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Strength analysis of styrene-butadiene latex modified cement concrete

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ABSTRACT

Polymer Modified Concrete (P.M.C.) has been discovered to be more potent than conventional cement because of its excellent strength and raised perseverance, so to enhance the performance, certain polymers are blended in with concrete. The impact of Styrene Butadiene Rubber (S.B.R.) over the compressive strengths, tensile strengths and carbonation of cement has been examined in this investigation, and the ideal polymer content for concrete has additionally been resolved. This examination was attempted to decide the impacts of polymer expansion on compressive and tensile strengths utilizing concrete at nearby ambient temperature with a consistent water-cement proportion blend design. The mixes were prepared with a 0 %, 5 %, 10 %, 15 % and 20 % cement-latex ratio of Styrene-Butadiene Rubber. The fresh concrete slump test was performed while the compressive and tensile strengths were analyzed at various ages. S.B.R. latex has been appeared to have an unfavourable effect at an early age, even though applying S.B.R. latex to concrete at 28 days brings about improved compressive and tensile strength. However, the dosage of S.B.R. latex for mixtures rich in cement needs to be optimized in order to preserve the desired concrete workability.

Keywords: *S.B.R., Compressive Strength, Carbonation, Tensile Strength, Slump*

1. INTRODUCTION

Due to the ease of availability of materials and economy, concrete is mostly used as a construction material globally. In order to improve the resilience of concrete buildings, the internal core of the concrete must be reinforced. Polymer concrete has high tensile strength, excellent ductility, and high impact resistance capacity due to the creation of a 3-dimensional network in the hardened cement-matrices. Over the past two decades, several experiments have been undertaken to use different polymers appropriate for mixing into fresh concrete materials. Concrete was commonly used in the past to strengthen mechanical properties, including styrene-butadiene rubber latex.

Latex is a polymer solution produced by polymerization of monomer emulsion and composed of 50 % solids by weight. The best examples of polymers commonly adopted as latex includes styrene-butadiene, acrylic, polyvinyl acetate and natural rubber. Study on the impact on lightweight concrete of polymeric materials found that the flexural and tensile strengths could be increased by applying S.B.R. to concrete. [10]. Ukrainczyk and Rogina recommended that the ideal proportion of latex should be considered to increase the strength of the modified S.B.R. concrete [7]. Generally, latex-modified concrete was better performed than standard concrete against chloride and sulphate attack [9]. Barluengaa et al. found that in PMC, the compressive strength reduced while the water/cement ratio was constant [6]. During the analysis of the strength of the Polymer Concrete, the compressive strength enhanced while the tensile strength was comparatively stable, by increasing the quantity of epoxy-resin [8]. In the field of civil engineering, cement replacement as a binder is used to strengthen concrete tensile, bending, and compressive capabilities. S.B.R. is a white, dense liquid in appearance with 52.7 % water content, and it has strong viscosity [3,4].

In this current paper, the impact of incorporating locally accessible S.B.R. latex over the compressive and tensile strength of standard grade concrete mix has been examined. In the presence of S.B.R. latex, compressive and tensile strengths development of the concrete was studied at 7 days, 14 days, 28 days and is compared with the standard concrete mix.

2. MATERIALS USED

The concrete utilized was OPC Grade 43 manufactured by ACC Limited, which conforms to IS 8112:2013. The concrete is in a dry fine structure with great compound creations and actual qualities. Locally accessible waterway sand and squashed stones were utilized as fine aggregate and coarse aggregate. The property of the aggregate used is stated in Table-1. Locally accessible S.B.R. latex was examined in this investigation, and the arrangement of the S.B.R. Latex utilized as the polymer is stated in Table-2.

Table 1: Properties of aggregate and cement

Property	Fine Aggregate	Coarse Aggregate

Specific Gravity	2.60	2.70
Water Absorption	1.50	0.50
Specific Gravity of Cement	3.15	

Table 2: Properties of Polymer Latex used

Properties	Specifications
Form	White Liquid
Density	1Kg/L at 25^0 C

3. METHODOLOGY

In the current findings, tensile strength, compressive strength, and carbonation tests are performed. For the assessment of compressive strength and tensile strength, the experimental design and evaluation protocol shall be in compliance with IS 456:2000 and IS 516:1959 clause 5.1 to 5.6.

- Compressive Strength Test: Cube blocks of dimensions 15cm x 15cm are evaluated under a universal testing machine. These cubes were cured for 7 days, 14 days, and 28 days to obtain the strength values.
- Split Tensile Test: The split tensile test is performed on a cylindrical sample with a diameter and a height of 15 cm and 30 cm, respectively. The indirect strength of the modified concrete mix can be achieved easily by bringing a cylinder under the ends of the universal testing unit's base plate.

4. RESULT AND DISCUSSION

4.1 Workability Test

Workability of modified concrete is performed through a slump cone to get its qualitative measurement as is shown in Table -3.

