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Utilization of Tannery Shredded Waste as Fine Aggregate in Concrete

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***Abstract*— Tannery waste is considered to be one of the major industrial wastes. The present study covers the use of the tannery shredded waste as a partial replacement for fine aggregate and to determine the mechanical properties of the concrete after replacing. Fine aggregate is an integral part in concrete. Due to increase in the construction activities the requirement of fine aggregate is more. In other hand tannery waste is abundant in nature; a proper replacement of tannery waste over the fine aggregate will not only reduce the tannery waste but also reduce demand for fine aggregate. The concrete produced due to this replacement will have reduced weight and also possess higher strength than the conventional concrete.**

Keywords*— Tannery shredded waste; Destructive test; Non Destructive test; Waste disposal and light weight concrete.

I. INTRODUCTION

River sand is considered to be one the unavoidable ingredient in construction. Due to increase in construction activities there is demand for the fine aggregate. The price of the fine aggregate is also increasing day by day. On the other hand tanneries in India are mainly located in Tamil Nadu, West Bengal, Uttar Pradesh and Punjab.

About 900 tanneries are present in Tamil Nadu. It has been found that the amount of tannery waste produced from these industries is about 43 million ton/year and about 30% is from Tamil Nadu. The wastes produced from these industries are difficult in disposal. The disposal of such waste can be done either by incineration or by land filling which leads to air or land pollution respectively. So to avoid pollution and reduce the cost of construction the experiment is carried out and the results are inferred.

The animal skin undergoes many processes to change from its raw nature to leather. The process called as “chrome-tan” is the widely used method to produce the leather. During the end of the formation of leather, the leather is made into approximate size when it is in wetted form. The size is maintained by shredding the materials. The shredded waste which is so obtained is used for the replacement of the fine aggregate. Angeline (2014) studied the strength by the replacement of the tannery sludge waste in the manufacturing of brick and strength parameters are determined.

As tannery wastes have less capacity to absorb water they do not degrade easily when they are disposed by land filling. It is estimated that the tannery waste which are processed takes about 65 years to start degrading and takes about 100 years for complete degradation of one ton of waste. So they cannot be dumped which may even affect the ground water table. When the tannery wastes are subjected to high temperature (incineration) certain gases like SO_x, CO, etc. causes major problems to human beings like carcinogen, irritation to eyes etc. So the process of disposal of such wastes becomes more complicated. With the view of the above criteria it can be concluded to use of tannery waste in construction.

II. MATERIALS AND ITS PROPERTIES

A. *Cement*

The type of cement used in this work is 53 – grade OPC. The specific gravity of the cement is 3.14 and having a fineness modulus of 2% which is less than the maximum value of 7%.

B. *Fine aggregate*

Fine aggregate is river sand and having the specific gravity of 2.63. The density of the fine aggregate is found to be 511.4 kg/m^3. The zone of fine aggregate is determined by sieve analysis. As per Indian standards the zone obtained is Zone – II.

Table 1: *Fineness modulus of fine aggregate*

I.S. Sieve designation	% passing as per IS (zone II)	% of passing (obtained)
10mm	100	100
4.75mm	90 – 100	95.87
2.36mm	75 – 100	88.4
1.18mm	55 – 90	68.6
600 micron	35 – 59	35.8
300 micron	8 – 30	12.6
150 micron	0 – 10	4.0

C. Coarse aggregate

Coarse aggregate having a size of 20mm were used. Its specific gravity and Impact strength is 2.65 and 13.3% which is found to be satisfied as per Indian standards.

D. Tannery shredded waste

The shredded waste of the processed tannery is brought from S.S. Tannery industry, Pallavaram, Chennai. As the tannery is replaced for fine aggregate, the waste that is obtained should be sieved and used for the work.

The tannery waste obtained from the industry is sieved with 2.36mm sieve and the passed materials are taken for the replacement.

Table 2: *Physical properties of F.A. and Tannery waste*

Physical properties	Fine aggregate	Tannery waste
Shape	Irregular	Irregular
Appearance	Brownish yellow	Greenish blue
Water absorption (%)	1.23	0.15 – 0.20
Moisture content (%)	0.5	0.1
Density (kg/m^3)	511.4	240.9
Bulking Point (%)	12	10

Figure 1: Tannery shredded waste

III. MIX PROPORTION

Control mixture for M25 grade concrete was designed as per IS:10262-1982. The concrete mix is prepared with replacement of tannery waste from 0%, 5%, 15% and 20% with fine aggregate by volume. In this work totally five concrete mixes namely CT0, CT5, CT10, CT15 & CT20 were used and cured with normal water for 28 days. For each mix 6 numbers of 150mm x 150mm cubes and 6 numbers of 15mmdia x 300 mm cylinders were casted and tested.

Table 3: *Concrete mix with different proportion.*

Mix	Cement	F.A.	C.A.	Water	Tannery Waste
	(kg/m3)				
CT0	343.0	456.2	946.7	154.4	0
CT5	343.0	433.4	946.7	154.4	22.81
CT10	343.0	410.6	946.7	154.4	45.62
CT15	343.0	387.8	946.7	154.4	68.43
CT20	343.0	365.0	946.7	154.4	91.24

IV. TESTING OF CONCRETE

A. Non – Destructive Test

1) Ultrasonic pulse velocity Test: As per IS – 13311(part 1) the ultrasonic pulse velocity method is done in order to determine the quality of concrete. For a concrete having good quality will have high strength. 28 days Cured Concrete specimens are taken for the test.

