

UTILIZATION OF TANNERY SLUDGE IN CONCRETE

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

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

MAY - 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of N. HARIHARAN (38200011) and K.KAILASH (38200015) who carried out the project entitled "UTILIZATION OF TANNERY SLUDGE IN CONCRETE" under our supervision from October 2021 to April 2022.

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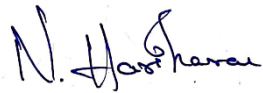
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DECLARATION

We **N. HARIHARAN** (Reg.No.38200011) and **K. KAILASH** (Reg.No.38200015) hereby declare that the project Reported entitled “**UTILIZATION OF TANNERY SLUDGE IN CONCRETE**” done by us under the guidance of **Dr.R.PADMAPRIYA,M.E,Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

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ABSTRACT

Concrete is made up of many components such as cement, aggregate, sand, and water. Due to the increased need for concrete, more resources are being created, and bound additives are also being added to improve its qualities. Industrial development is critical to a country's progress. Animal skin is one of the above-mentioned main sectors that generates better financial gains for governments. The amount of garbage created by this industry is also larger, and it's classified as risky waste due to its higher content of heavy metals. The workplace trade is on the list of main polluting industries in Bharat, according to the government pollution control panel. Due to the large amount of solid waste generated by nursing and its negative influence on the environment, a different solution is required. The goal of this research is to replace worksite muck with a fine mixture during the construction of a concrete block. Due to the rising cost of watercourse sand, the use of stuff makes concrete more cost-effective. The concrete grade used for this investigation is M25, and the fine mixture is partially replaced with industrial sludge at varied percentages of 0, 10%, 20%, and 30%. Concrete's mechanical characteristics and toughness were explored.

Table of Contents

1. INTRODUCTION:	8
1.1 GENRAL	9
1.2 UTILIZATION OF INDUSTRIAL WASTE IN CONCRETE:.....	10
1.3 INDUSTRIAL WASTE CAUSES:	13
2. LITERATURE REVIEW:.....	16
3. Materials and Methodology	20
3.1 Methodology.....	20
3.2 Materials.....	21
3.3 Cement	21
3.4 Fine Aggregate.....	22
3.5 Coarse Aggregate	23
3.6 Tannery Sludge.....	24
4. Mix Design and Proportion.....	27
4.1 Experimental procedure	28
4.1.1 Preparing Mix	28
4.1.2 Casting into the Mold	28
4.1.3 Making of Block	29
4.1.4 Demolding and Curing	29
4.1.5 Workability	30
5.Results and Discussion.....	31
5.1 Compressive Strength Test	31
5.2 Split Tensile Strength Test	32
5.3 Flexural Strength Test	34
5.4 Durability of Concrete Test.....	35
6.Conclusion.....	38
7. Reference	39

LIST OF TABLES:

s/no	TITLE	Pg.no
1	Characteristics of cement	22
2	Characteristics of Fine Aggregate	23
3	Characteristics of Carouse Aggregate	24
4	Physical characteristics of the sludge.	25
5	Chemical Characteristic of the sludge	26
6	Mix Ratio and Proportion	27
7	Test On Fresh concrete	30
8	Durability Of Concrete	37

LIST OF FIGURES:

S/no	TITLE	Pg.no
1	Methodology	20
2	Compression strength of concrete	32
3	Split tensile strength of concrete	33
4	Flexural strength of concrete	34

1. INTRODUCTION:

Concrete is a structural material made consisting of a difficult, chemically inert particle matter (usually sand and gravel) bound together in construction by cement and water. Among ordinary Assyrians and Babylonians, clay was the most prevalent bonding substance. Using lime and mineral binders, the Egyptians created a product that resembled elegant concrete. Until the early 1800s, the principal pozzolanic, or cement-forming, agent was lime (calcium oxide) produced from rock, chalk, or (where accessible) oyster shells. Joseph Aspdin, an associate English developer, burnt and crushed a combination of rock and clay in 1824. Cement, as a compound, has remained the most extensively utilised cementing agent in concrete production.

The type of mixture or cement used, the precise characteristics it exhibits, or the degree to which it has been acclimated are all factors that distinguish concrete. The water-to-cement magnitude connection has a significant impact on the character of traditional structural concrete. The lower the water content, all other factors being equal, the stronger the concrete is. The mixture should be just wet enough to ensure that the cement paste thoroughly covers each particle, that the gap between the particles is packed, and that the concrete is liquid enough to be poured and distributed properly. Another problem with the mixture's strength is the amount of cement in it (expressed as a three-part ratio cement to the fine mixture to coarse aggregate). There will be less mixture if very long-lasting concrete is required.

