanneries as a concrete replacement for fine aggregate was covered in the review paper. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

C. Dias et al (2012) The usage of tannery waste in construction materials, including concrete, was covered in the review article. The investigations that looked into how tannery waste affected these materials' durability, mechanical characteristics, and environmental impact were summarized in the article.

A. Praveen Kumar et al (2012) The use of waste from tanneries as an environmentally benign alternative to fine gravel in concrete was covered in the review paper. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

M. M. Mashreque et al (2017) The review article covered the environmentally friendly usage of concrete's fine aggregate as an interim substitute for tannery sludge. The research on the impact of sludge from tanneries on the durability, long-term viability and environmental effects of concrete was summarized in the article.

S. Sivakumar et al (2015) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

A. Subashini et al (2014) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

K. Manoj et al (2019) The review study covered the characteristics of concrete using tannery sludge in place of some of the fine aggregate. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

M. A. Rashid et al (2018) The review essay covered the topic of using sludge from tanneries as an alternative substance for environmentally friendly concrete. The research on the impact of sludge from tanneries on the durability, long-term viability and environmental effects of concrete was summarized in the article.

P. Chandramouli et al (2014) The use of sludge from tanneries as an alternative for fine gravel in concrete was covered in the review article. The investigations that looked into how tannery sludge affected the durability, mechanical qualities, and environmental effects of concrete were summarized in the article.

CHAPTER 3

METHODS AND MATERIALS

3.1 METHODOLOGY

Methodology describes the complete procedure from surveying of literatures to comparison of results of Tannery Sludge and behavior of concrete. Fig 3.1 shows methodological frame-work.

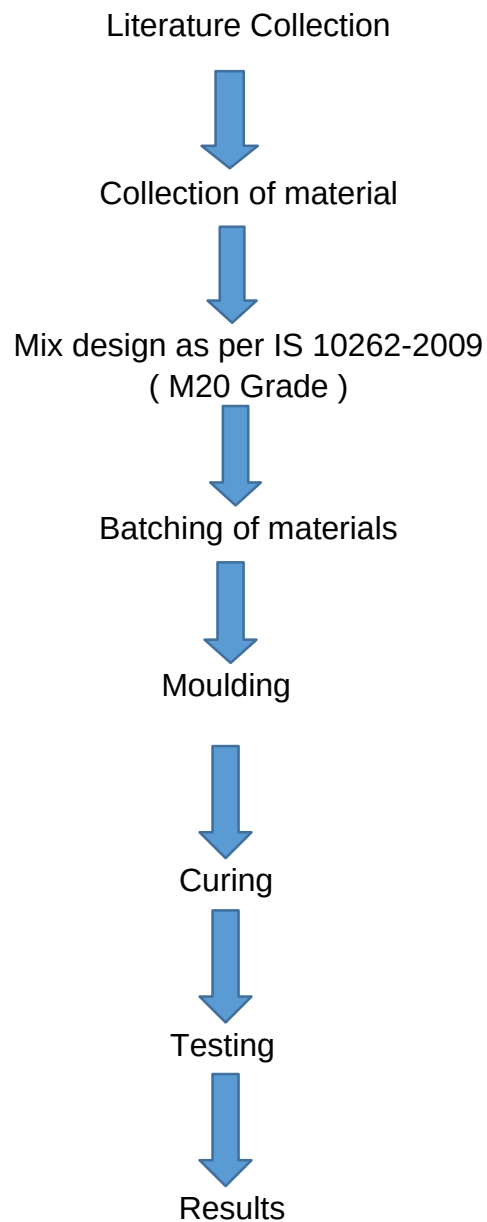


Fig 3.1: Methodology

3.2 MATERIALS USED

3.2.1 Cement

Cement is a hydraulic binding material utilized when manufacturing that hardens and sets when mixed with water. It is created by heating clay, limestone, and other materials in a furnace to a fine powder. kiln at very high temperatures, typically over 1,400°C (2,552°F). This process, known as calcination, causes the raw materials to undergo a chemical reaction and form a clinker, It is subsequently crushed into a powder to produce the final product - cement. When mixed with water, cement reacts chemically to form a hard and durable material known as concrete. Aggregates (like sand and gravel) are also a component of concrete, which is a composite material, water, and sometimes additives. Cement is a crucial component in the construction industry and is used to create various structures, including buildings, bridges, roads, and dams.



Fig 3.2: Cement

Properties of cement

Properties	Values
Specific gravity	3.12
Normal consistency	29%
Initial setting time	65min
Final setting time	275min
Fineness	330kg/m ²
Soundness	2.5mm
Bulk Density	830 – 1650 m ³

Table 3.1: Properties of cement

3.2.2. Fine aggregate (M sand)

Fine aggregates in concrete are typically smaller particles of material, generally between 0.15 mm (0.006 inches) and 4.75 mm (0.187 inches) in size. Fine aggregates are commonly made up of materials such as sand, crushed stone, or gravel screenings. Hard granite rocks are crushed into manufactured sand, a sort of fine aggregate, to create sand-sized particles. M-sand has become a popular alternative to natural sand in recent years, particularly in construction projects where there are concerns about the availability and quality of natural sand.

