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# Effect of Styrene Butadiene Rubber Latex Polymer on the Compressive and Tensile Strength of Concrete Containing one or two Admixtures.

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Abstract- *This paper reports on the beneficial use of Styrene Butadiene Rubber Latex (SBR Latex) polymer in concrete containing one or more admixtures namely fly ash and silica fume. Overall 180 specimens were tested for 7 days and 28 days Compressive and Split Tensile Strength tests. Mix proportioning was done for M-30 concrete in accordance with IS 10262: 2009. Silica Fume and Fly Ash were used as admixtures.*

*Optimum dosage of SBR latex polymer was found to be 2% for all the combinations of Silica fume and Fly ash. Binary blend concrete having 10% silica fume showed peak value of Compressive strength and Tensile strength in which 28 days cured Compressive Strength was 22% more than that of control mix and 28 days Tensile strength was 26% more than that of Control mix.*

*Key Words:SBR Latex, Ternary blend concrete, Polymer modification, Compressive strength, Tensile strength, Super Plasticizer.*

## 1. INTRODUCTION

Use of admixtures in concrete to improve its properties has become very common practice in the construction industry. But using two admixtures thereby making it ternary blend concrete is also catching up. The basic idea of using the admixtures is to overcome the disadvantage of one admixture by using one more admixture. Use of silica fume in fly ash concrete improves the strength gain in 7 days cured concrete.
Use of polymer such as SBR Latex along with two admixtures has not been tried extensively.
Lot of work is carried out in the polymer altered cement concrete, Polymer cement concrete and polymer-impregnated cement concrete. Because of its high performance, the same is utilized as prevalent development materials compared to conventional concrete. Polymer concrete is environment friendly and it leads to the saving of natural resources, and increases the life span of the infrastructure.
Incorporating the liquid polymer or polymer powder into the fresh concrete paste makes polymer altered concrete. Polymer altered concrete is an often utilized modern technique to improve the mechanical properties of the normal concrete like tensile strength, compression strength and impact strength, corrosion resistance and it gives low adhesion of fresh concrete as compared to general concrete.

## 2. EXPERIMENTAL WORK

After carrying out mix proportioning to produce M-30 concrete, proportion of various ingredients of concrete was finalized, mix not containing admixtures and polymer was designated as control mix.
15 different mix proportions were prepared by varying the relative percentage of silica fume and fly ash. Percentage variation of SBR latex polymer was 0%, 2% and 4%.
After 7 days curing and 28 days curing tests were conducted to evaluate compressive strength and tensile strengths. Universal Testing Machine of capacity 2000kN was used.

### 2.1 Mix Design

The mix design is prepared to obtain the M-30 Grade concrete is in accordance with IS: 10262-2009.

#### 2.1.1 Mix Proportion for trails

From the mix design calculations, obtained mix proportion is 1: 1.8: 3.15. The following quantities of materials are obtained from the mix design.

Table- 1: Quantities of materials as per mix design in accordance with IS: 10262-2009

| Sl. No | Materials | Specific Gravity | Quantity (Kg/m3) |
|---|---|---|---|
| 1 | Cement | 3.15 | 284.90 |
| 2 | Sand | 2.70 | 731.85 |
| 3 | Aggregate | 2.90 | 1282.51 |
| 4 | Fly ash | 2.60 | 148.00 |
| 5 | Silica fume | 2.25 | 101.75 |
| 6 | Water | 1.00 | 20.35 |

 

| | | | |
|---|---|---|---|
| 7 | Super Plasticizer | 1.15 | 6.10 |

Table- 2:Mix Proportions:

| Mix ID | Proportions/ Ingredients | | | |
|---|---|---|---|---|
| | Cement (%) | Fly Ash (%) | Silica Fume (%) | Polymer (%) |
| MX-01 | 100 | 0 | 0 | 0 |
| MX-02 | 100 | 0 | 0 | 2 |
| MX-03 | 100 | 0 | 0 | 4 |
| MX-04 | 70 | 30 | 0 | 0 |
| MX-05 | 70 | 30 | 0 | 2 |
| MX-06 | 70 | 30 | 0 | 4 |
| MX-07 | 90 | 0 | 10 | 0 |
| MX-08 | 90 | 0 | 10 | 2 |
| MX-09 | 90 | 0 | 10 | 4 |
| MX-10 | 70 | 20 | 10 | 0 |
| MX-11 | 70 | 20 | 10 | 2 |
| MX-12 | 70 | 20 | 10 | 4 |
| MX-13 | 70 | 25 | 5 | 0 |
| MX-14 | 70 | 25 | 5 | 2 |
| MX-15 | 70 | 25 | 5 | 4 |

### 2.1.2 Workability

The workability is found by using Slump cone. The vertical distance by which the concrete of the mould subsides is record as the slump value of the mix in mm.
Slump test was conducted on all mixes having water cement ratio 0.40 and the desired slump of 40mm to 70mm was obtained using 1.5 to 1.75% of super plasticizer.

