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Fiber Reinforced Mortar For Repair And Rehabilitation Of Structures

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Abstract—The effective utilization of artificial fibres in construction work will enhance the performance and durability of the concrete. The use of fibres as reinforcement in traditional concrete mixes has been extensively studied and has been slowly finding its place in practice. The use of fibres in masonry applications, repair and rehabilitation of structures, nowadays plays a beneficial role in improving the strength of mortar and makes it more suitable for use in structures subjected to impacts and earthquake loads. The Fibre Reinforced Mortar (FRM) will also increase the flexural Strength of Cement Mortar. This paper will summarize the findings for improving the strength of 43 grade mortar which may be very much applied as material in Repair and Rehabilitation of Civil Engineering Structures. In this research, the combination of cement mortar with addition of different fibres such as Basalt, Steel and Nylon are effectively mixed in proper ratios. Cubes are casted in standard sizes (75mmX 75mm X 75mm) and tested for the compressive strength after 7, 14 and 28 days to obtain the optimum values of compressive strength for FRM. For this matrix, the cement is replaced by 0.5%, 1%, 1.5% and 2% of fibres with cement sand ratio of 1:3. From the results the compressive strength for FRM was comparatively higher than traditional mortar cubes. The flexural strength was also drastically increased.

Keywords— Basalt Fibres, Cement Mortar, Compressive Strength, Flexural strength, Nylon Fibres, Steel Fibres ,

1. INTRODUCTION:

A large number of civil infrastructures around the world are in a state of serious deterioration today due to carbonation, chloride attack, etc. In order to maintain efficient serviceability, older structures must be repairs on strengthened so that they meet the same requirement demands of the structures built today and in future.

For structure protection, reinforced cement mortar is commonly used. However mortar which is made with ordinary Portland cement are known to form and relatively strong in compression and weak in tension, are tend to be brittle and poor impact strength and toughness. So fibres are used as primary reinforcement to increase both strength and toughness of the composite.

The use of fibres in masonry applications, repair and rehabilitation of structures nowadays play a beneficial role in improving the strength of mortar.

1.1. CEMENT REINFORCEMENT MORTAR

Fiber reinforced cement based mortars have been suggested as one of the most effective methods to improve the strength and the structural behavior of the mortar. Three part of sand, one part of cement and some reinforcing fiber in order to make some reinforced mortar to repoint a lead roof valley. This mortar is mixed with SBR instead of water, which helps to make the mortar more flexible.

Cement mortar reinforced by short carbon fibers was improved by using acrylic dispersion as an admixture. The main purpose of this work is to evaluate mechanical behavior of sisal fiber. Cement lime base matrices in masonry applications are widely used.

1.2. IMPORTANCE OF FIBERS:

Fibers, when added to cementitious matrix substantially increases the static and dynamic properties, changing an inherently brittle material with low tensile strength and impact resistance into a strong composite with superior crack resistance, improved ductility and distinctive post cracking behavior to failure. The strengthening mechanism of fibers involves transfer of stress from matrix to the fiber by interfacial shear or by interlock between the fibers and the matrix and improves the bonding characteristics.

Fibers bridging a crack can absorb energy by deforming and or pulling out, depending on their bond characteristics. Fibers resist the nucleation of cracks by acting as stress-transfer bridges, and once cracks nucleate, fibers abate their propagation by providing crack tip plasticity and increased fracture toughness.

1.3. TYPES OF FIBERS AND HIS PROPERTIES

1.3.1. BASALT FIBER

Basalt fiber are usually strong and light in weight and it is generally used for reinforcement in civil construction, road repairing and infrastructures it does not get affected by acid of base or any organic chemical.

The fibre are heat resistance and not affected the temperature upto 600-700 degree celcius. Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the material plagioclase, pyroxene and olivine.

And also the properties of basalt fibre has shown in table 1.

TABLE 1. PROPERTIES OF BASALT FIBER

SL.NO.	BASALT FIBER	PROPERTIES
1	Length (mm)	13
2	Diameter	0.14*0.80
3	Aspect ratio	16.6
4	Specific Gravity	2.60
5	Tensile Strength	3100
6	Young's modulus	73

1.3.2. STEEL FIBER

Steel fibers are short, discrete lengths of steel with an aspect ratio from about 20 to 100, and with any of several cross section. Some steel fibers have hooked ends to improve resistance to pull out from a cement based matrix. Various type of steel fiber like hooker end steel fiber, round steel fiber and flat crimped steel fiber.

