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SBR-LATEX MODIFIED CONCRETE: A NEW AVENUE FOR CONCRETE MATERIALS, A REVIEW

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Abstract — Use of polymer modified concrete as a construction material for structural applications in recent years is becoming gradually popular. Among the Polymers, Styrene-Butadiene Rubber (SBR)-latex modified concrete has proven strength and healthiness properties. From various Literature survey, we came to know that Styrene contributes rigidity and chemical resistance to the polymer, while butadiene contributes flexibility and elasticity. The random copolymerization of these two monomers in SBR results in a polymer with a wide range of properties, including good abrasion resistance, low-temperature flexibility, and high tensile strength. In different ratio of Styrene-Butadiene Rubber (SBR) latex-cement shows that compressive strength and flexural strength were determined at different ages. It has been observed that SBR latex has negative effect at early age while at 28 days, the addition of SBR latex in concrete results in enhancement of compressive strength as well as Flexural Strength. It can be used as an additive in concrete repair mortars, helping to improve the bond between existing concrete surfaces and the repair material, and reducing the risk of cracks forming in the repaired area, increases compressive and Flexural Strength compared with samples having old and new concrete without bonding layer.

Keywords — Styrene-Butadiene Rubber (SBR)-latex, Compressive strength, Flexural strength, Concrete

1. INTRODUCTION

Concrete is a composite material composed of cement, water, and aggregates (such as sand, gravel, or crushed stone). Cement is a binding agent that reacts with water to harden and bind the other components together, Concrete is one of the most widely used construction materials in the world due to its strength and versatility.

When SBR is added to concrete, it acts as a polymer modifier, improving the properties of concrete by increasing durability, flexibility, and adhesive strength. SBR can improve the durability of concrete by reducing the permeability of water. This makes it useful in the construction of structures that are exposed to harsh environmental conditions, such as

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bridges, parking lots, and industrial floors. [1, 2] SBR can also improve the flexibility and adhesive strength of concrete, making it useful in the repair of cracks and joints. SBR latex also fills in the gaps between the cement particles of the concrete, reducing the porosity and increasing the density of the concrete matrix. This leads to improved mechanical properties, such as higher compressive strength, tensile strength, and flexural strength. Overall, the addition of SBR to concrete can result in a more durable and long-lasting material with improved performance characteristics, making it a popular choice in a variety of construction applications. [3, 4].

2.HOW SBR IS FORMED

SBR (Styrene Butadiene Rubber) is a synthetic rubber that is formed through a process called emulsion polymerization. In this process, butadiene (CH=CH-CH=CH) and styrene (CH =CH-Ph) monomers are mixed together with water and a soap-like surfactant in a reactor vessel (**Figure 1**). The reactor is then heated and mixed to initiate the polymerization reaction. The butadiene and styrene monomers react with one another to form a long chain random copolymer, with the surfactant molecules forming a protective layer around the newly formed polymer particles to prevent them from coagulating. This reaction is exothermic, meaning it releases heat, so the reactor is typically cooled to maintain the desired reaction temperature. The resulting SBR latex is then stabilized with additional surfactant and other additives to improve its stability and processability. The properties of SBR can be tailored by varying the ratio of butadiene to styrene. This allows the production of SBR rubber with a wide range of properties, such as high abrasion resistance, oil resistance, and improved low-temperature flexibility [5, 6].

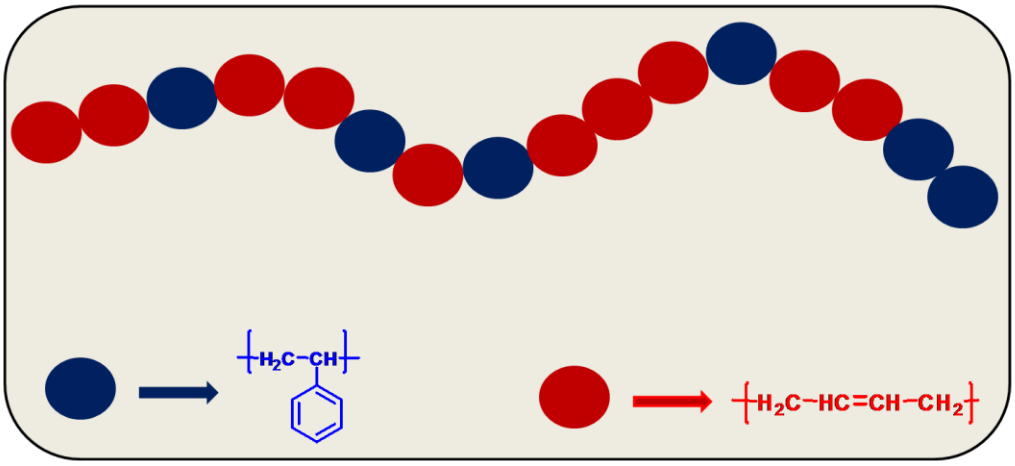

Figure 1: Cartoon representation of styrene-butadiene rubber (SBR)-latex random-copolymer