M-sand is known for its consistent quality, which makes it ideal for use in concrete and other construction applications. It has a more angular and rough texture compared to natural sand, which allows it to provide better bonding between the aggregate in the concrete and the cement paste mix. This, in turn, can lead to concrete that is stronger and more resilient.

Overall, M-sand is a type of fine aggregate that can be utilized in place of natural sand in concrete. and other construction applications.



Fig 3.3: Fine aggregate (M sand)

Properties of fine aggregate

Properties	Values
Fineness modulus	3.63
Specific gravity	2.66
Size	Passing through 4.75mm sieve
Water absorption ratio	1%

Table 3.2 properties of fine aggregate

3.2.3 Coarse aggregate

Coarse aggregate in concrete refers to the larger particles of material, usually more than 4.75 mm (3/16 inch) in size. Coarse aggregates can be made up of various materials, including crushed stone, gravel, or recycled concrete. Concrete's coarse aggregate's main purpose is to provide bulk and stability to the mix.

When selecting coarse aggregate for concrete, several factors are considered, including its strength, durability, and shape. The aggregate particles should be strong enough to withstand the forces of the hardened concrete and should resist wear and degradation over time. Concrete's characteristics can also be impacted by the form of the coarse aggregate, with more angular shapes generally providing better interlocking and increased strength compared to rounded shapes.



Fig 3.4: Coarse aggregate

Properties of coarse aggregate

Properties	Values
Fineness modulus	7.19
Specific gravity	2.75
Size	20mm
Water absorption ratio	1.60
Density	1830

Table 3.3 properties of coarse aggregate

3.2.4 Water

Water is commonly used as a key ingredient the process of making concrete. It is added to the mix to activate the cement and create a chemical reaction that leads to the hardening and setting of the concrete. The strength, resilience, and workability of the finished product can all be affected by the amount of liquid used in the mixture. Additionally, to its use in concrete production, water is also used in construction for a variety of other purposes, including cleaning, irrigation, and dust suppression.

3.2.5 Super Plasticizers

High-range water reducers, commonly referred to as superplasticizers, are chemical additives used in concrete production to increase its workability without sacrificing strength or durability. Superplasticizers are typically added to concrete mixtures to lower the quantity of water required to obtain the necessary workability, which lowers the proportion of water to cement and raises the concrete's strength and durability.

Superplasticizers work by dispersing and suspending the cement particles in the mix, allowing for a more fluid and workable concrete without adding more water. This makes it more compact and portable. The concrete, resulting in a smoother and more uniform finish.

Superplasticizers can be synthetic or derived from natural materials and are typically added to the mix in small quantities, often less than 1% of the cement's overall weight. They are frequently employed in the creation of strong concrete, self-consolidating concrete, and other specialized concrete applications where improved workability is essential.

Overall, superplasticizers are an important tool in the construction sector for producing concrete with good performance with improved workability, strength, and durability.

3.2.6 Tannery sludge

Tannery sludge is a by-product of the leather is produced through the process of tanning, which involves treating skins from animals with various chemicals. The method of tanning generates large amounts of wastewater, which contains a variety of substances, both biological and inorganic, such as proteins, fats, collagen, and salts.

To treat the wastewater, tanneries typically use various methods, including sedimentation, filtration, and chemical treatment, to remove solids and contaminants. The resulting sludge is a mixture of solids and water and contains various organic and inorganic compounds, including heavy metals, salts, and pathogens.

Tannery sludge can be difficult to dispose of due to the presence of and high organic content of heavy metals and other contaminants. Traditionally, tanneries have disposed of sludge in landfills, which can pose environmental risks such as contamination of groundwater and soil.



Fig 3.5: Tannery sludge

Properties of Tannery sludge

Properties	Values
Bulk density	0.140
Total pore space	94.72
Available water	8.93

properties of Tannery sludge

3.3 MIX DESIGN

The designed mix proportion 1:2.48:3.55 was used for all the mixes and quantity of Partially replacing the tannery sludge with fine aggregate in different percentage of volume is changed and added in mixes as per the percentage content required.