The force required to grind a sample of a certain age or hardness is quantified in pounds per unit of measurement or kilogrammes per sq. cm of force. Environmental conditions, such as temperature and status, play a big role in concrete's strength. If it's allowed to cure too long, it'll be subjected to unequal tensile stresses that can't be sustained in its hardened form. One of the tactics offered as a bonus is to keep the concrete moist for a period of time after it has been run to prevent the shrinkage that happens as a result of its hardening. Low temperatures have an unfavourable

effect on its strength when combined. An companion Associate in Nursing component, such as salt, is added in with the cement to make amends for this. This helps to accelerate the setting process, resulting in a heat-tight seal that can tolerate temperatures as low as 40°F. Large, non-lined concrete forms do not appear to be poured in active temperatures.

1.1 GENRAL

Waste material has been quickly rising in developing nations such as India in recent years. India's economy is booming in a variety of sectors. Many companies dump significant amounts of wastewater into the environment, which pollutes the ecosystem and has an impact on human activities. Many effluent treatment plants can handle these wastes however, as a result of the process, sludge is created. There are three options for disposing of solid waste (dry sludge): land filling, incineration, and composting (fertilizer). The majority of the sludge is handled through land filling, which has negative environmental consequences. As a result, an alternate sludge disposal system is required.

The experimental investigations are planned to employ effluent treated dry sludge as fine aggregate to lower building costs and to cut down on the amount of natural sand needed in the concrete production. The disposal of a large volume of garbage puts a pressure on the landfill site. An attempt is made in this study to evaluate the possible effect of combining solid wastes in various proportions to replace sand in the production of concrete in order to lower the maximum requirement of natural resources (Fine Aggregate). These investigations have resulted in improved compressive strength for advantageous applications.

1.2 UTILIZATION OF INDUSTRIAL WASTE IN CONCRETE:

Enormous quantities of unwanted industrial wastes are made by varied industries. As a result, the problems associated with the atmosphere and land insufficiency are raised. the use of business waste as raw materials may be a sensible answer to resolve these issues. Bottom ash, rice husk ash, vegetable oil kernel, metals, rubbish, oil, solvent - based, chemicals, weed grass, trees, timber, wood waste, tannery sludge, and other wastes were investigated and summarised in this study.

1. BOTTOM ASH

Bottom ash, a coarser form of coal ash, accounts for 10% of the waste stream. It lands on the very cheap of the facilities plant's boiler instead of wandering towards the exhaust stacks. Bottom ash is approximately as valuable as ash, despite attempts by power plant owners to develop "beneficial use" options such as structural fill and road-base material.

2. RICE HUSK ASH

Rice husk ash (RHA) is an agricultural waste by-productSS that waste managers face a considerable issue in disposing of. RHA from parboiling plants poses significant environmental risks, hence methods for reducing it are urgently needed. Because of its high silicon dioxide content (about 85–90%), RHA material is considered a real super pozzolan.

3. SCRAP METALS:

Ferric and non-ferrous metals are the two major classes of useable scrap metal. The most common type of waste is ferric metals. Metals containing iron or iron alloys, such as stainless steel, fall under this category. Metallic

elements, such as copper, lead, nickel, tin, titanium, zinc, and alloys like brass, are examples of non-ferrous waste.

Non-ferrous metals have a higher per-pound value than ferrous metals, so while scrap yards don't need metal separation, it's important to type to get a rough estimate. The simplest technique to filter various sorts of metals is via a magnet. Ferric metals and iron-based steel are magnetic because they contain iron. For example, brass and copper do not appear to be magnetic.

You'll be able to tell what kind of metals you have in your possession once your metals have been classified as ferric or non-ferrous. Metals have various looks that can be easily identified:

- **Stainless steel** – used in cutlery, appliances, vehicles, construction, and other places, stainless steel is supposed to stain, rust, and corrode less easily than traditional steel. This metal is available in a variety of grades and is distinguished by its chemical composition, which includes components such as nickel, carbon, copper, and particularly, titanium. In 2017, American companies and homeowners purchased 1.33 million metric tonnes of stainless steel.
- **Copper** – regarded as the most precious non-ferrous metal, copper can be found in kitchen utensils, electrical wiring, and physical science. Pure copper has a chromatic colour, however tarnished copper can have a brown, cherry-red hue, and when copper is modified, it can turn inexperienced. In 2017, copper scrap accounted for 34% of total copper use in the United States, and recycled copper meets 40% of global demand. Copper and copper-containing alloys come in a variety of styles.
- **Brass or bronze** – This yellow material, which is used in decorations, sculptures, musical instruments, and pipes, is one of copper's alloys.

Heating cores and radiators are frequently made of brass. Hold a metal under a fluorescent light to see whether it's brass; brass can exhibit a chromatic colour.

- **Aluminum** - is great for holding soda in your icebox because it is rust-resistant and lightweight. Because it is the most often consumed nonferrous metal in the United States, buyers frequently think of the metallic element while gathering metal for use. Recycled metallic elements account for 55% of total metallic element use in the United States. One amusing fact about metallic pieces is that they can construct their way back onto a shelf in as little as sixty days.

