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# Experimental Investigation On Latex Modified Basalt Fibre Concrete

[1]M.Arul kumar, [2]R. Ravi, [3]A. Vijay, [4]M. Sowmiya, [5]V. Soundappan
[1]Assistant Professor, [2]Adviser, [3,4,5]Student
[1,3,4,5]Dhirajlal Gandhi College of Engineering, Salem, Tamil Nadu, India.
[2]Sengunthar Educational Institutions,Tharamangalam,Salem

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*Abstract*— **This report deals with the method of using polymer modified basalt fibre concrete in areas having special requirements. Polymer modified concrete (PMC) have superior characteristic behavior when compared to conventional concrete. Fibre reinforced concrete (FBR) is also proven to be quite successful in strength and maintenance aspects. This paper describes the property of concrete in which both fibre (basalt fibre) and polymer (Styrene Butadiene Rubber-SBR) is used together, thus called as Latex Modified Basalt Fibre Concrete (LMBFC). This will be a preferable solution in repair work of concrete elements or used in areas where concrete have to face severe conditions. Three different percentage of basalt fibre were used in the concrete (0.1%,0.3%,0.5%) and most suitable percentage is chosen based on the test results. Polymer concentration is kept at 10% at weight of cement [1]. A study over mechanical property of the LMBFC showed that they have viable increase in those properties. Comparison was made between the conventional concrete and the LMBFC at the stages of curing and the results obtained were satisfactory. And it is also observed that addition of polymer reduces w/c ratio and curing period is reduced thus saving more water.**

**Keywords: LMBFC ,SBR , FBR, Basalt fibre.**

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## Introduction:

Portland cement concrete have various inadequacies in its fresh and hardened state. Researches were going on to overcome those defects according to the required situation. This concrete itself is a wise and satisfactory material but if its defects were also rectified it will become more successful one.Various addition and replacement experiments were made on the scope of making the concrete better one existed before. Thus, from each of the newer technique arises we ought to learn continuously in order to make progress in this field. It should be noted that it is not possible to overcome all the inadequacies in the concrete at once, so we will only make the concrete better one on the basis of the need arises within the surrounding. In the forthcoming days and even nowadays also civil engineering constructions demand their unique structural and durability requirements. Every structure has its own intended purpose to serve, thus to meet this purpose there comes the need to modify the traditional concrete. Addition of fibres in specific percentage to the concrete improves the mechanical properties, durability, and serviceability of the structure [3].

Fibre Reinforced Concrete(FRC) is concrete which has fibre as one of its component material which facilitates the better performance. They are short discrete fibre uniformly distributed and randomly oriented. Various types of fibres were available such as steel fibre, glass fibre, synthetic fibre and natural fibres and each of them owns their respective properties. Behavior of the fibre reinforced concrete changes accordingly with fibre material, geometries, distribution, orientation, and densities. The concrete matrix is usually weak and by addition of the fibre to the concrete the matrix is well strengthened as it tends to behave as a composite material.Polymers are made from simple organic molecules(monomers) that combine to form more complex structure. The process which facilitates this complex structure formation is called polymerization. The addition of polymer in minor amount to the cement will result in material having high performance called as polymer modified concrete(PMC). The mechanical properties of polymer concrete are notable in many of its aspects due to its advanced behavior.Polymer modified concrete overcomes various disadvantages of the conventional concrete. In addition to the polymer basalt fibre is also added. Thus, it holds the advantage of both polymer modified concrete and fibre modified concrete. Concrete is very good at compressional actions but its tensional properties were quite to enhanced. As said above both the compressive, tensile and flexural strength were increased by inclusion of polymer and basalt fibre in the concrete. Usually concrete acquires strength by compact bonding between the components(ingredients). Polymer increases better bonding at micro level by following layer by layer method. Thus, it enables greater level of bonding in the structure. Concrete is modified by using more than one component latex (SBR latex) and basalt fibre thus called as Latex Modified Basalt Fibre Concrete(LMBFC).