Mix design for M20 grade as per (IS 10262:2019)

- Type of cement: OPC
- Exposure: Severe
- Slump: 65mm
- Max. cement: 450/m³
- Chemical admixtures: Super plasticisers
- S.P gravity of cement:2.88
- C.A: 2.74
- F.A: 2.65
- Chemical Admixtures: 1.45
- Water Absorption- C.A: 0.5%
- F.A: 1.0%

Target Strength f_{ck}

$$\begin{aligned}f'_{ck} &= f_{ck} + 1.653 \\&= 20 + 1.65 \times 4.0 \text{ [value of } S \text{ from table 2, IS10262:2019]} \\&= 26.6 \text{ N/mm}^2\end{aligned}$$

or

$$\begin{aligned}f_{ck} &= f_{ck} + x \\&= 20 + 5.5; \text{ Table 1, } m_{20}=5.5 \\&= 25.5 \text{ N/mm}^2\end{aligned}$$

$$\text{Greater } f_{ck} = 26.6 \text{ N/mm}^2$$

Nominal maximum aggregate size is 20 mm; entrapped air as a percentage of concrete volume =1.0 correct water cement ratio for PPC, curve 2 can be used

Target strength= 26.6N/mm^2

Approximately for 26.6N/mm^2 ; water cement ratio=0.55

For severe condition, $w/c \geq 0.45$

$w/c=0.45$

Water content:

For 20mm CA, water content = 186kg

Interpolating = $0 + (3-0) / (15-50) * (65-50)$
 $= 1.8\%$

Increase by 1.8%

Increased water content = $1.018 * 186$
 $= 176\text{kg}$

Reduction due to super plasticizer

For 1.0% of weight of cement, 23% of water can be reduced.

Assume 1% super plasticizer is used.

Water content = $0.77 * 189.35 = 145.80\text{kg}$.

Calculation of cement content:

Water content ratio= $0.45 = w/c$

Cement content= water content $\div 0.45$
 $= 145.80 \div 0.45$
 $= 320\text{kg/m}^3$

As per IS456, table 5, Cement must contain at least 320 kg/m^3 for severe exposure consequently, cement content $= 320\text{kg/m}^3$

Volume of coarse and fine aggregate:

Assume zone 2, 20mm CA [table 5]

CA volume as a percentage of total aggregate volume: 0.62

For 0.5 w/c

for every 0.05 decrease in w/c, increases 0.01

For 0.45 w/c = C. A = 0.63

$$F. A = 1 - 0.63$$

$$= 0.37$$

Mix Calculation:

Assume, total volume = 1m³

Volume of entrapped air = 0.01m³

Volume of cement = mass of cement/sp. Gravity * 1/1000

$$= 324 / 2.88 * 1/1000$$

$$= 0.113 \text{m}^3$$

(d) Volume of water = 145.5/1*1/1000

$$= 0.146$$

(e) Volume of plasticizers = 3.24/1.145*1/1000

$$= 0.0028 \text{m}^3$$

(f) Volume of aggregate = 1 - 0.01 = 0.113 - 0.146 - 0.0028

$$= 1 - 0.273$$

$$= 0.73 \text{m}^3$$

(g) Mass of CA = (f) * ratio of CA * SP.gravity * 1000

$$= 1138 \text{kg}$$

(h)Mass of FA= (f)*ratio of FA*specific gravity*1000

$$=0.73*0.037*2.65*1000$$

$$= 794\text{kg}$$

Cement= 320kg/m³ Water= 176kg/m³ FA= 794kg/m³ CA= 1138kg/m³

3.3.1 Concrete mixes

Designation	Cement (kg/m ³)	Fine aggregate (kg/m ³)	Coarse aggregate (kg/m ³)	Tannery sludge (kg/m ³)
CC M20	320	794	1138	-
M1	320	714.6	1138	79.4
M2	320	635.2	1138	158.8
M3	320	555.8	1138	238.2
M4	320	476.4	1138	317.6

Table 3.5 Quantity of materials per m³ of concrete

Fives concrete mix are designed with varied tannery sludge contents:

In M20 - concrete of fck 20 N/mm²

In mix 1 – concrete 10% Tannery sludge replacing with sand

In mix 2 – concrete 20% Tannery sludge replacing with sand

In mix 3 – concrete 30% Tannery sludge replacing with sand

In mix 4 – concrete 40% Tannery sludge replacing with sand

3.3.2 Number of specimens

MIXES	Compressive strength	Tensile strength	Flexural strength	Water absorption
CC M20	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days
M1	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days
M2	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days
M3	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days
M4	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cylinder of size 150mm x 300mm 2 for 14 days 2 for 28days	Cubes of size 150mm x 150mm 3 for 7 days 3 for 14 days 3 for 28 days

Table 3.6 Number of specimens

All the constituents are measured and mixed in a mixer. The aggregates are mixed for more than 2 minutes and Cement is then added. After another minute of mixing, water was added to the mixer.

For Tannery Sludge, it is added in the dry mix and mixed well. Sludge is added gradually with dry mix and then 4 more minutes are spent combining the liquids in order to mix the tannery sludge evenly, manually it is ensured that all Sludge are mixed.

3.4 CASTING

Concrete casting is a process of pouring or molding liquid concrete into a mold or form, allowing it to harden and take the desired shape. It is a common method used in construction and engineering projects for creating various structures such as walls, floors, columns, beams, and other architectural features.

The process of concrete casting involves several steps, including preparing the mold or form, mixing the concrete, pouring the concrete into the mold, compacting and leveling the concrete, and allowing it to harden and cure. Depending on the complexity of the project and the desired finish, the concrete may also be reinforced with steel or other materials, colored, stamped, or polished.