4. WOOD

Following concrete, wood waste is the 2nd most frequent component of demolition waste (C&D) debris. It accounts for 20% to 30% of all construction-related expenditures and expenses. Each year, around 10 percent of all garbage deposited in landfills is made up of wood.

5. TANNERY SLUDGE

Industrial sludge is made up of waste activated sludge from biological treatment units and sludge from physical-chemical treatments (such as primary sedimentation). Industrial sludge is a solid waste that must be treated properly, and its disposal is one of the most serious workplace problems.

- Tannery waste may be used efficiently in the building industry, and its disposal can be done properly and without polluting the environment.
- The cost of building is reduced, and a new concrete replacement material is available.

- Tannery waste concrete can minimise the amount of river sand used in concrete, making it lighter.



1.3 INDUSTRIAL WASTE CAUSES:

Industrial waste is waste that is generated as a result of manufacturing or industrial activity. A variety of variables contribute to workplace pollution. A variety of variables contribute to workplace pollution.

1. Lack of Policies to manage Pollution

Many companies were able to escape the pollution device's constraints because to a lack of effective laws and a lack of collective action motivation, resulting in widespread pollution that damaged the lives of many people.

2. Unprecedented Industrial Development

Most industrial townships had unplanned expansion as businesses broke laws and regulations, contaminating the environment with air and pollutants.

3. Use of antiquated technology

Most industries still believe in using cutting-edge technology to create a product that generates a large amount of garbage. Many companies still use archaic

technologies to make high-end items in order to avoid exorbitant pricing and expenses.

4. Presence of the associated outside form of Small-Scale Industries

Many smaller companies and manufacturers that lack adequate funding and rely on government assistance to conduct their day-to-day activities frequently violate environmental regulations and release excessive amounts of dangerous pollutants into the air.

5. Inefficient Waste Disposal

A lack of garbage disposal frequently leads to water pollution and soil depletion. Extended exposure to polluted air and water causes chronic health problems, making business pollution a critical concern. It degrades the pollution levels in nearby areas, leading in a wide range of biological process disorders.

6. Activity of Resources from Our plants

Industries would like the large quantity of staples required to mould them into a final product. This organisation encourages mineral mining from under the earth's surface. When extracted minerals are disseminated over the world, they may harm the environment. Vessel breaks can result in oil spills, which are hazardous to sea life.

7. Natural resources Use

The material could and should be for industries that want them, including birth control subsurface components. Fracking for oil is one of the most popular types of natural resource-related activity.



2. LITERATURE REVIEW:

India ranks fifth and largest among process adders, indicating that tanning industries are gaining pace as a source of money for emerging countries. Animal skin products have a huge output (144 million tonnes per year) and waste (1.3 million tonnes per year), which need proper waste management. It's simple math to figure out that the animal skin process produces 200 times the amount of garbage as the entire product line. A circular economy is an economic structure designed to reduce waste and resource usage.

In **2021**, **R Dharmaraj, S Gopi Kumar, and P Ebby Darnay** examine the amount of garbage generated and how it is intended to be converted into raw materials for various sectors using various concepts and methods.

Kizinievic and Olga will investigate the feasibility of reusing tannery sludge (TS) in the production of clay bricks in **2020**.

In Bangladesh, tannery waste is used to make bricks in a sustainable manner. (2017), Md.ArifullIslamJuel,AIMizanb, TanvirAhmedc -

In both lab and field circumstances, clay bricks were made with various percentages of sludge (10%, 20%, 30%, and 40% by dry weight), and their usefulness as a building material was assessed strength characteristics, water holding capacity, shrinkage, loss of weight on ignition, and bulk density.

Options for Utilization of Tannery Sludge (2020), - M.Jothilingam, PratheebaPaul, G.Janardhanan

The results of several studies on the qualities of natural clay, ceramic, and cement-based stabilization of tannery sludge have been covered in this review, as well as research gaps.

PAPER TITLE	MAIN SCOP	RESULT
Greening of the industry is a resource- and environment-constrained world -- R Dharmaraj, S Gopi Kumar, P Ebby Darnay	Tannery waste is utilised as an additive and a fabric aggregate alternative.	By presenting long-lasting concrete with the ability to withstand potential, this trial encourages innovation in the construction of creating materials.
Utilization of Tannery Sludge in Building Construction – Mageshkumar, Shoba Ramesh	This study reveals that possible to be the most economical option in the disposal of tannery sludge.	This mixture can be used in filling the area between the footings in the load-bearing structures and the subbase course in road pavements.
Tannery Scrap Waste as a Partial Replacement for Fine Aggregate in Concrete - Dr. M. Vijaya Sekhar Reddy	There is a discount on the building cost and a brand-new concrete replacement material is provided. Tannery waste will be disposed of safely and without causing pollution to the environment.	The maximal compressive strength achieved for seven and 28 days is 29.20 and 43.64 N/mm ² , respectively, when tannery waste is replaced with fine aggregate by 10%.