### 2.2 Casting and Testing of Specimens

This experimental work is made to investigate the properties of the polymer modified concrete. In this experimental work the SBR Latex polymer is used in a varying percentage of 0%, 2% and 4%.
The two more supplementary materials silica fume and fly ash are used in this work to investigate the mechanical properties of the mixed concrete. The individual effect of fly ash is checked by replacing cement with fly ash by 30%, and the individual effect of silica fume checked by replacing cement with silica fume by 10%.
The concrete mix is designed to obtain M-30 grade and the effect of both Silica fume and fly ash along with polymer is determined in this study. The compression and split tensile strength tests were conducted.
For compression strength test the specimens of standard size 150mmX150mmX150mm are casted and are cured for 7 Days and 28 Days. And for determining the Split Tensile test, the Cylinders of size 150mmΦ X 300mm height are casted and are also cured for 7 and 28 Days in a curing tank at an temperature of about 27±2°C.
After curing for 7 days and 28 days specimens are removed from curing tank and are dried in room temperature and are weighed before testing and then are tested to find the Compressive strength and Split Tensile strength. The readings are recorded in a systematic manner.
In this work for all the mix proportions the water-binder ratio is kept constant at 0.4 and the super plasticizer is used to get the required workability.
Specimens are tested on 2000KN capacity compression testing machine as per IS 516:1959.

Fig-1:Compression strength test setup.

 

Fig-2:Split Tensile strength test setup.

## 3. Results and Discussions

The details of test conducted to find compressive and split tensile strength of all specimens and their average values and graphs are below.

Table- 3:Compressive Strength of M-0 Mix (0% SF+0%FA)

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 23.26 | 33.63 |
| 2 | 26.82 | 37.78 |
| 4 | 22.37 | 33.33 |

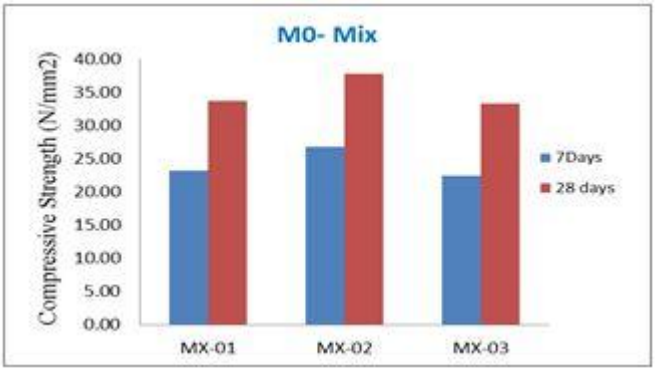


Chart-1:Variation of Compressive strength of M-0 Mix.

Table- 4:Split Tensile Strength of M-0 Mix (0% SF+0%FA)

| % of Polymer | 7DAYS | 28DAYS |
|---|---|---|
| 0 | 2.17 | 3.25 |
| 2 | 2.38 | 3.47 |
| 4 | 2.20 | 2.90 |

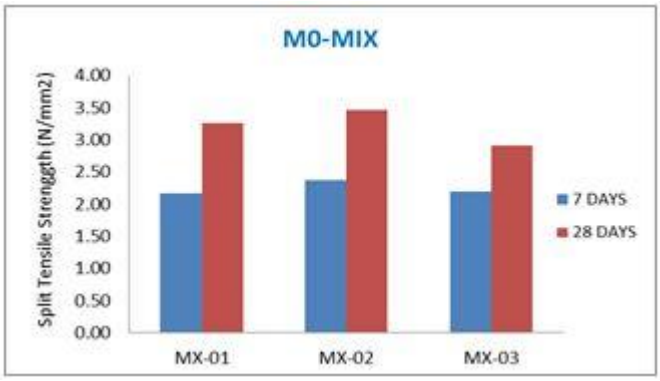


Chart-2:Variation of Split Tensile strength of M-0 Mix.

Table- 5:Compressive Strength of M-1 Mix.

| % of Polymer | 7DAYS | 28DAYS |
|---|---|---|
| 0 | 20.59 | 28.59 |
| 2 | 24.15 | 30.22 |
| 4 | 23.11 | 25.93 |

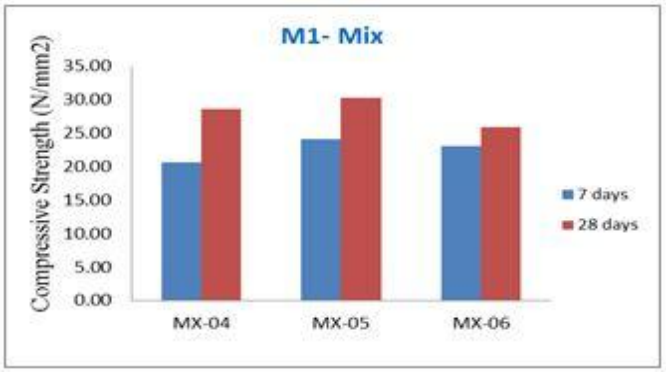


Chart-3:Variation of Compressive strength of M-1 Mix.