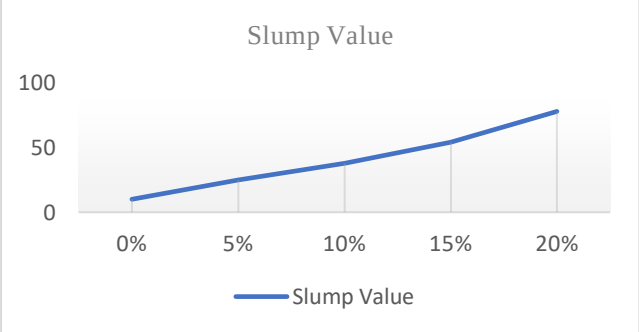

Fig. 1: Slump Value Comparison

Table 3: Slump Test for workability

S no.	Sample Name	Slump Value (mm)
1	L0	10
2	L5	25
3	L10	38
4	L15	54
5	L20	78

4.2 Compressive Strength Test

Compression strength is usually used in concrete grade specification, monitoring and measurement. The compression strength decides the overall image of concrete efficiency. The compressive strength relies on a variety of factors, such as the ratio of water-cement, methods of curing, rate of hydration, loading rate. The strength values that were obtained at 7 days, 14 days, 28 days of curing for S.B.R. adjusted concrete samples are tabulated in Table-4. For S.B.R. adjusted concrete samples, the graph displaying the compressive strength is shown in Figure-1.

Table 4: Compressive Strength Results

S no.	Cube Sample Name	SBR Latex (%)	Average Strength		
			7 Days	14 Days	28 Days
1	L0	0	17	22	25
2	L5	5	15.15	19.62	29.77
3	L10	10	15.23	20.13	33
4	L15	15	14.36	17.44	30.66
5	L20	20	13.59	16.62	28.56

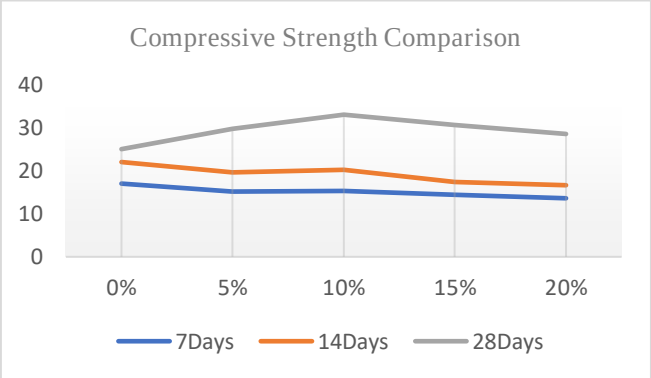

Fig. 2: Compressive Strength Comparison

4.2 Split Tensile Test

The tensile strength of Concrete is responsible for the behavior of cracking, influencing some other properties, such as rigidity, resilience, damping effects and toughness of concrete. Indirect tensile tests like split tensile tests are performed to determine the tensile strength [1]. Table-5 presents the tensile strength values that were obtained for S.B.R.-latex modified concrete specimens at 28 days of curing. The graphs demonstrating the split tensile strength comparison are displayed in Figure-3.

Table 5: Split Tensile Strength Results

S no.	Cylinders sample name	SBR Latex (%)	28 Days Strength (N/mm^2)
1	C0	0	2.56
2	C5	5	3.07
3	C10	10	3.30
4	C15	15	3.06
5	C20	20	2.85

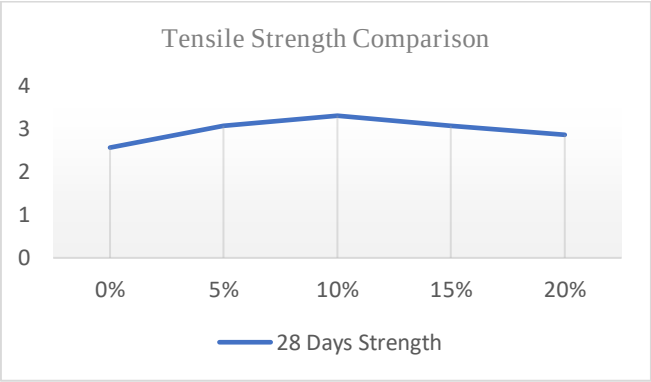

Fig. 3: Split Tensile Strength Comparison

5. CONCLUSION

In light of the outcomes and perceptions made in this test study, the accompanying ends are drawn:

1. Out of five dosage levels of S.B.R. Latex polymer, namely 0%, 5%, 10%, 15%, and 20%, the optimum dosage is found to be 10% for peak values of compressive and tensile strengths. At 28days, compressive strength was increased by 32% (33MPa), and 28days tensile strength was increased by 28.90% (3.30MPa).
2. In the case of polymer modified concrete, it is observed that the compressive strength decreases with the introduction of S.B.R. latex at an initial stage.
3. The workability of modified concrete is increasing with the introduction of S.B.R. latex as the polymer proportion increases.
4. Because of the enhancements in compressive and tensile strengths by mixing S.B.R. latex, the demand for concrete should be comparatively lower than the normal mix under the same conditions. Therefore, S.B.R. latex blend concrete building will be economical than standard concrete.

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