ENVIRONMENTALLY SOUND DISPOSAL OF TANNERY SLUDGE, Geethakarathi A

The disposal of sludge at various generation stages, such as the beam house (BHS) and after the tertiary treatment process (TS), is investigated in this study.

STUDIES ON A TANNERY'S WASTE MANAGEMENT SYSTEM , - A B M Wahid MuradMd

This study looked into approaches to reduce waste discharge and waste management in a tannery by optimising chemical, water, and energy consumption.

Characterization and Composting of Tannery Sludge, - Mahdi Haroun

The goal of this research is to characterise tannery sludge and see how it might be used as a composting material. The compost had an electrolytic conductivity (EC) of 2.0 mS cm⁻¹, a pH of 6.6, and a C/N ratio of 16. According to the findings, the compost had an electrolytic conductivity (EC) of 2.0 mS cm⁻¹, a pH of 6.6, and a C/N ratio of 16.

Textile and Tannery Sludge Can Be Used in Concrete Fine Aggregates, - M.P.RAJ, Anna University; Dr.N.Vasudevan, Anna university

This study looked at the effects of employing recycling process and industrial effluents sludge as natural sand materials in concrete blocks. In this study, the control concrete blocks are made with ordinary Portland cement (M-53 grade).

EFFECT OF USING TANNERY SLUDGE IN CONCRETE , -SONIA HASSAN

The major goal of this research is to determine whether heavy metals in tannery sludge can be stabilised with concrete and whether sludge-mixed concrete may be used in construction projects.

Sathish Kumar V and Vijay Aravind S (2015), The concrete qualities improved after a partial substitution of tannery waste with fine aggregate were calculated. Replacement concrete is lighter in weight and has a stronger strength than regular

concrete. The original material was substituted in percentages of 0%, 5%, 15%, and 20%, respectively. Compressive strength rises by 24 percent and tensile strength improves by 88 percent when 15 percent of tannery waste is replaced.

Karthikeyan M, Asha B, and Raja Ramachandran P (2014) Conduct study to see if sludge is used as fine particles in M25 concrete is feasible. Concrete examples were cast with varied amounts of sludge (0, 5, 15, and 20% for sand in concretes). This method might be used to dispose of solid waste in a more ecologically responsible manner. During the 7th and 28th day phases, concrete CS was uncovered. According to test results, the ideal proportion of sludge in concrete is 5%.

Vasudevan N and Raj M. P (2016), The effects of replacing sand in concrete with textile and tannery waste were explored. Sludge from textile mills and tanneries, which include certain harmful heavy metals, are among the manufacturing wastes employed in this procedure. An experiment was carried out with M15 grade concrete during the 7th and 28th days. For both tannery and textile sludge replacement, the best results were 15% and 20%, respectively, for textile waste replacement.

3. Materials and Methodology

3.1 Methodology

The following technique was developed and implemented based on the findings of the initial investigation. The methodology flowchart is shown in Figure 1.

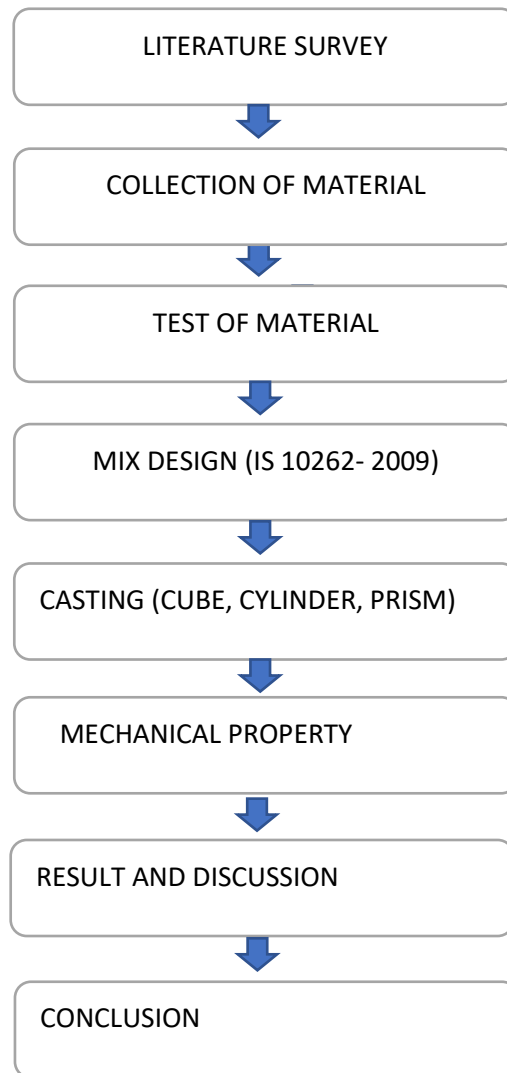


Figure 1. Methodology Flowchart.