Concrete casting can be done using different types of molds or forms, such as wooden molds, metal molds, plastic molds, or precast forms. The type of mold used depends on the final product's intended shape, size, and finish. A flexible and economical technique for building strong, long-lasting structures is concrete casting. From modest residential constructions to big commercial and industrial buildings, it is used in a variety of construction projects.



Fig 3.6: casting

3.5 CURING

Curing concrete in water is a method of wet curing, which involves keeping the concrete surface constantly wet by submerging it in water. This method is typically used for concrete structures that are exposed to water, such as bridges, dams, or marine structures, where the concrete needs to have high durability and resistance to water penetration.

After the concrete has been placed, it is waterproof membrane to stop water from penetrating the surface penetrating into the concrete. Once the membrane is in place, the concrete is flooded with water, and it is continuously kept wet for the entire curing period. The water is typically kept at a temperature between 10-21°C to ensure optimal curing conditions. The curing period for concrete cured in water is typically longer than for other curing methods, lasting up to 28 days or longer, the form of concrete used, and environmental conditions.

Curing concrete in water provides several benefits, such as reducing the risk of shrinkage and bracking strengthening the concrete's resilience to damage from water and enhancing its tensile strength. It is particularly useful in harsh environments where the concrete is exposed to water, such as marine structures, water tanks, and swimming pools.

However, curing concrete in water requires careful attention to prevent contamination of the water with cement particles, which can affect the water quality. It is essential to follow proper procedures and guidelines to ensure that the concrete is cured effectively and without any adverse effects on the environment.



Fig 3.7 curing

3.6 TESTING

3.6.1 Compressive strength test

Breaking strength test is a test performed on a material, typically a concrete or cement-based material, to determine its ability to withstand breaking forces. To perform the test, a specimen is subjected to an increasing load until it breaks, at which point the greatest breaking load that it can withstand is measured.

The breaking strength of a material is influenced by a range of factors, such as the quality of the materials used, the curing conditions, the age of the material, and the presence of any defects or cracks. The breaking strength test provides valuable information about the quality and performance of the material, and can help identify any issues that need to be addressed to ensure the material meets the desired performance specifications.

3.6.2 Procedure of compressive strength test on cube

The procedure for performing a breaking strength test on a concrete cube typically involves the following steps:

- **Sample preparation:** A sample of fresh concrete is prepared by pouring it into a 150mm x 150mm x 150mm cube mould. Each layer of filling in the mould is compressed by tamping it with a steel rod.
- **Curing:** After the mould is filled, the cube is covered with a plastic sheet. Then put in an incubator to undergo a period of 28 days. The temperature in the tank that cures is kept at $27 \pm 2^{\circ}\text{C}$ and a humidity of 90%.
- **Testing:** The cube is taken out from its mould and put into the compression testing equipment after curing for 28 days. The strain on the cube is steadily increased by the machine until it breaks.
- **Recording results:** The cube fails at its maximum load, which is noted. From there, the maximum force is divided by the cube's cross-sectional area to get the concrete's breaking strength.
- **Reporting:** The results of the test are reported in units of psi or MPa, comparing the outcomes to the minimum strength requirements specified by the design engineer or the relevant standards.



Fig 3.8: Compressive strength

3.6.3 Tensile strength test

Tensile strength test is a type of mechanical test used to determine the maximum stress a material can withstand before breaking under tension. A small amount of the substance is pulled for this test. apart by applying a gradually increasing tensile force until it reaches its breaking point. The test results are used to evaluate the strength, quality, and suitability of the material for specific applications.

The substance is grasped at both ends and dragged in opposite ways until it breaks during the test. By dividing the highest load by the sample's cross-sectional area, the strength at tensile stress is computed. The amount of force necessary to break the substance is recorded.

3.6.4 Procedure of tensile strength test on cylinder

The steps involved in conducting the tensile strength test on a cylindrical specimen typically involves the following steps:

- **Sample preparation:** A cylindrical sample of the material is prepared by cutting it to the appropriate size and shape. The sample is then polished to remove any surface irregularities and to ensure uniformity.
- **Fixturing:** The sample is mounted in a tensile testing machine using special grips

that are designed to hold the cylindrical shape. The sample is subjected to an ever-increasing tensile tension by the machine until it snaps.

- **Tensile testing:** The testing machine pulls the sample in opposite directions at a constant rate, and the force applied to the sample is measured. The test is typically conducted until the sample breaks.
- **Recording results:** The greatest force that causes the sample to break is noted. The greatest load is then divided by the cross-sectional region of the sample to get the material's tensile strength.
- **Reporting:** The test's findings are presented in psi or MPa units, and they are contrasted with the minimum strength. Requirements specified by the design engineer or the relevant standards.



Fig 3.9 Tensile strength test

3.6.5 Flexural strength test

Bending A mechanical test called a "strength test" is performed to figure out how much stress an object can take before cracking under twisting or bending loads. A sample of the substance is put through a three- or four-point bending test in this test, and the maximum load required to cause the sample to fail is recorded.