Table- 6:Split Tensile Strength of M-1 Mix.

| % of Polymer | 7DAYS | 28DAYS |
|---|---|---|
| 0 | 1.81 | 2.09 |
| 2 | 2.09 | 2.21 |
| 4 | 2.02 | 2.15 |

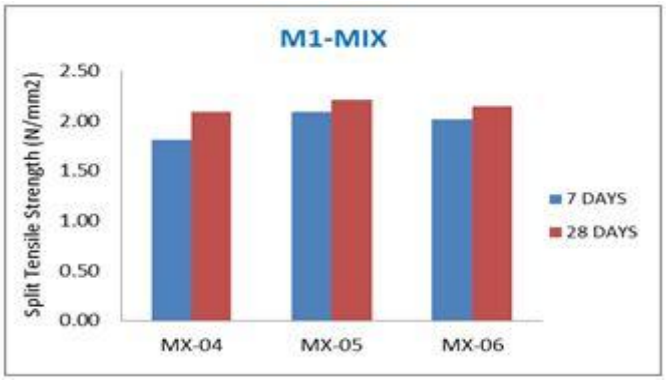


Chart-4:Variation of Split Tensile strength of M-1 Mix.

Table- 7:Compressive Strength of M-2 Mix.

| % of Polymer | 7DAYS | 28DAYS |
|---|---|---|
| 0 | 25.93 | 37.04 |
| 2 | 29.19 | 41.04 |
| 4 | 25.48 | 33.63 |


Chart-5:Variation of Compressive strength of M-2 Mix.

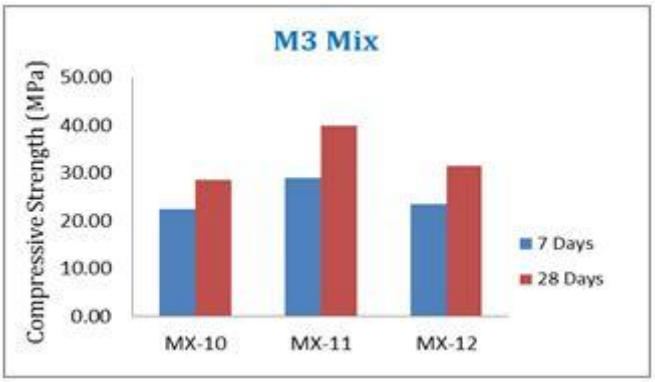


Chart-7:Variation of Compressive strength of M-3 Mix.

Table- 8:Split Tensile Strength of M-2 Mix.

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 2.34 | 2.69 |
| 2 | 2.53 | 4.09 |
| 4 | 2.20 | 2.76 |

Table- 10:Split Tensile Strength of M-3 Mix.

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 2.45 | 3.03 |
| 2 | 2.50 | 3.35 |
| 4 | 2.46 | 3.16 |

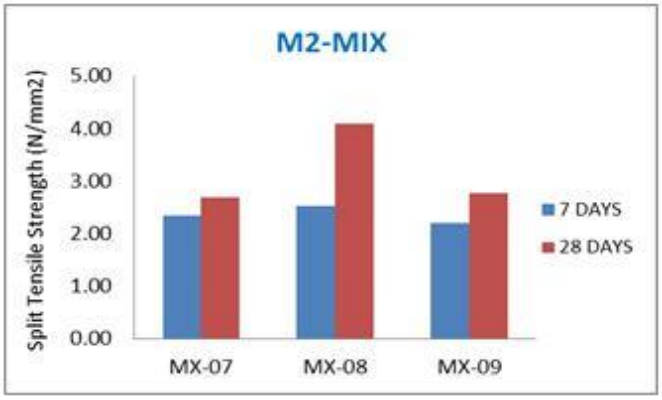


Chart-6:Variation of Split Tensile strength of M-2 Mix.