3. MICROSTRUCTURE OF THE SBR POLYMER

SBR (Styrene Butadiene Rubber) can form a bond with concrete and increase its strength through a process called polymer-cement composites. When SBR is added to concrete mixture, it coats the surfaces of the aggregates and reacts with the cement hydrates, forming strong chemical bonds. The polymer-cement composites formed by SBR and cement hydrates improve the overall physical properties of the concrete, such as its strength, toughness, and durability. The SBR polymer can fill in the gaps between the cement particles in the concrete mixture, which can reduce the porosity and permeability of the hardened concrete. This makes the concrete more resistant to water penetration, freeze-thaw cycles, and chemical attacks. In addition to forming chemical bonds with the cement hydrates, the SBR polymer can also form physical interlocks with the concrete, which improves the adhesion between the concrete matrix and the aggregates. This can help to prevent the aggregates from pulling out of the concrete, which can improve the overall strength and durability of the concrete. Therefore, the addition of SBR to concrete can improve its mechanical properties, making it stronger, more durable, and more resistant to the effects of weathering and aging. (**Figure 2**). [7, 8]

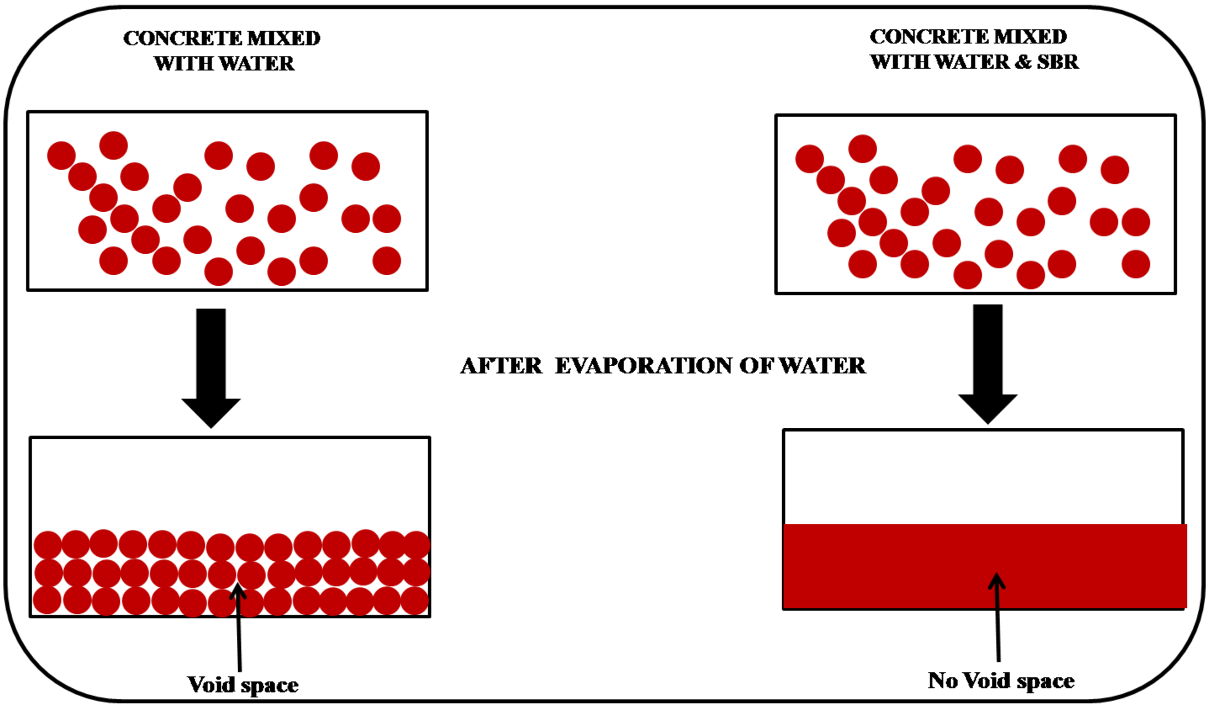

Figure 2: Most probable mechanism of SBR with concrete.