During the test, the sample is supported at two points or three points, depending on the testing standard being followed, and a load is applied at the sample's center using a testing device. The sample is subjected to an increasing load until it

fails, and the maximum load required to cause failure is recorded.

3.6.6 Procedure of flexural strength test on prism

The procedure for performing a bending strength test on a prismatic specimen typically involves the following steps:

- **Sample preparation:** A prismatic sample of the material is prepared by cutting it to the appropriate size and shape. The sample is then polished to remove any surface irregularities and to ensure uniformity.
- **Fixturing:** The sample is supported on two points or three points, depending on the testing standard being followed. The supports are positioned at a specified distance apart, and the sample is centered on the supports.
- **Loading:** A testing device applies a load to the centre of the sample. The stress is gradually applied, and the sample's deflection is measured. Up until the sample breaks, the load is raised.
- **Recording results:** The highest load that causes a sample to break is noted. By doing so, it is possible to determine the material's bending strength by dividing the greatest load by the sample's moment of inertia.
- **Reporting:** The test's outcomes are presented in psi or MPa units, and they are contrasted with the minimum strength requirements specified by the design engineer or the relevant standards.



Fig 3.10 flexural strength test

CHAPTER – 4

RESULTS AND DISCUSSION

4.1 NABL TEST REPORTS OF TANNERY SLUDGE

Test Parameters	Test Methods / Standard	result	UNIT
pH	IS 3025: Part 11	8.88	NA
Total dissolved solids	In House	334	Mg/L
Alkalinity	IS 3025: part 23	637	%

Table 4.1 NABL Test reports of Tannery Sludge

NEOSCIENCE LABS PVT.LTD.
91, Mahalingam Nagar, Chittoor, Chennai-600126, India
Phone: +91-44-29872432, E-mail: info@neosciencelabs.com, URL: http://www.neosciencelabs.com

Report of Analysis

Report No.: ZSR-03021-RD-V1 LIMS Sample Code No.: Z35-03136

Customer Name & Address
Sathyabama Institute of Science and Technology
Jeppiaar Nagar, Regu Ganesh Salai,
Chennai, Tamil Nadu, 600119
India

Sample / Product Name: Tannery sludge

Sample Description: Tannery sludge

Storage Condition: RT

Sampling Location: Chennai

Sampling Procedure: NA

Sampled By: Client

Sample Quantity Received: 1 Pack

Sample Identification By: NA

Sampled On: NA

Sample Receipt Date: 13-04-2023

Test Started Date: 13-04-2023

Test Completed Date: 13-04-2023

Report date: 13-04-2023

TEST PARAMETERS / NAME	TEST METHOD / STANDARD	RESULT	UNIT	SPECIFICATION LIMIT
pH	IS 3025 : Part 11	8.88	NA	Report the result
Total Dissolved Solids				
Total dissolved solids	In House	334	mg/L	Report the result
Alkalinity				
Alkalinity	IS 3025 Part 23	637	%	Report the result

Verified by: 
Date: 13-04-2023 16:13

Authorized by: 
Date: 13-04-2023 16:16

End of Report

Note:

- Results are related only to the item tested.
- The results apply to the sample as received.
- This is an electronically generated report, hence does not require manual signatures.

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Fig 4.1 Lab Test reports of Tannery sludge

4.1.1 COMPRESSIVE STRENGTH

Fig 4.1.1 shows the 7, 14, and 28 days compressive strength of different mixtures. According to observations, compressive strength for m2 mix is high comparative of another mixes.