## MATERIALS

### Cement

The cement used is Ordinary Portland Cement (OPC 53 grade). Following Table 1 is the various tests conducted as per the Indian standard to determine the properties of the cement.

Table.1. Physical properties of cement.

| S NO | PROPERTIES | VALUE |
|---|---|---|
| 1 | Specific gravity | 3.15 |
| 2 | Standard consistency | 35% |

| | | |
|---|---|---|
| 3 | Initial setting time in minutes | 80 min |
| 4 | Final setting time in minutes | 210 min |

**Fine aggregate**

River sand is used in this experiment. Corresponding tests were conducted to determine the properties and showed in Table 2. Particle size distribution of the of an aggregate is determined by sieve analysis

Table 2. Properties of fine aggregate.

| S NO | PROPERTIES | VALUE |
|---|---|---|
| 1 | Specific gravity | 2.7 |
| 2 | Fineness modulus | 2.6 |
| 3 | Water absorption | 1.6% |
| 4 | Zone | II |

**Coarse aggregate**

Coarse aggregate is the material which fills mostly the concrete, it accounts for 60-80% of the volume and 70-855 of the weight. Natural coarse aggregate is used in this experiment and is free from dust and deleterious material. Table 3. Shows the tests conducted on the coarse aggregate and its results.

Table 3. Properties of coarse aggregate.

| S NO | PROPERTIES | VALUE |
|---|---|---|
| 1 | Specific gravity | 2.68 |
| 2 | Fineness modulus | 7.2 |
| 3 | Water absorption | 1.7% |

**Basalt fibre**

Basalt rock is a volcanic rock and can be divided into small particles then formed into continuous or chopped fibres. It has good resistance to chemical attack, impact load, and fire with less poisonous fumes. Basalt composites are used as plastic polymer reinforcement, soil strengthening, industrial floors, heat and sound insulation for residential and industrial buildings, bullet proof vests and retrofitting and rehabilitation of structures.

Basalt is an igneous rock composed of plagioclase, feldspar, pyroxene and magnetite, in some cases olivine. Production method similar to the production technique of conventional glass fibre. Basalt is excavated from mines, grined well, washed and then heated in a furnance at 1500°C. It is molten at this stage and is allowed to flow through a nozzle to acquire the required fibrous form.

Specific gravity is about 2.64 and Density is 2650 kg/m$^3$. Following Fig..1. shows the basalt fibre

Fig.1. Basalt Fibre.

**SBR (Styrene Butadiene Rubber) LATEX.**

Styrene Butadiene Rubber is from the family of synthetic rubber and is derived from styrene and butadiene by a reaction called emulsion polymerization. It is composed of 75% Butadiene and 25% styrene. The following Table 4 contains the properties of styrene Butadiene Rubber (SBR) Latex.

Table 4. Properties of SBR Latex

| S NO | PROPERTIES | DESCRIPTION |
|---|---|---|
| 1 | Color | White |
| 2 | Specific gravity | 1.03±0.02 |
| 3 | Glass transition temperature. | -50(@℃) |
| 4 | Freezing and thawing resistance | Excellent |
| 5 | Thermal property | Non-Inflammable |

The following fig.2. shows SBR latex

Fig.2. SBR latex

**Experiment procedure**.

Both Basalt fibre and later are to be used, so it is important to determine the proportion and the ratio. Polymer content is assumed to be added at 10% of cement [4]. But basalt fibre content is determined by performing test. Three concentration of basalt fibre (0.1%,0.3%,0.5%) were added to the concrete and then compressive strength test is done at 7 days after casting. And based on the test results basalt fibre concentration is chosen.

