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Experimental Study of Latex Modified Concrete with Partial Replacement of Fine Aggregate with Tannery Shredded Waste

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Abstract – *Concrete is a mixture of cement, fine aggregate, coarse aggregate with proper percentage of water. There are different grades of concrete which can be formed by varying the ratio of all the ingredients which are present in concrete. It has been found that river sand is decreasing day by day on a regular basis and there is quite drastic increase in the amount of waste which are coming out from several industries. There is also a type of waste, produced in tannery industries which are responsible for polluting rivers and putting some bad effect on our environment. So, if these wastes can be utilized in concrete by replacing fine aggregate then there could be decrease in the amount of waste and can also decrease the use of river sand which is decreasing from wide use in the construction industries. 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[1]. On the other hand, SBR Latex is a having good cementing properties as it is used for providing better workability and for bonding old concrete with new concrete.*

Key Words: Concrete, Fine Aggregate, Tannery Shredded Waste, Styrene Butadiene Rubber, Compressive Strength, Flexural Strength, Split Tensile Strength.

I. INTRODUCTION

Tannery Shredded Waste are obtained from tannery industries situated mainly in Uttar Pradesh, Tamil Nadu, Punjab, West Bengal and many other states of India. These industries are producing about 49 million ton/year and about 22% are from Uttar Pradesh and that too from the city Kanpur.

SBR Latex is a copolymer made up of Styrene and Butadiene in which styrene is 75% and butadiene is 25%. Latex is used as an additional in the concrete for improving the workability and is used for making new bond between old concrete and new concrete. The effect of latex on concrete with the partial replacement of fine aggregate with tannery shredded waste will increase the workability and decrease the permeability as SBR latex is having good adhesion property which can be used in concrete construction and also quite much helpful in repair works[2].
The research consists of partially replacing fine aggregate from concrete with tannery shredded waste and fixing the percentage of SBR Latex as 10% by the weight of cement. The tannery waste will be varied in different percentage starting from 1% and increasing the percentage till a maximum value of compressive strength, split tensile strength and flexural strength is obtained.

A. Tannery Shredded Waste

Tannery waste was brought from from Park Tanning Industries, 94-A, Wajidpur, Jajmau, Kanpur (U.P.)-208010. 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 2.36 mm sieve and the passed materials are taken for the replacement of fine aggregate.

Figure 1: Tannery Shredded Waste

B. SBR Latex

Latex was in the form of liquid and was of Berger Home Shield Company which is a well-known company used for manufacture of paints. Latex Plus used was made up of polymer of styrene and butadiene mainly used for repair and water proofing works.

Figure 2: SBR Latex Plus

II. MATERIALS AND ITS PROPERTIES

A. Cement

The type of cement used in this work is 43 – grade OPC. The specific gravity of the cement is 3.15 and having normal consistency of 32%. The initial setting time of cement was 40 minutes while the final setting time of cement was 620 minutes. The compressive strength of cement was found to be 43.3 MPa at a testing of 28 days.

B. Fine aggregate

The fine aggregate used was locally available river sand passed through 4.75mm IS sieve and having the specific gravity of 2.62. The Fineness Modulus of fine aggregate was found to be 2.767. The zone of fine aggregate is determined by sieve analysis. As per Indian standards the zone obtained is Zone – II. The silt content was found to be 2.08%.

C. Coarse aggregate

Coarse aggregate having a size of 20mm were used. Its specific gravity and water absorption was found to be 2.637 using perforated basket as per **(IS : 2386 – Part - 3)** and 0.408% respectively. The fineness modulus of coarse aggregate was found to be 6.916.