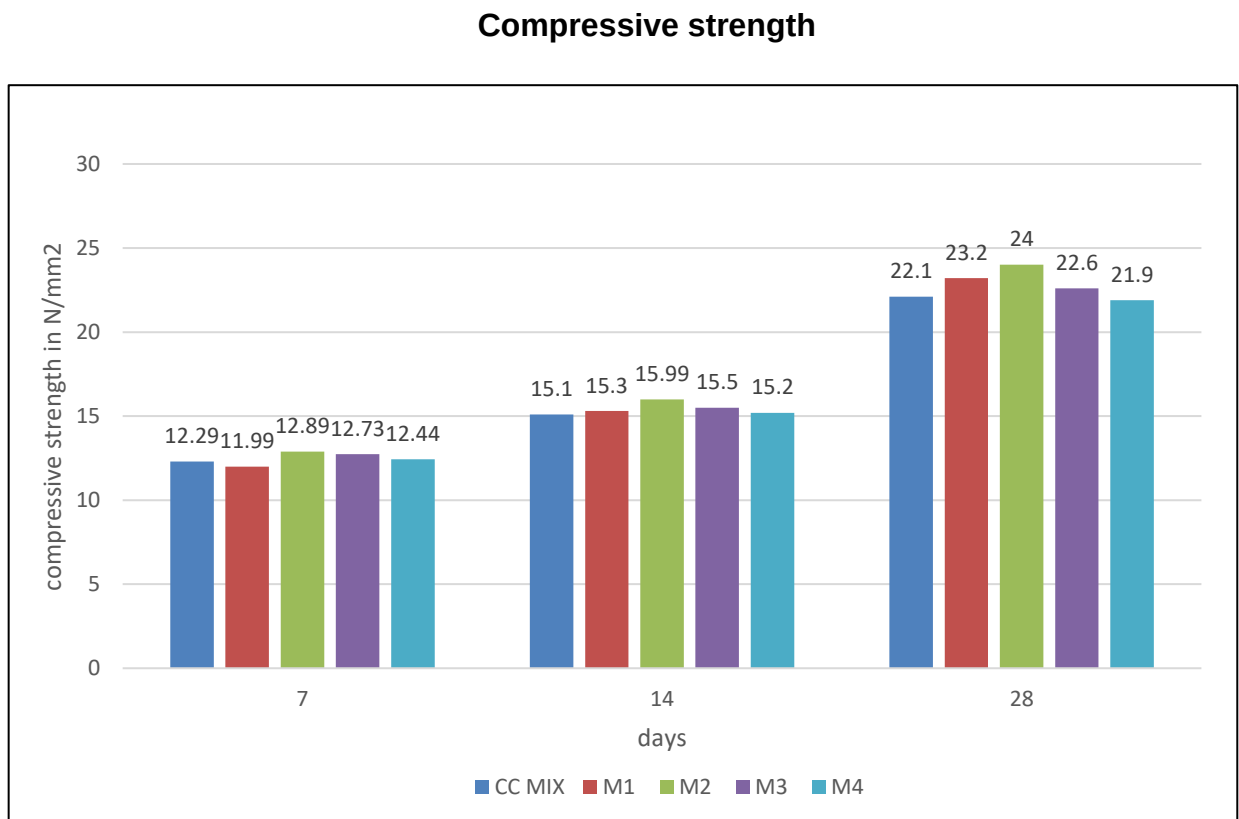


Fig 4.2: comparison of compressive strength

Tannery Sludge has significant amounts of organic materials and heavy metals, this may have an impact on the concrete's qualities. The durability of the concrete can be weakened by the presence of living substances. due to the generation of voids, which weaken the material. On the other hand, the heavy metals present in the sludge can have a pozzolanic effect, which can increase the concrete's durability. The amount of tannery sludge utilized, its quality, the conditions under which the concrete is being cured, and the type of concrete all have an actual impact on the breaking point of the material. cement used.

Breaking Concrete's strength declines as the amount of Tannery sludge content for this study, the 10% Tannery sludge content which is replacing with fine aggregate is found to be with maximum compressive. strength which is 15 – 25% greater in the instance of mix 1 concrete, it is greater than that of traditional concrete. The strength, however, falls short of the desired strength.

4.1.2 TENSILE STRENGTH TEST RESULTS

Fig 4.1.2 shows the 7, 14, and 28 days tensile strength of different mixtures. Tensile strength is seen to be a for m2 mix is high comparative of another mixes.