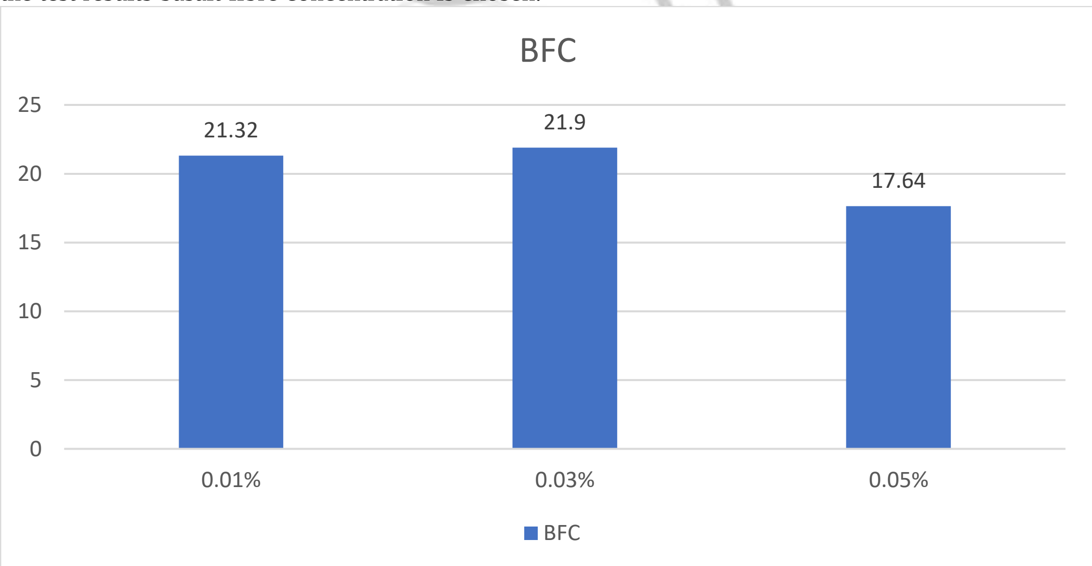

Fig.3. Compressive strength of Basalt fibre added concrete at 7 days of curing.

The above Fig.3. shows the compressive strength of concrete at 7 days. It is seen from the graph that 0.03% is having higher strength when compared to other percentages. The value is 0.57 $kN/m^3$ higher than 0.01%. This increase in strength only contributes about 2.6% increase but consumes of about 200% more basalt fibre, so it is not economical. Thus, we were adopting 0.1% as most suitable percentage.
Now basalt fibre amount is fixed and polymer concentration is assumed to be 10% [4]. Conventional moulds (cube, cylinder, prism) were casted for the grade $M_{25}$. Mix design is prepared for the same grade of concrete with addition of basalt fibre and polymer as per IS10262. The following Table.5. contains the mix design details for the Latex Modified Basalt Fibre Concrete(LMBFC).

Table.5. Mix design.

| S NO | MATERIAL | AMOUNT FOR $1m^3$ OF CONCRETE. |
|---|---|---|
| 1 | Cement | 441 kg |
| 2 | Water | 151 kg |
| 3 | Fine aggregate | 568 kg |
| 4 | Coarse aggregate | 1206 kg |
| 5 | Chemical admixture (10% in weight of cement) | 44 kg |
| 6 | Basalt fibre (0.1% in overall volume of the concrete) | 2.65 kg |
| 7 | Water cement ratio (w/c) | 0.35 |

After mix designing and arriving all those values cubes, cylinders and prisms were casted with standard moulds. Both conventional moulds and LMBFC moulds of grade $M_{25}$ were casted so as to enable easier comparison. Following Fig.4. shows the mixing of concrete

Fig.4. Mixing of LMBFC.

Hand mixing done in this process. Addition of polymer to the basalt fibre added concrete showed increased workability. Basalt fibre is mixed with the concrete as dry mix and then polymer is added to the mixture and then mixed well by adding water.
After mixing specimens were made and are cured for a period of 7 days by immersing in the curing tank containing water. After 7 days of curing the specimens were taken out and were allowed to be in open air conditions till the days of testing. While the conventional specimens were cured for all the 28 days by immersing in the curing tank.

**Test results**

Results were obtained by testing the specimens in the respective testing apparatus. Compressive strength test and split tensile strength test were performed in compression testing machine and flexural strength tests were performed in Universal Testing Machine(UTM). Test results were calculated and comparison between normally used conventional concrete and LMBFC were done.