III. MIX PROPORTION

The design mix of M25 grade concrete used was made using IS-10262:2009 in the Material Testing Laboratory of Integral University, Lucknow and was found to be **1:1.49:2.67** with water cement ratio of 0.45. Once the mix design and all the required tests on ingredients of concrete are done and their suitability is found satisfactory, the task of casting cubes, beams and cylinders was taken up. The available laboratory equipment's were utilized in accomplishing the experimental program. The guidelines in IS-10262:2009 were strictly followed in mixing. Coarse aggregate was washed a day before casting to make it silt free and were laid to dry. On the day of casting, coarse aggregate remained satisfactorily moist so that it does not absorb any further water from the mix i.e. the design of water cement ratio is carefully regulated. The moulds used for cubes, beams and cylinders were of steel having an internal dimension of 150 mm x 150 mm x 150 mm for cube, 100 mm x 100 mm x 500 mm for beam and 150 mm x 300 mm for cylinder. The cement, coarse and fine aggregate were mixed thoroughly with the help of mechanical mixer. Then tannery shredded waste is dispersed to the above mixture while mixer is working. SBR latex is mixed in water and is put into the mixture. For all test specimens, moulds were kept on table vibrator and the concrete was poured into the moulds in three layers by tamping with a tamping rod and the vibration was effected by table vibrator after filling up the moulds. The moulds are kept in vibration for one minute and it was maintained constant for all the specimens. The tannery shredded waste is varied in a fraction of 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7% and SBR latex was kept fixed at 10% by weight of cement. 3 cubes, 3 beams and 3 cylinder specimen are made for each set.

The moulds were removed after 24 hours and the specimens were kept immersed in a clear water tank. After curing the specimens in water for a period of 28 days the specimens were removed out and allowed to dry under shade.

Figure 3: Workability Test using Slump Cone

Table - 1: Concrete Mix with Different Proportion

Mix	Percentage Replacement	Cement	F.A.	C.A.	Water	Tannery Waste
		Kg/m^3				
A0	0%L+0%TSW	425.73	635.71	1137.49	191.58	0
A1	10%L+0%TSW	425.73	635.71	1137.49	191.58	0
A2	10%L+1%TSW	425.73	629.36	1137.49	191.58	6.35
A3	10%L+2%TSW	425.73	623.13	1137.49	191.58	12.58
A4	10%L+3%TSW	425.73	616.64	1137.49	191.58	19.07
A5	10%L+4%TSW	425.73	610.29	1137.49	191.58	25.42
A6	10%L+5%TSW	425.73	603.93	1137.49	191.58	31.78
A7	10%L+6%TSW	425.73	597.57	1137.49	191.58	38.14
A8	10%L+7%TSW	425.73	591.22	1137.49	191.58	44.49

IV. TESTING OF CONCRETE

A. Compressive Strength Test : The most important test which is made on concrete is compressive strength as concrete is strong in compression and weak in tension. So, the concrete is tested in compression testing machine (CTM) at 28 days of curing.

$$\text{Compressive strength} = \frac{\text{Load at failure (N)}}{\text{Surface area of cube (mm2)}}$$

Figure 4: Cube under Compression Testing Machine

Table - 2: 28th Days Compressive Strength of Concrete

Mix	Average Load (KN)	Compressive Strength (N/mm²)	% increase in strength
A0	713.26	31.70	0
A1	731.43	32.50	2.52
A2	743.46	33.04	4.22
A3	795.73	35.36	11.54
A4	815.70	36.25	14.35
A5	834.84	37.10	17.03
A6	904.03	40.17	26.71
A7	838.46	37.26	17.53
A8	816.17	36.27	14.41

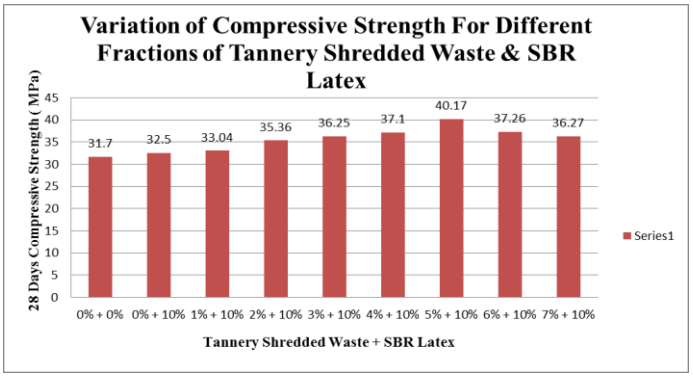

Chart-1: Variation of Compressive Strength at 28 days of Curing

B. Split Tensile Strength Test : The test which is conducted to check the tensile strength of concrete using cylinder of size 150mm x 300mm. Now a days, construction activities is increasing and the use of tensile strength is becoming an important test these days.

$$\text{Split tensile strength} = \frac{2 \text{ X Load at failure (N)}}{\pi \text{ X L X D (mm2)}}$$