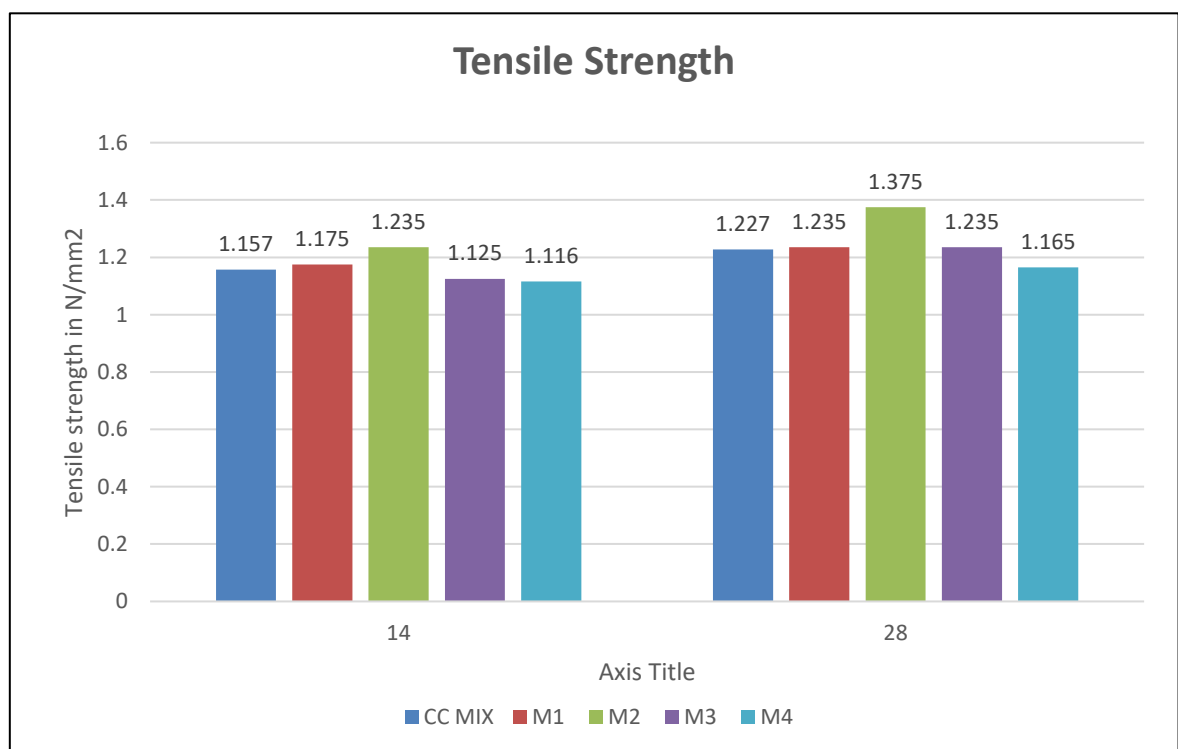


Fig 4.3: comparison of tensile strength

The capacity of concrete to withstand tension forces brought on by twisting or stretching is known as tensile strength. By offering a smooth surface, fine particles contribute to the elasticity of concrete. Matrix for the cement paste to bond with and helping to distribute the tensile stresses evenly throughout the concrete.

When tannery sludge is used due to the existence of voids, the resulting concrete might have a lower tensile strength as a partial substitute of fine aggregate. caused by the organic matter in the sludge. The organic matter can act as a lubricant, reducing the friction between the cement and the aggregate and resulting in a weaker bond.

Here as shown in the figure 4.2 this study shows that increase in Tannery sludge content will gradually decreases compared to the standard mix, although we may observe an improvement in tension strength in the 10% of Tannery sludge replaced with the fine aggregate.

4.1.3 FLEXURAL STRENGTH TEST REPORT

Fig 4.1.3 shows the 7, 14, and 28 days flexural strength of different mixtures. According to observations, compressive strength for m2 mix is high comparative of another mixes.

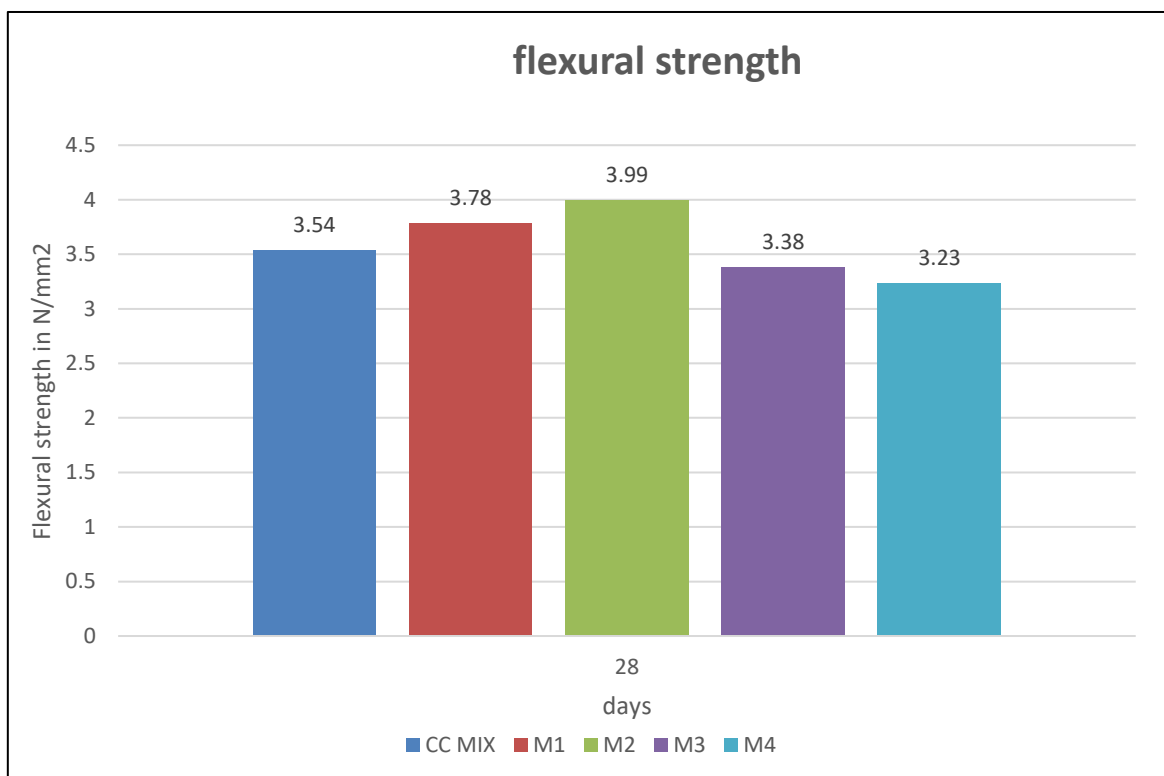


Fig 4.4: comparison of flexural strength

Tannery sludge as a substitute for fine aggregate in concrete can potentially impact the bending strength of the resulting material due to the organic content present

in the sludge. The organic matter can create voids, leading to weakened interfacial transition zones between the cement paste and aggregate, which may result in cracking and the formation of additional voids. This could ultimately lead to a reduction in the concrete's strength.