4. EFFECT OF SBR ON CONVENTIONAL CONCRETE

The addition of SBR (Styrene Butadiene Rubber) to conventional concrete can improve its mechanical properties and durability, making it a popular choice for many construction applications. Compared to other polymers, SBR has several advantages due to its unique chemistry and physical properties. One advantage of SBR over other polymers is its ability to form strong chemical bonds with the cement hydrates in the concrete matrix. This leads to improved adhesion and interfacial bonding between the polymer and the concrete, resulting in a more robust and durable material. Another advantage of SBR is its excellent water resistance and low-temperature flexibility, which make it ideal for use in harsh environments, such as marine structures, dams, and underground tunnels. SBR can also improve the freeze-thaw resistance of concrete by reducing the ingress of water and other harmful substances, such as chloride ions [9, 10]. Compared to other polymers, such as acrylics or polyurethanes, SBR is more cost-effective and easier to produce, making it a more affordable choice for many construction applications. SBR can also be easily incorporated into the concrete mix, without the need for special equipment or complex application procedures. Overall, the addition of SBR to conventional concrete can provide several benefits over other polymers, including improved mechanical properties, durability, and water resistance, at a lower cost and with simpler application procedures. However, the choice of polymer for specific applications will depend on the desired properties and requirements of the project **(Figure 3)** [11, 12].

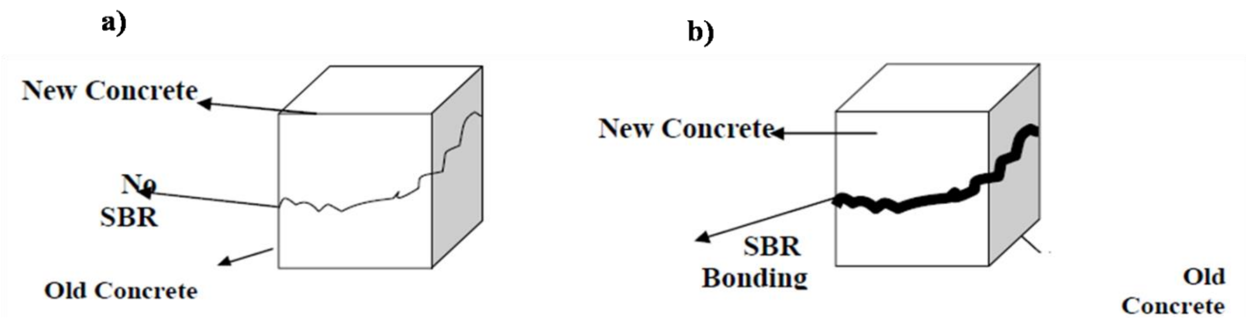

Figure 3: samples with and without SBR as a bonding mortar layer.

5. DIFFERENT EXPERIMENTAL RESULTS OF SBR MODIFIED CONCRETE

It is generally observed that in compressive strength affects unfavourably in different dosages of SBR 10%, 25%, and 35% added to cement mortar. **Figure 4** clearly showed that with increasing of SBR dosage in increasing days (7, 28, 60 days), there was a reduction in compressive strength. The most probable reason behind it, partially increasing the total liquid content (water + SBR) to cement ratio.

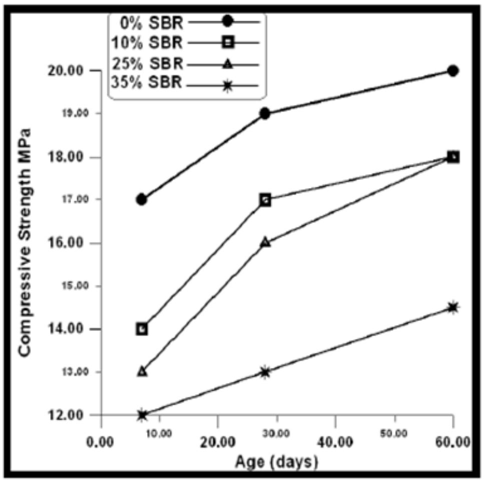

Figure 4: Development of compressive strength with age for different dosages of SBR in cement mortar