Figure 5: Cylinder under Compression Testing Machine

Table - 3: 28th Days Split Tensile Strength of Concrete

Mix	Average Load (KN)	Split Tensile Strength (N/mm²)
A0	218.63	3.09
A1	233.56	3.30
A2	250.15	3.53
A3	269.83	3.81
A4	276.36	3.90
A5	283.35	4.00
A6	288.63	4.08
A7	278.36	3.93
A8	263.97	3.73

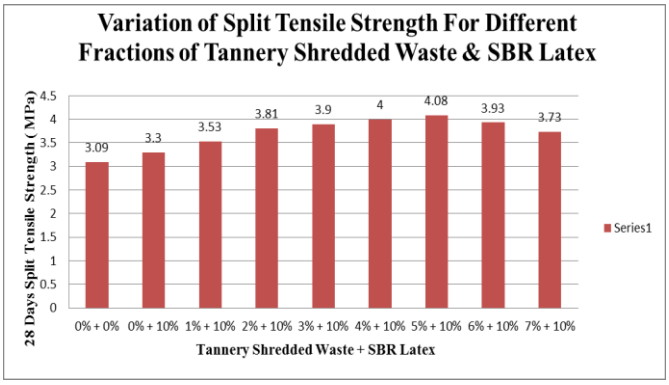

Chart-2: Variation of Split Tensile Strength at 28 days of Curing

C. ***Flexural Strength Test :*** The test which is conducted by flexural testing machine by four point loading using a beam of size 100mm x 100mm x 500mm. This is a simple case of pure bending as there is no shear force present in it.

$$\text{Flexural strength} = \frac{Load\ at\ failure\ X\ L\ X\ 1000(N)}{B\ X\ D\text{^}2\ (mm2)}$$

Figure 6: Cylinder under Flexural Testing Machine

Table - 4: 28th Days Flexural Strength of Concrete

Mix	Average Load (KN)	Flexural Strength (N/mm^2)
A0	9.17	4.58
A1	9.73	4.86
A2	10.03	5.01
A3	10.42	5.21
A4	10.52	5.26
A5	10.96	5.48
A6	11.13	5.56
A7	10.92	5.46
A8	10.40	5.20

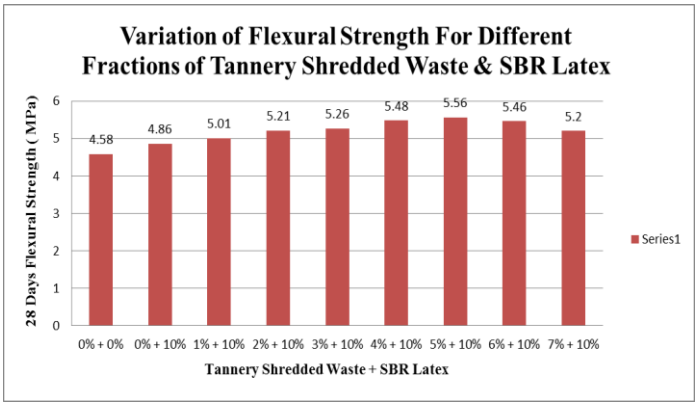

Chart-3: Variation of Flexural Strength at 28 days of Curing

V. CONCLUSIONS

Based on these results and observations made in this experimental research study, the following conclusions are drawn:-

1. It has been found that compressive, split tensile and flexural strength have their maximum values for 5% tannery shredded waste with 10% SBR Latex fixed by weight of cement. The compressive strength is increased by 26.71%, split tensile strength by 32.03% and flexural strength by 21.39% when compared to their nominal strength. For any further increase in tannery shredded waste content, the values of strengths decrease gradually.
2. When 10% SBR latex is added in concrete without any replacement, there is also increase in workability and strength of concrete. The compressive strength is increased by 2.52%, split tensile strength by 6.79% and flexural strength by 6.11% when compared to their nominal strength.
3. There is increase in ductility of concrete as we all know that concrete has brittle failure so it is good to have ductility in concrete.
4. By the addition of SBR latex, there is an increase in the workability of concrete as the polymer content is increased.
5. The addition of tannery shredded waste plays an important role for arresting, delaying and propagation of cracks.

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BIOGRAPHIES

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