Table 4: *Ultra Sonic Pulse Velocity for Cubes.*

Mix	Time (µsec)	Path Length (mm)	Pulse velocity (km/sec)	Concrete quality
CT 0	37.6	150	3.99	Good
CT 5	39.86	150	3.76	Good
CT 10	38.96	150	3.85	Good
CT 15	39.12	150	3.83	Good
CT 20	42.04	150	3.57	Good

2) Rebound Hammer Test: As per ASTM C805 the rebound hammer test is done to determine the Hardness of the concrete. The 28 days old concrete cube specimens are taken and the rebound hammer test is conducted.

Table 5: *Rebound Hammer test for Cubes.*

Mix	Average Rebound Number	Concrete Quality
CT 0	26.3	Good Layer
CT 5	26	Good Layer
CT 10	26.1	Good Layer
CT 15	24.8	Good Layer
CT 20	23.2	Good Layer

3) Density of Concrete: Density of Tannery waste concrete is found to be less than normal concrete. This shows that the addition of tannery waste reduces the weight and results in light weight concrete.

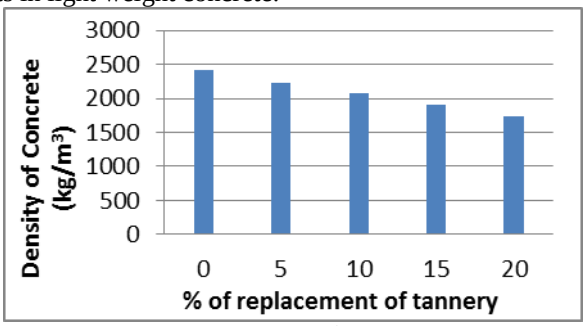

Figure 2: Density of Concrete

B. DESTRUCTIVE TEST

1) Compressive Strength Test: One of the basic parameters for the concrete is compressive strength. It is known that concrete is good in compression and weak in tension. For a good concrete the compressive strength must be relatively higher. The table shows the compressive strength of concrete with various replacement of tannery waste with fine aggregate.

Table 6: *28th day compressive strength of concrete.*

Mix	Average load (kN)	Compressive strength (N/mm^2)	% of increase in strength
CT 0	676.0	30.04	0
CT 5	688.5	30.60	1.85
CT 10	750.47	33.35	11.02
CT 15	840.13	37.33	24.28
CT 20	670.50	29.8	-0.81

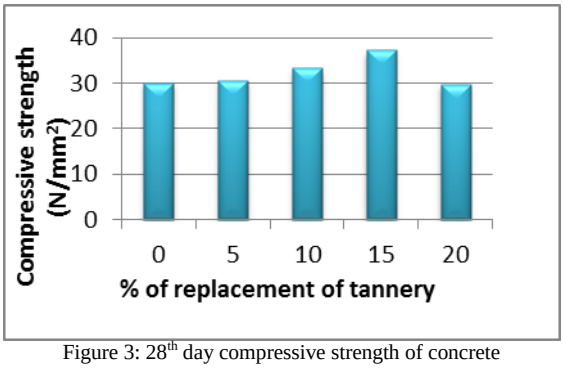

Figure 3: 28th day compressive strength of concrete

2) Split tensile strength of concrete: With increase in the technology in construction field many innovative concrete have been developed such that the concrete having the capacity to with stand more tensile strength than its actual strength. By partial replacement of the tannery waste the tensile nature of the concrete is also studied and the results are inferred. The formula used for the calculation of tensile strength of concrete is given below.

$$\text{Tensile strength} = \frac{2P}{\pi LD}$$

Table 7: *28th day Split tensile strength of concrete.*

Mix	Load (kN)	Tensile strength (N/mm^2)
CT 0	157.7	2.23
CT 5	175.2	2.48
CT 10	226.1	3.20
CT 15	296.7	4.20
CT 20	289.6	4.10

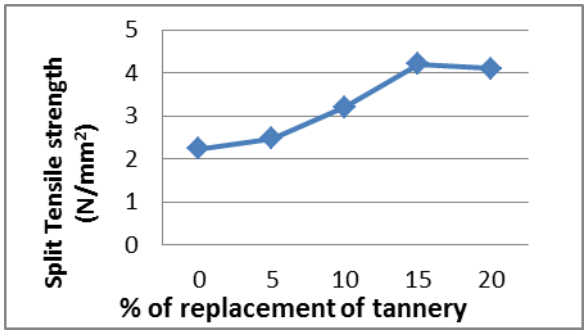

Figure 4: Split tensile strength of concrete

V. RESULTS AND DISCUSSIONS

a) The result obtained from the Non-destructive test shows that the increase in the amount of tannery waste will not affect the quality of the concrete.
b) There is gradual increase in the Mechanical properties of the concrete by increasing the tannery waste up to 15% and on further addition of the tannery waste decreases the strength parameters.
c) Compressive strength of the concrete is increased by 24% of the normal concrete mix for 15% replacement of tannery waste.
d) The tensile property of the concrete is increased by 88% for 15% replacement of the tannery waste when comparing to conventional concrete.
e) Thus, the partial replacement of 15% of tannery waste over fine aggregate will eventually increase the strength of the concrete and found to be optimum replacement.

VI. CONCLUSION

a) Tannery waste can be used effectively in the construction field.
b) The disposal of tannery waste can be done safely without causing any pollution to the environment.
c) There is reduction in the cost of construction and provides a new replacing material for the concrete.
d) Increase in Tannery waste in concrete from 0% to 20% decreases the density of the concrete from 2419kg/m^3 to 1738 kg/m^3
e) Tannery waste concrete can reduce the use of river sand in concrete and results in light weight concrete.

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