**Compressive strength**

This test was performed in compression testing machine, specimen of dimension 150×150×150 mm is used. Initially compression testing machine (CTM) is cleaned as any solid dirt in the pressuring area can change the result. Then cubes were placed at the CTM and the machine is switched on. The reading goes up increasing until it reaches the breakage point. And then it decreases gradually so eminent observation is essential.

Cubes were tested at 7, 14 and 28 days for both conventional and LMBFC and results were listed in the Table.6.

Table.6. Compressive strength of cubes

| CONCRETE | STRENGTH AT 7 DAYS (N/ mm$^2$) | STRENGTH AT 14 DAYS (N/ mm$^2$) | STRENGTH AT 28 DAYS (N/ mm$^2$) |
|---|---|---|---|
| CONVENTIONAL | 17.82 | 18.68 | 27.73 |
| LMBFC | 29.4 | 33.37 | 43 |

At 28 days of completion compressive strength showed an increase of about 55.06%. The following Fig.5. represents graphical comparison between the two.

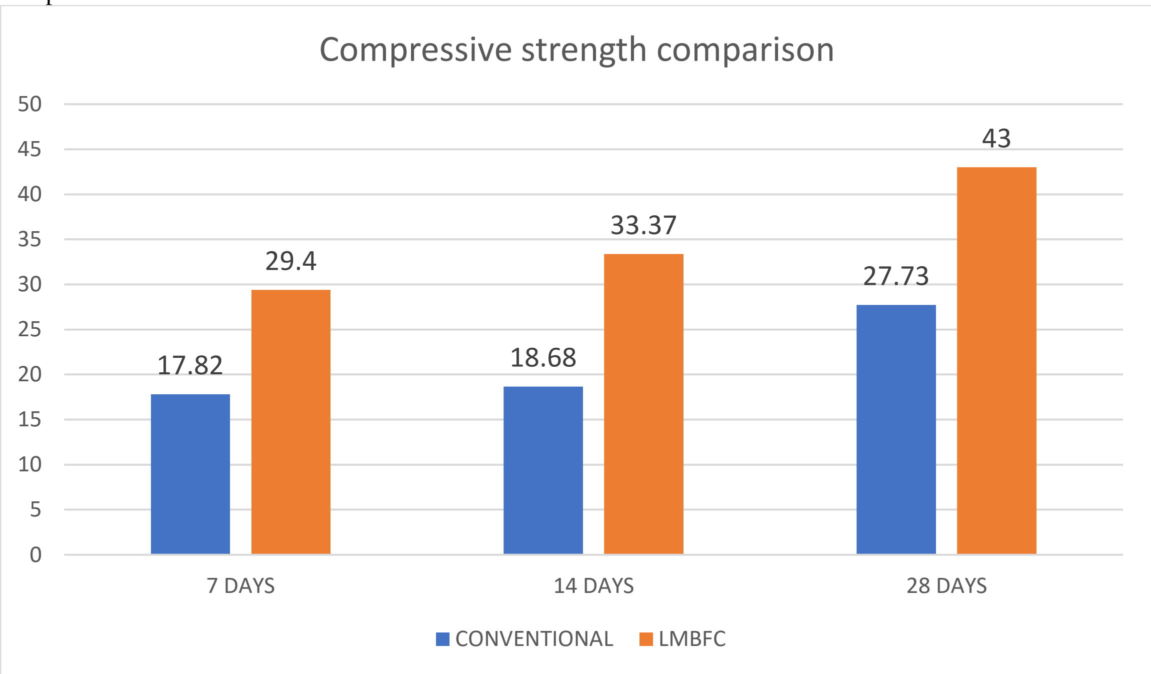


Fig.5. Comparison of compressive strength of cubes

**Split tensile strength**

It is also performed in compression testing machine. Cylinders which were casted are used in split tensile test. Same compression testing machine is used here. But the cylinders were placed horizontally in the machine and the force is applied. Breakdown occurs similarly as in case if cube. But the value obtained in this case would be split tensile strength of the cylinder/