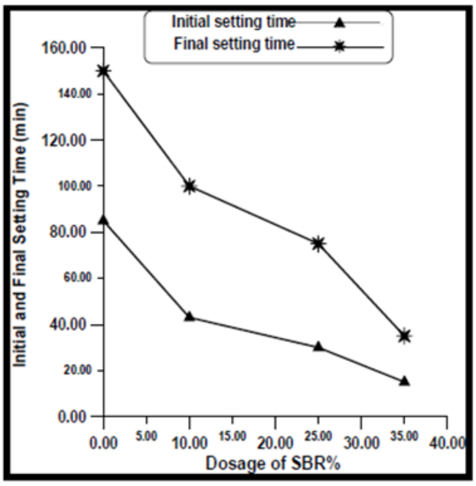

Figure 5: Decreasing of initial and final setting time with dosage of SBR in of cement mortar

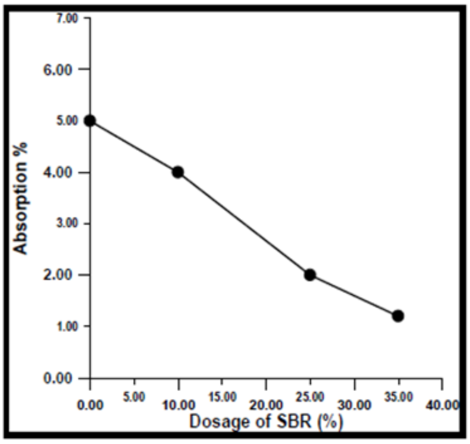

Figure 6: Effect of SBR on absorption of concrete samples

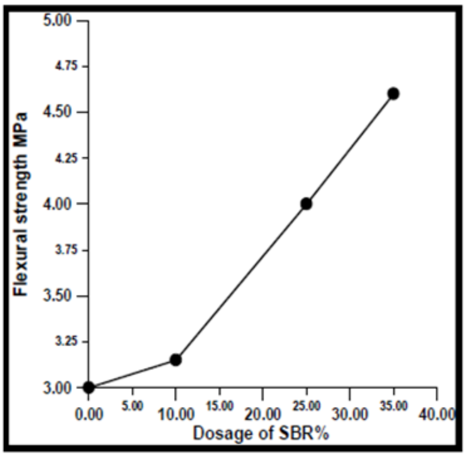

Figure 7: Development of flexural strength with dosage of SBR in concrete samples

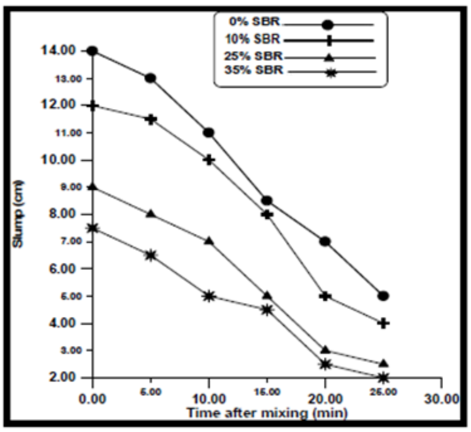

Figure 8: Slump loss with time for with concrete samples

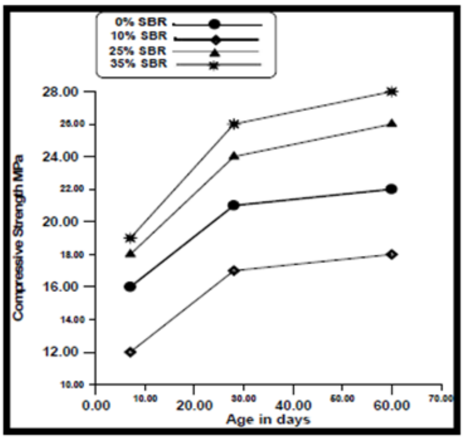

Figure 9: Development of compressive strength with age for defferent dosages of SBR for concrete samples

Figure 5 clarified that with increasing the dosage of SBR there is a reduction in initial and final setting time. It gives us useful information about the setting time with increasing dosage of SBR.
Figure 6 elucidated that with increasing the dosage of SBR there is a high reduction in percentage absorption. **Figure 7** clearly explained that with increasing the dosage of SBR there is a development of flexural strength of SBR-concrete composite. By **Figure 8** we came to know that with increasing the dosage of SBR there is a decreasing in slump values. It gives us the solid idea about the negative effect to workability of the concrete.
In **Figure 9** the results showed that with the dosage of SBR (25 %, 35%) atages of (7, 28, 60) days, compressive strength of SBR-concrete composite gradually increases. But the concrete mix with a dosage of (10 %) SBR by volume of water shows a decreasing in compressive strength. Low concentration of SBR may be the reason of this fact.
From **Figures 10** and **11** it was clearly found that the is a increasing flexural and compressive strength as compared with samples of old and new concrete without bond layer to old and new concrete with bond layer when SBR used as a bonding mortar layer with ratio of 1: 1: 3 SBR, water , OPC cement.