3.2 Materials

The study's basic materials were obtained, and the study's basic properties were investigated.

3.3 Cement

OPC 53 grade cement is a high-strength, high-quality cement that is designed to meet current construction requirements. This cement is ideal for producing high-strength, high-performance concrete for applications such as high-rise structures, bridges, flyovers, pre-stressed concrete, below-water concreting, and concrete roads. In the experiments, OPC grade 53 cement was used. Cement characteristics were tested according to IS specifications [10][11][12][13], and the results are as follows:



Table 1. Characteristics of cement

EXPEREMENTAL IN CEMENT	RESULT
Specific Gravity	2.79
consistency	30%

3.4 Fine Aggregate

M sand is a type of man-made sand that is produced in a factory by crushing big hard stones, primarily boulders or granite, into fine particles that are then washed and finely polished. It's mostly employed in the manufacturing of concrete as a substitute for watercourse sand in building applications. For the experimental work, M-sand is employed as an FA in concrete. Fine aggregate qualities were examined according to IS requirements (IS 2386-Part III) (IS 2386-Part I) [16], and the results are as follows.

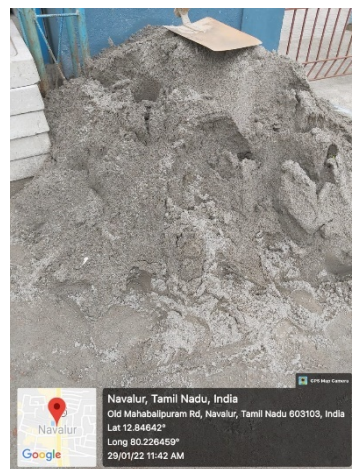


Table 2. Characteristics of Fine Aggregate.

S.NO	TEST	RESULT	PERMISSIBLE LIMIT
1.	Specific gravity	2.62	2.50-3.0
2.	Fineness modulus	2.60	2.0-2.4
3.	Water Absorption	2.12%	3%

3.5 Coarse Aggregate

Coarse aggregate is a type of stone that has been broken down into small pieces and has an irregular shape. Aggregates such as limestone and granite, as well as river aggregate, are utilised in building. Concrete is made up of various ingredients or elements, but one of the most important is coarse aggregates, which are one of the most important portions of concrete and take up a lot of space in the mix. This study used a locally accessible CA with a maximum size of 0mm. The qualities of CA were investigated according to IS specification [14] (IS 2386-Part IV), and the following results were obtained.

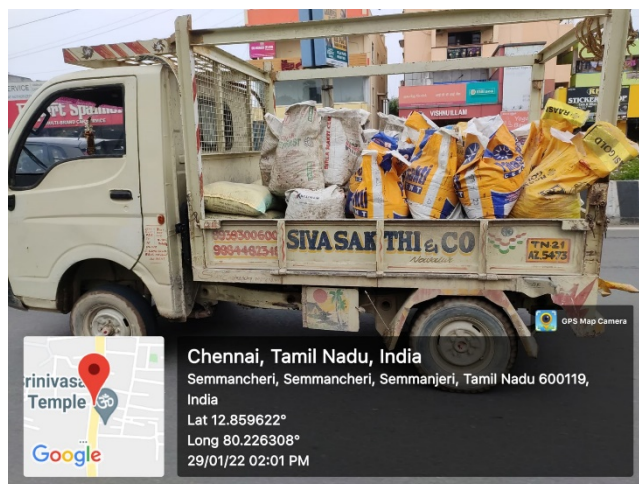


Table 3. Characteristics of Coarse aggregate.

S.NO	TEST	RESULT	PERMISSIBLE LIMIT
1.	Specific gravity	2.56	2.5-3.0
2.	Water Absorption	0.74%	2%
3.	Impact Value	10.87%	45%

3.6 Tannery Sludge

Tannery waste was collected in Pallavaram, Chennai, for this study. Fine aggregate is used to replace tannery sludge. The qualities of tannery sludge, as well as chemical removal or reduction strategies, have been investigated [17][18][19] [20]. The physical and chemical characteristics of sludge, as well as the test results, are listed below.