As by procedure tests were done at 7, 14 and 28 days. For each testing three of the specimens were used and the average of those were obtained as results. The following Table.7. contains the details

Table.7. Split tensile strength

| CONCRETE | STRENGTH AT 7 DAYS (N/ mm$^2$) | STRENGTHAT 14 DAYS (N/ mm$^2$) | STRENGTHAT 28 DAYS (N/ mm$^2$) |
|---|---|---|---|
| CONVENTIONAL | 1.17 | 1.507 | 2.95 |
| LMBFC | 2.8 | 3.24 | 3.63 |

Strength difference holds at a range of 0.68 N/mm$^2$ which holds for an amount of about 23.05% higher than normal concrete.Fig.7. represents the comparison of split tensile strength between the two concretes.

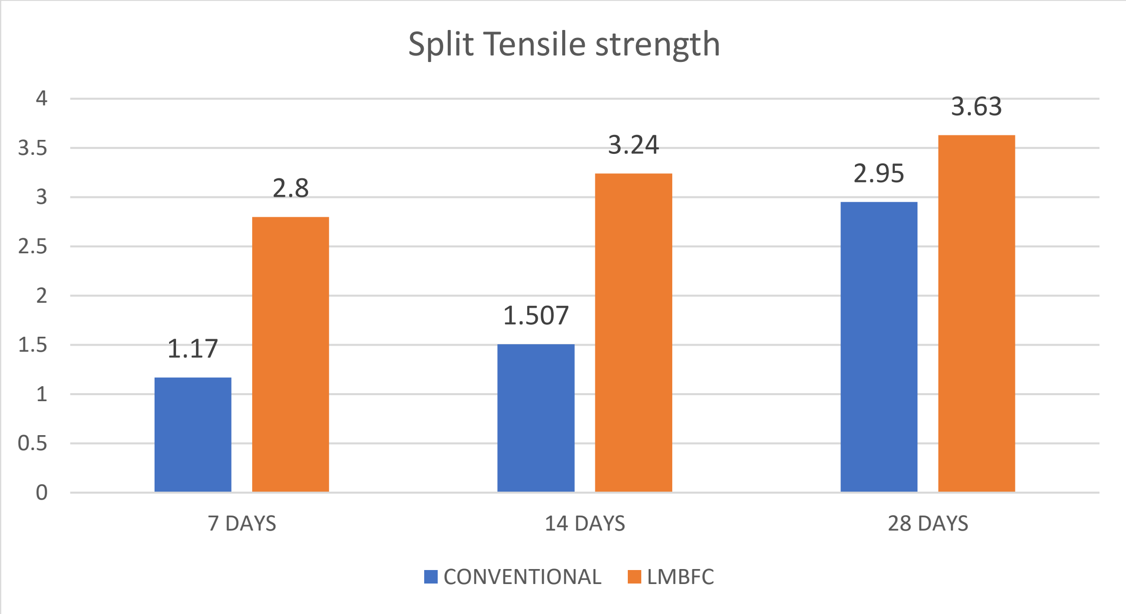


Fig.7. Split tensile strength test comparison

**Flexural strength**

Unlike the above two tests which were performed in the same testing machine flexural strength is measured in Universal Testing Machine (UTM).

The prism is placed in the UTM over two steel rods each at 18.3cm from the end. Instrument is switched on and then readings were note down.

The following table.8. shows the result of universal testing machine.