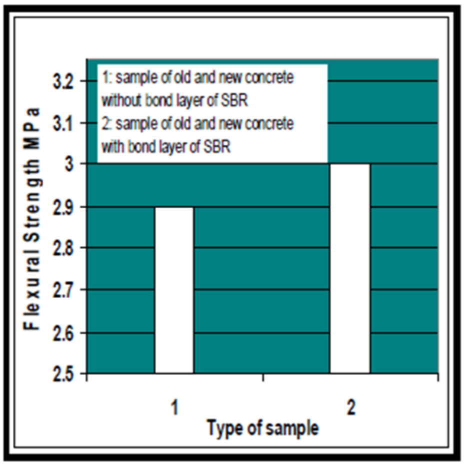

Figure 10: Development of flexural strength for concrete samples with and without bond layer of SBR

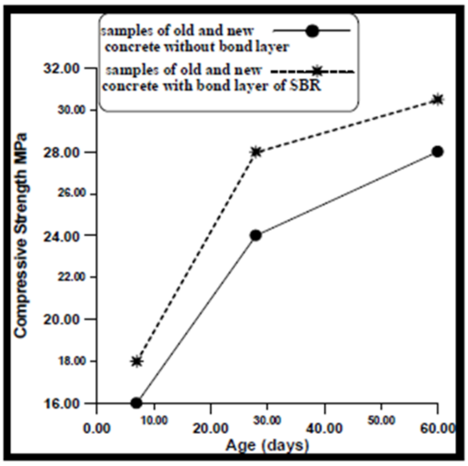

Figure 11: Development in compressive strength with age for concrete samples with and without bond layer of SBR

6. CONCLUSION

In conclusion, SBR latex modified concrete is a great choice as it is known for its excellent strength, durability, and resistance to water and other environmental factors. This type of composite material is often used in the construction of bridges, tunnels, and other structures that require strong and long-lasting materials. The addition of SBR latex to the concrete mix improves the bond strength between the concrete and reinforcing steel, which helps to prevent cracking and other damage. Therefore, The synergic action of polymers and cement mortars, concrete suggest great enhancement for ample series of novel applications increasing tensile strength, less-water curing, resistance to cracking, has confirmed that SBR latex as best modifiers for the composites.

References

1]. Soni1, E. K.; Joshi Y.P. Int. *Journal of Engineering Research and Applications*, 4, **2014**, 838-844.

[2]. Ohama Y., *Concrete Admixtures Handbook (Properties, Science and Technology),* Noyes publication, Park ridge, New Jersey,U.S.A.,**1924**. 3.

[3]. Fowler, D. W. , *Polymers in concrete Handbook of structural concrete,* Mc- Graw-Hill publication, New York,**1983**.

[4]. Radhakrishnan, R. Syam Prakash,V., and Thampan, C. K. P. V. *International Journal of Advancements in Research & Technology*, 1, **2012**, 1-5.

[5]. Darwin, D. et al. Causes Evaluation And Repair Cracks In Concrete Structures, *American Concrete Journal*, 9, **1984**, 224.

[6]. *Encyclopædia Britannica Inc*., **2016**.

[7]. kordan, J. B. Polymer Modified Concrete-Review, *Journal of materials in civil engineering,* 9, **1997**, 85-92.

[8]. Shivani R. B. and Yuvraj M. G., *International Journal of Research in Engineering and Technology*, **2015**, 845-848.

[9]. Hirde, S. K. Dudhal, O. S. *International Journal of Engineering Research* 5, **2016**, 766-769

[10]. Mahdi S. E., Abeer M., Nada F. H., *Kufa journal of engineering*, 4, **2012**, 81-95.

[11]. Hirde S.K., Dudhal O. S., *International Journal of Engineering Research*, 5, **2016**, 766-769.

[12].]. Kim, K. K. Yeon, j. Lee, H. J. Yeon, K. S. *Polymers* 11, **2019**, 1321.

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