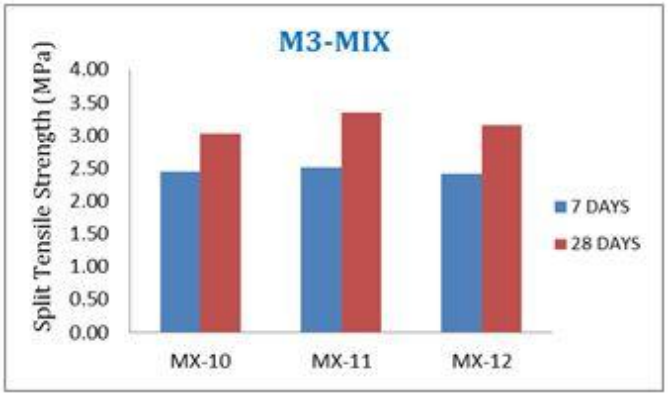


Chart-8:Variation of Split Tensile strength of M-3 Mix.

Table- 9:Compressive Strength of M-3 Mix.

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 22.40 | 28.59 |
| 2 | 29.04 | 40.00 |
| 4 | 23.41 | 31.41 |

Table- 11: Compressive Strength of M-4 Mix.

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 20.80 | 32.89 |
| 2 | 27.59 | 39.11 |
| 4 | 22.31 | 31.26 |

 

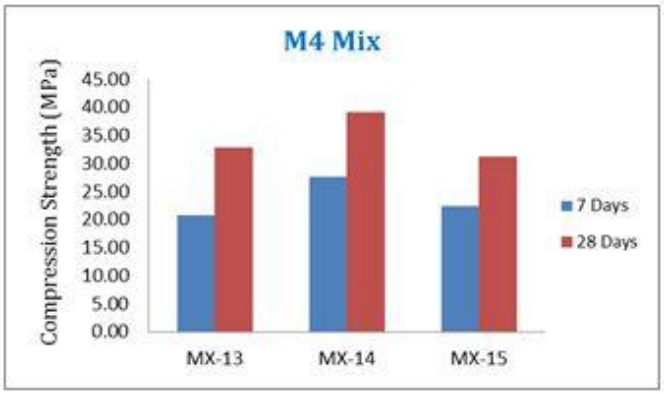


Chart-9:Variation of Compressive strength of M-4 Mix.

Table- 12: Split tensile Strength of M-4 Mix.

| % of Polymer | 7 Days | 28 Days |
|---|---|---|
| 0 | 2.46 | 3.31 |
| 2 | 2.47 | 3.25 |
| 4 | 2.09 | 2.45 |

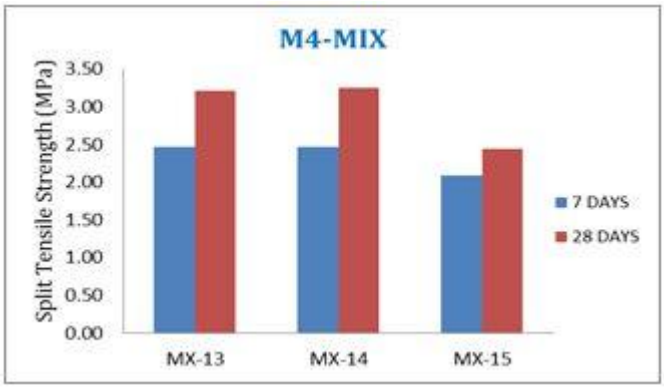


Chart-10:Variation of Split Tensile strength of M-4 Mix.

## 3. CONCLUSIONS

From the above Experimental investigation the following conclusions are drawn.

1. Out of three dosage levels of SBR Latex polymer namely 0%, 2% and 4% optimum dosage is found to be 2% for peak values of compressive and tensile strengths.

2. Based on strength criteria, MX-08 mix proved to be very good concrete comparing with control mix. 28 days compressive strength was increased by 22% (41.04MPa) and 28 days tensile strength was increased by 26% (4.09MPa) making the concrete M-40 even though mix design was carried out for M-30.

3. More eco-friendly concrete MX-11proved to be better performer. Here 28days compressive strength was found to be 40MPa and 28 days split tensile strength was found to be 3.35MPa. Hence this concrete is recommended wherever in the design M-30 Mix is stipulated.

4. When only one admixture fly ash is used at 30% replacement level without polymer, the strength drops below 30MPa. But with just 2% polymer addition 28 days compressive strength reaches 30MPa (MX-05). Hence whenever Fly Ash alone is used at 30% replacement it is better to add 2% polymer.

5. A similar trend is observed in case of all the mixes corresponding to 7 days cured compressive and split tensile strengths.

6. In case of MX-04, MX-05 and MX-06 mixes in which only fly ash is used, it is observed that 7 days strength is very less compared to reference mix which clearly indicates that when fly ash is used without silica fume the gain in strength is very slow; however some improvement was observed when 2% polymer was added without silica fume. Percentage increased in 7 days strength with 30% Fly Ash and 2% polymer is 17% with reference to control mix.

7. It can also be concluded that 2% polymer not only helps in increasing 28 days strength but also increases the 7 days strength.

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