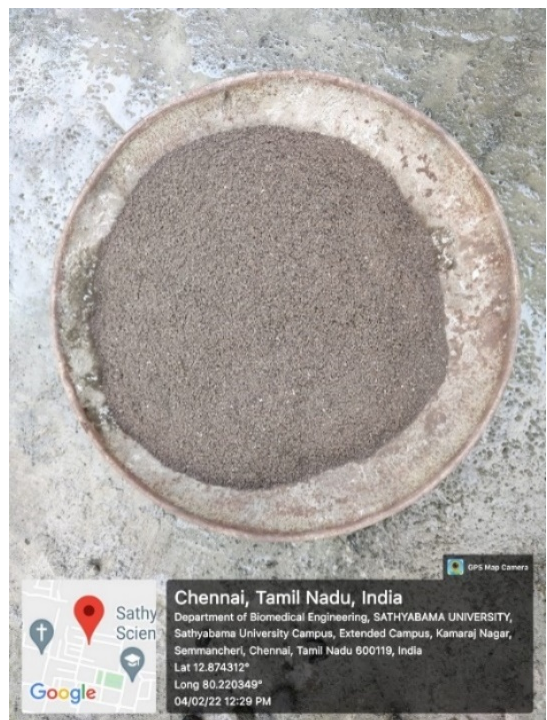


Table 4. Physical characteristics of the sludge.

S.NO	TEST	RESULT
1.	Appearance	Fine
2.	Colour	Grey
3.	Odor	Yes
4.	Fineness Modulus	6.35%
5.	Water Absorption	1.26%
6.	Specific Gravity	1.73

Table 5. Chemical Characteristics of sludge.

S.NO	TEST	RESULT (%)
1.	Silica dioxide	6.1
2.	Aluminum oxide	67.12
3.	Chloride content	1.53
4.	Chromium oxide	0.85
5.	Phosphorous pentoxide	0.06
6.	Sodium oxide	0.17
7.	Calcium oxide	24.52
8.	Potassium oxide	0.07
9.	Ferric oxide	0.48
10.	Volatile organic matter	2

4. Mix Design and Proportion FOR SINGLE MIX:

Cube for compressive test: 6 (2 for 7th-day test, 2 for 14th day, 2 for 28th day)

Cube for acid and alkali test: 2

Total cube to be cast: 8

Cylinder: 2 (28th-day test)

Beam: 2 (28th-day test)

The M25 mix design was adopted and summarized in Table 6 [22] according to IS 10262:2009.

Water Cement ratio: 0.5

Water – 8.93L

Table 6. Mix Ratio and Proportion.

Materials Mix	Cement	Fine Aggregate			Coarse Aggregate
		Tannery waste (%)	Tannery waste	Fine Aggregate	
Nominal mix	17.86kg	0	0kg	33.7kg	55kg
Mix 1	17.86kg	10%	3.37kg	30.33kg	55kg
Mix 2	17.86kg	20%	6.74kg	26.96kg	55kg
Mix 3	17.86kg	30%	10.10kg	23.6kg	55kg
Total	71.5kg		20.21kg	114.6kg	220kg

4.1 Experimental procedure

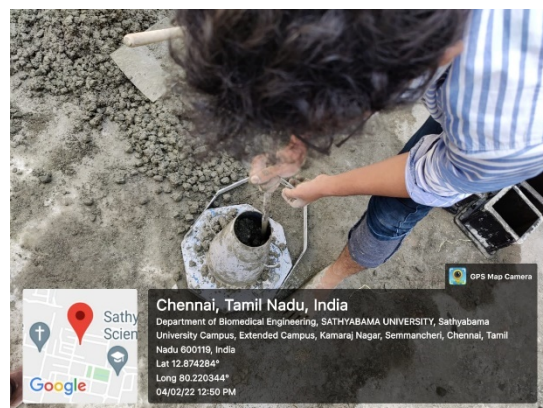
4.1.1 Preparing Mix

Mix design is the process of selecting acceptable concrete materials and establishing their relative proportions with the goal of creating concrete with a minimum strength and durability while being as cost-effective as feasible.



4.1.2 Casting into the Mold

After preparing the mold and the mixture, the mixture is then poured into the mold with respect to the proportion.



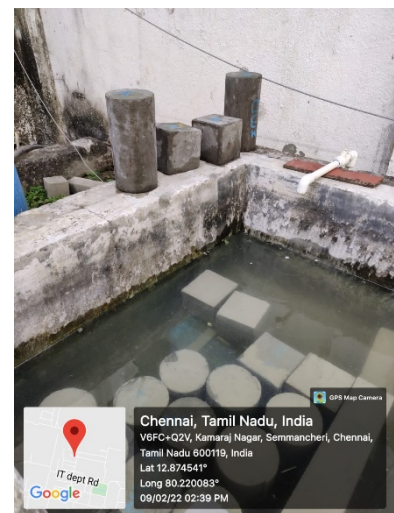
4.1.3 Making of Block

Once Fill the mold completely with the prepared mixture and put aside for 24 hours. It will be stored for natural drying and once the block has been made.