Wah reference to the Table 4.6, it is informed that the bending strength of concrete increases with the increase in sludge content in the concrete mixture. From graph Fig 4.3 is clear that increase in tannery sludge content will lead to the gradual decrease in bending strength.

Where 10% tannery sludge content is replaced with the fine aggregate shows increase in the bending strength compared to conventional mix, the bending strength increased by 6.417 percent. So, the increase in the bending strength is noticeable.

4.1.4 WATER ABSORPTION

Fig 4.1.4 shows the 7, 14, and 28 days water absorption of various mixes. It is observed that water absorption for m2 mix is high comparative of another mixes.

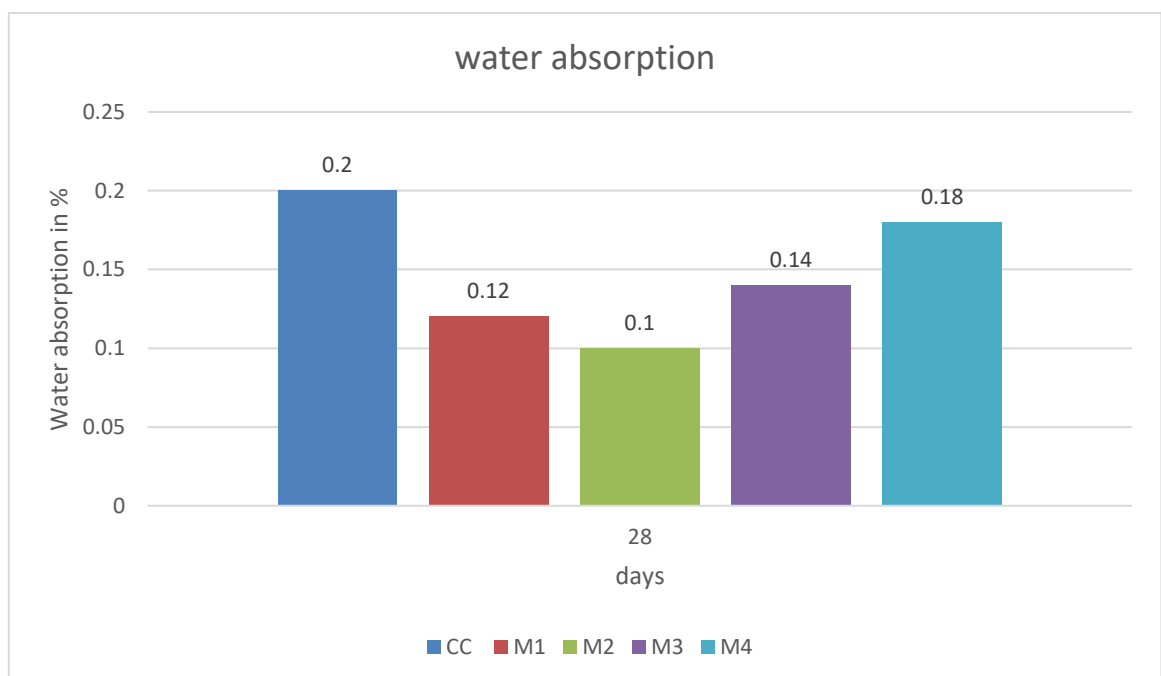


Fig 4.5 Water absorption

4.1.5 DENSITY OF CONCRETE

Fig 4.1.5 shows the 7, 14, and 28 days density of concrete of various mixes. It is observed that compressive strength for m2 mix is high comparative of another mixes.

Mixes	Weight of fresh concrete (kg/m ³)	Weight of hardened concrete	Density of concrete (kg/m ³)
CC M20	2328	8.390	2485.92
M1	2328	8.480	2512.59
M2	2328	8.590	2545.16
M3	2328	8.480	2512.59
M4	2328	8.390	2477.03

Table 4.2 density of concrete

CHAPTER 5

CONCLUSION AND REFERENCE

5.1 CONCLUSION

- In this study, using tannery sludge as A replacement for m sand in cement offers the ability to improve the concrete's workability and decrease the quantity of water required in the mixture, which will assist reduce the utilization of earth's resources and lower the environmental impact. waste content as we replacing it.
- Here According to this study, tannery sludge reduces the compressive strength, tensile strength, and flexural strength of concrete. However, the actual impact on the mechanical characteristics of concrete depends on a number of variables, including the amount of sludge used, its quality, the concrete's curing conditions, and the tannery type of cement used.

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