Steel fiber is a kind of advance composite material, which is most widely used as concrete reinforcing material in construction engineering works in now a days. And also the properties of steel fibre has shown in table 2.

TABLE 2. PROPERTIES OF STEEL FIBER

SL.NO.	STEEL FIBER	PROPERTIES
1	Length (mm)	13
2	Diameter	0.20
3	Aspect ratio	66.5
4	Specific Gravity	7.85
5	Tensile Strength	500
6	Young's modulus	210

1.3.3. NYLON FIBER

Nylon fiber is one of the fiber having the longest history among synthetic fibers. They are used for a variety

of users from chothing to home furnishing and industrial uses. In nylon fibers, there are many types depending on the raw materials. The fibers most manufactured in japan.

They can be melt-processed into fibers, films or shapes. Nylon fiber was the first truly synthetic to be commercialized(1939). Nylon was developed in 1930s by scientists. The luster of the fiber can be modified by adding the delustering stage at the molten stage. Hence nylon is a strong, light synthetic fiber. And also the properties of nylon fibre has shown in table 3.

SL.NO.	NYLON FIBER	PROPERTIES
1	Length (mm)	1.57-1.59
2	Diameter	263
3	Aspect ratio	20-60
4	Specific Gravity	1.14
5	Tensile Strength	870
6	Young's modulus	6.74

1. LITREATURE COLLECTION:

There are a large number of investigations on the effect of addition of fibers on the strength and ductility of flexural members. The study carried out by Ganesan, (2007). indicates that ductility and ultimate resistance of compressive members are remarkably enhanced due to the addition of fibers. Also it was emphasized that the neglect of fiber contribution may considerably underestimate the compressive capacity of fiber reinforced mortar.

As per Khilesh Sarwe(2014). The rapid Urbanization and Industrialization all over the world has resulted in large deposition of plastic waste. This waste can be utilized under proper condition as content in concrete. In this paper we study to the compressive strength of mortar using waste plastics and also add steel fibre with waste plastics..

As suggested by Falah Almottiri(2011), The structural behaviour of steel fiber reinforced fly ash concrete under compression and flexure was studied by conducting tests on standard control specimens. The use of steel fibres in fly ash concrete improves its structural properties, especially the flexural tensile strength. Increasing the percentages offly ash upto 30% and steel fibre upto 1.5% in concrete enhances the flexural tensile strength as well as the compressive strength. Finally, the use of fibre

reinforced fly ash concrete is recommended as an alternative to fibre reinforced plain concrete.

As per Khadake S. N Konapure C.G. (2012). This paper deals with Investigation for M-25 grade of concrete having mix proportion 1:1.50:3.17with water cement ratio 0.465 to study the compressive strength, and Flexural strength of steel fiber reinforced concrete (SFRC) containing fibers of an interval of 0.5% from 0.0% to 1.5% volume fraction of hook end Steel fibers of 71 aspect ratio were used. The percentage of Fly Ash by weight is to be increased by 10% from 00% to 30%. After curing this specimen were tested as per relevant codes of practice Bureau of Indian Standard. A result data obtained has been analyzed and compared with a control specimen. A relationship between Compressive strength vs. days, and flexural strength vs. days represented graphically. Result data clearly shows percentage increase in7, 28 & 45 days Compressive strength for M-25 Grade of Concrete.

3.EXPERIMENTAL INVESTIGATION:

3.1 TEST ON CEMENT

A powdery substance made by calcinating Lime and Clay, mixed with water to form mortar or mixed with sand, gravel, and water to make concrete. It is a binder, a substance that sets and hardens independently, and can bind other materials together. Lime + Clay +Water = Cement and Cement + Sand + Gravel = Concrete Cements may be used alone, but the normal use is in mortar and concrete in which the cement is mixed with inert material known as aggregate. Concrete is a mixture of cement, sand or other fine aggregates. Mixtures of soil and Portland cement are used as a base for roads. Portland cement also used in the manufacture of bricks, tiles, shingles, pipes, beams, railroad, ties and various extruded products. Because concrete is the most widely used of all construction materials in the world today. Each year almost one ton of concrete is poured per capita in the developed countries. And the properties of cement has shown in table 4.