Table.8. Flexural strength

| CONCRETE | STRENGTH AT 7 DAYS (N/ $mm^2$) | STRENGT AT 14 DAYS (N/ $mm^2$) | STRENGTH AT 28 DAYS (N/ $mm^2$) |
|---|---|---|---|
| CONVENTIONAL | 3.5 | 4.5 | 5 |
| LMBFC | 4 | 4.75 | 6.75 |

Flexural strength showed an increase of about 35%. Fig.8. shows the graphical comparison between the flexural strength of the conventional and LMBFC concrete

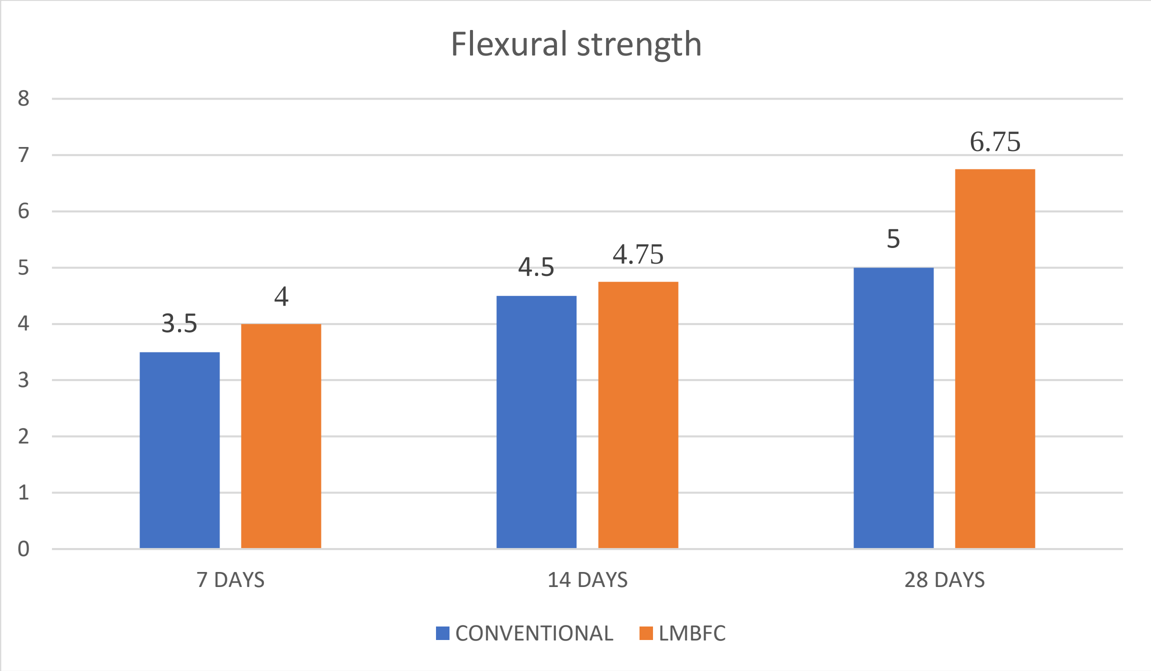


Fig.8. Flexural strength comparison.

**Conclusion.**

Workability of concrete shows a measurable increase with respect to addition of the polymer content (SBR latex).

Curing period is reduced to 7 days in case of LMBFC, as we only cured the moulds for about 7 days, and after 7 days they were moist cured.

Reduction in water cement ratio (w/c) is achieved thus, saving of water is done in more than one aspect (curing and w/c ratio).

Compressive strength of conventional concrete at 28 days is 27.73 N/mm$^2$ while LMBFC stands at 43N/mm$^2$, which has an increase in strength of about 15.27N/mm$^2$

Split tensile of conventional concrete at 28 days is 2.95N/mm$^2$ while LMBFC has a value of about 3.63N/mm$^2$ thus, 0.68N/mm$^2$ is increased in tensile strength.

Similarly, flexural strength of conventional concrete at 28 days is 5N/mm$^2$ and LMBFC is about 6.75 N/mm$^2$. LMBFC holds an increase of about 1.75 N/mm$^2$.

Addition of basalt fibre and SBR latex to the concrete shows a viable increase in the strength parameters.

Compressive strength showed an increase of about 55.05%, split tensile strength of about 23.05% and flexural strength of about 35%.

It is seen that polymer concentration of about 10% on weight of cement and basalt fibre concentration of about 0.1% on overall volume is giving more appreciable results.

Thus, LMBFC has far much better performance while comparing to the conventional concrete making it more suitable for placing facilitating extreme exposure condition to the concrete.

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