4.1.4 Demolding and Curing

After 24 hours, it must be demolded and placed in a curing tank.



4.1.5 Workability

To test the workability of fresh concrete, a variety of methods can be utilised. The slump cone test is used to determine how consistent concrete is. The workability of concrete was determined to be medium in both slump and compaction factor tests, according to the study as shown in Table 7.



Table 7. Test on Fresh Concrete.

S.N O	MIX	SLUMP	COMPACTION FACTOR	WORKABILITY
1.	Nominal Mix	62	0.92	Medium
2.	Mix one	58	0.90	Medium
3.	Mix two	60	0.91	Medium
4.	Mix three	57	0.89	Medium

5.Results and Discussion

Cube, cylinder, and prism examples were cast to see if tannery waste could be utilized as fine aggregate in concrete. The basic concrete strength test was carried out, and the results were discussed further [23].

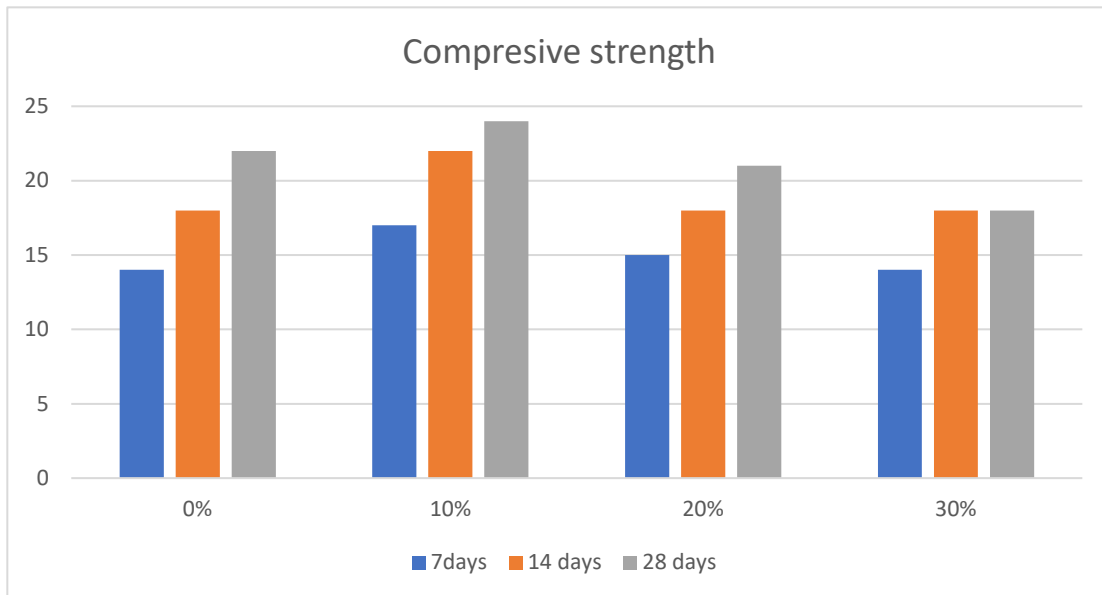
5.1 Compressive Strength Test

Compressive strength is one of the most well-known qualities of concrete, which is used in structural sections to resist compressive stress. A compression strength test was done on casted cube specimens to determine the ability of concrete to withstand crushing force. A test specimen cube of size 150mm*150mm*150mm is cast on the 7th, 14th, and 28th days of cure. When compared to IS456:2000, the compressive strength of casted concrete rises in 10% and decrease in 20 and 30 percentages, as illustrated in Figure 2. The test results vary with different percentages and cure durations when compared to nominal mix concrete.





Figure 2. Compressive strength

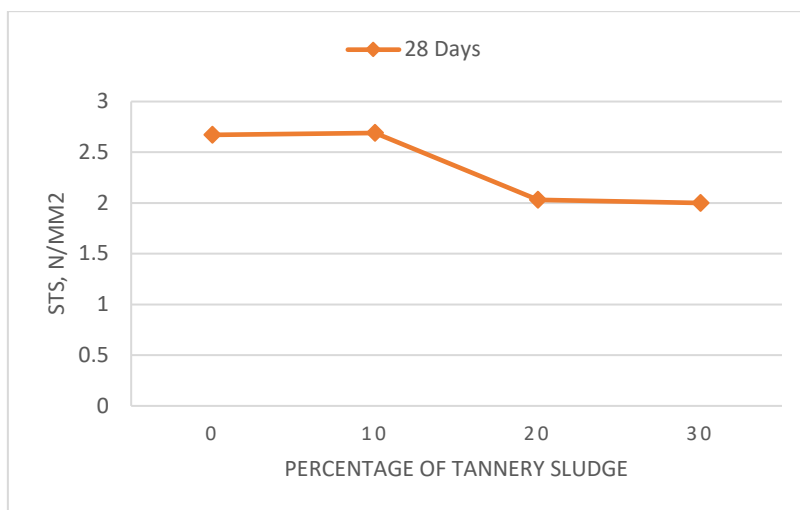


5.2 Split Tensile Strength Test

The split tensile strength of concrete is the most fundamental characteristic for effectively calculating its tensile force. On the 28th day of curing, we tested a specimen cylinder with a diameter of 150mm and a height of 300mm that was cast. The split tensile strength of concrete declines for both 20% and 30% replacement and increases for 10% replacement on the 28th day after curing when compared to nominal concrete as per IS456: 2000 criteria. as illustrated in Figure 3. The test findings differ by a percentage when compared to nominal mix concrete.