TABLE 4. PROPERTIES OF CEMENT

S.No	Test properties	Results	Standard value
1	Specific gravity	3.12	3.15
2	Consistency	28%	30%
3	Fineness of cement	0.01%	Less than 10%

3.2. TEST ON FINE AGGREGATE

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The most common constituent of sand is silica (silicon dioxide, or SiO2), usually in the form of quartz. Sand is formed by the weathering of rocks. Based on the natural sources from which sand is obtained. This sand is widely used for all purposes. It is obtained from the banks or beds of rivers and it consists of fine rounded grains. The presence of fine rounded grains is due to mutual attrition under the action of water current.

The river sand is available in clean conditions. The river sand is almost white in color. River sand On the basis of particle size, fine aggregate is graded into four zones. IS Sieve Percentage passing for Grading Zone Grading I Zone II Grading Zone III Grading Zone IV 10mm 100 100 100 100 4.75mm 90 – 100 90 – 100 90 – 100 90 – 100 2.36mm 60 – 95 75 – 100 85 – 100 95 – 100 1.18 mm 30 – 70 55 – 90 75 – 100 90 – 100 600 micron 15 – 34 35 – 59 60 – 79 80 – 100 300 microns 5 – 20 8 – 30 12 – 40 15 – 50 150 microns 0 – 10 0 – 10 0 – 10 0 – 15. Sand for Construction Works Different construction works requires different standards of sand for construction.

Brick Works: finest modulus of fine sand should be 1.2 to 1.5 and silt contents should not be more than 4%. Plastering Works: finest modulus of fine sand should not be more than 1.5 and silt contents should not be more than 4%.Concreting Works: coarse sand should be used with finest modulus 2.5 to 3.5 and silt contents should not be more than 4%. It should be clean and coarse. It should be free from any organic or vegetable matter; usually 3-4 per cent clay is permitted. It should be chemically inert.

It should contain sharp, angular, coarse and durable grains. It should not contain salts which attract moisture from the atmosphere. It should be well graded, i.e., it should contain particles of various sizes in suitable proportions. It should be strong and durable. It should be clean and free from coatings of clay and silt. And the properties of fine aggregate has shown in table 5.

TABLE 5. PROPERTIES OF FINE AGGREGATE

S.No	Test properties	Results	Standard value
1	Specific gravity	2.5	2.6
2	Fineness modulus	2.86	3
3	Bulk density	1.59kg/m3	1.520-1.680kg/m^3

3.3. EXPERIMENTAL SETUP:

3.3.1. Cube test:

Cubes are casted in the dimensions of 75mm x 75mm x 75mm. The cubes are tested by using Compressive Testing Machine as shown in fig 1.

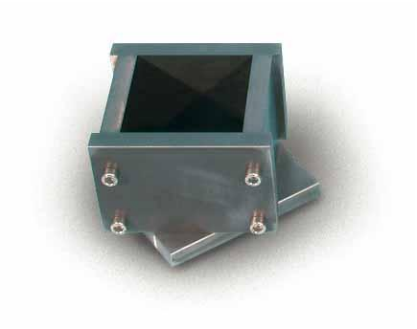

Fig.1 Cube Mould

3.3.2. Flexural test:

Beam are casted in the dimension of 75mm x 75mm x350mm and tested for the flexure in Universal testing machine as shown in figure 2.

Figure.2. Beam Mould

4. TEST RESULTS & DISCUSSION:

4.1 Compressive Strength:

The compression strength or compressive strength is the capacity of a material or structure to withstand loads tending to reduce size as opposed to tensile strength, which withstand loads tending to elongate.

In other words, compressive strength resists compression whereas tensile strength resists tension. In the study of strength of material tensile strength, compressive strength and shear strength can be analysed independently. Compressive strength is often measured on a Universal testing machine(UTM)

Table 6. Compressive strength of Mortar after 7 days, 14 days and 28 days on Basalt fiber.