Figure 3. Split tensile strength

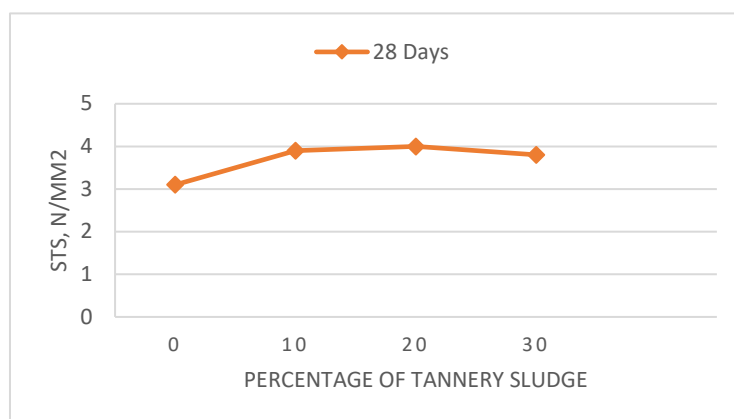


5.3 Flexural Strength Test

Concrete's flexural strength was tested to see how well it could withstand breaking force. The test was performed on a 100mm by 100mm by 500mm specimen prism that had been cast after 28 days of cure. Flexural strength is measured using the three-point loading technique. Figure 4 depicts how concrete flexural strength rises in all percentages as compared to IS 456:2000, as well as when waste is included.



Figure 4. Flexural strength



5.4 Durability of Concrete Test

Concrete's durability refers to its capacity to survive a variety of conditions throughout time. The results of the water absorption, alkali attack, and acid attack tests are presented in Table 8.

Water Absorption test:

The specimen was first weighed before being submerged in water at room temperature for 28 days. The specimen was then taken out of the water and dried for 24 hours at room temperature. We can calculate the consume water absorption % by weighing the dry specimen and noting the weights.



Alkali Attack:

Initially, the weight of the specimen was noted. The alkaline solution is prepared in a container by dissolving 4% of sodium hydroxide in water. The specimen was completely immersed in an alkaline solution and the whole setup was kept at room temperature for 28 days, after which the specimen was removed from the solution and dried at room temperature for 24 hours. The dried specimen was weighed and using these noted weights alkali attack percentage was calculated.



Acid Attack:

Initially, the weight of the specimen was noted. The acid solution was prepared in a container by mixing 5% of concentrated sulphuric acid in water. For 28 days, the test specimen was totally submerged in acid solution and the entire setup was maintained at room temperature. The specimen was then taken from the solution and dried for 24 hours at room temperature. The dried specimen was weighed, and the acid attack % was computed using these weights.



Table 8. The durability of Concrete tests.

S.NO	MIX	WATER ABSORPTION PERCENTAGE	ALKALI ATTACK PERCENTAGE	ACID ATTACK PERCENTAGE
1.	Nominal Mix	1.36	2.48	4.71
2.	Mix one	1.54	2.56	4.66
3.	Mix two	1.68	2.51	4.08
4.	Mix three	1.94	2.53	3.74

6. Conclusion

Experiments were carried out to see what effect Fine aggregate replacement with tannery waste had on the characteristics of concrete. The following are the findings reached as a consequence of the tests:

1. When compared to nominal concrete, the compressive strength of concrete with 10% replacement improves and provides superior results on the 7th, 14th, and 28th days after curing and decrease at both 20% and 30%.
2. The split tensile strength of concrete declines for both 20% and 30% replacement and increases for 10% replacement on the 28th day after curing when compared to nominal concrete.
3. Adaptive When 10% and 20% of the sludge in concrete is replaced, the strength of the concrete rises, but when 30% of the sludge is replaced, the strength of the concrete decreases.
4. Concrete's durability is adequate at all tannery waste replacement percentages.

Based on the foregoing findings, an ideal amount of sludge replacement for M25 concrete is advised at 10%. This study was conducted with standard M25 grade concrete replacement in mind; however, In the future, it may be expanded to incorporate higher-quality concrete and the removal of heavy metals from sludge prior to restoration.

7. Reference

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