BASALT FIBER	7 Days	14 Days	28 Days
0%	16.22	25.74	35.29
0.5%	16.68	27.13	42.2
1%	18.62	32.49	54
1.5%	17.13	28.14	43.41
2%	15.4	23.15	38.14

The table 6 shows the compressive strength of mortar by using basalt fibre for 7, 14, 28 days of curing strength. The fibres can be utilized as per the percentages of 0.5, 1, 1.5, 2. Among this the maximum strength attained while adding 1% of basalt fibre to the mix. And the further usage of fibres are drastically decreased . The graphical attainment of compressive strength also shown in figure 3.

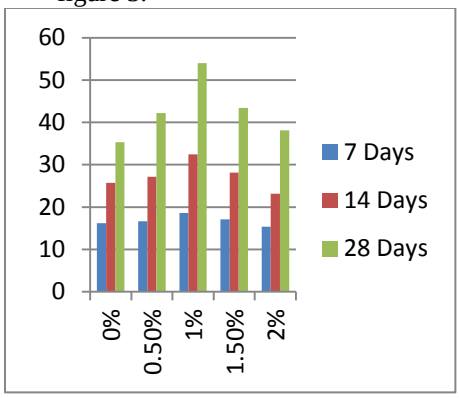

Table 7. Compressive strength of Mortar after 7 days, 14 days and 28 days on Steel fiber

STEEL FIBER	7 Days	14 Days	28 Days
0%	16.22	25.74	35.29
0.5%	14.26	23.24	40.52
1%	17	26.24	45.92
1.5%	17.22	26.89	47.44
2%	15.14	23.96	41.74

The table 7 shows the compressive strength of mortar by using steel fibre for 7,14,28 days of curing strength. The maximum strength attained while adding 1.5% of steel fibre to the proportions. And further addition of fibres will drastically decreased the strength of mortar. The graphical attainment of compressive strength also shown in figure 4.

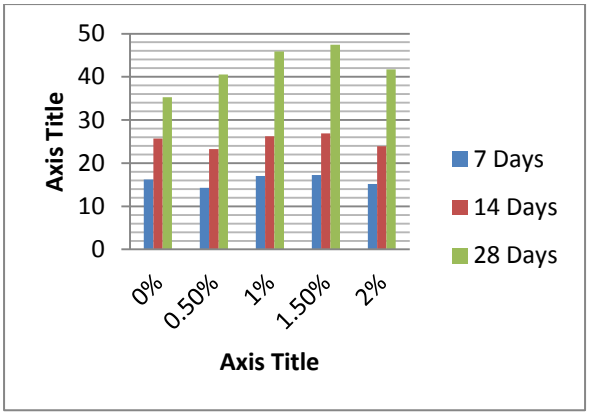

Figure 4

Table 8. Compressive strength of Mortar after 7 days, 14 days and 28 days on Nylon fibre.

NYLON FIBER	7 Days	14 Days	28 Days
0%	16.22	25.74	35.29
0.5%	16.92	26.45	37.84
1%	18.46	29.36	42.92
1.5%	15.4	23.13	32.8
2%	13.76	21.38	29.52

In this table 8 the compressive strength of mortar by using nylon fibre for 7, 14, 28 days curing strength are given. The maximum strength obtained by 1% of utilization of nylon fibres to the proportions. And the further addition fibres will drastically decreased. The graphical attainment of compressive strength also shown figure 5.

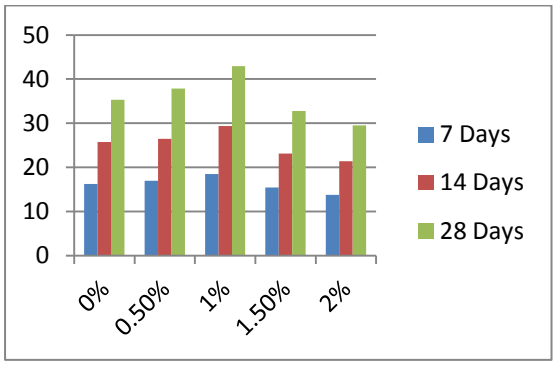

Figure 5

5.CONCLUSION:

- The research projects covered in this paper would conclude that the addition of fibers in the composite will relatively increase the compressive strength and these composites are successfully used, both in new construction and in repairs and reconstruction of already existing structures.
- The fiber content and fiber length because these are also important to contribute the mechanical strength of mortars and also increase the plaster strength and decrease the permeability.
- Finding more artificial fibers in construction industry is highly recommended at optimum cost toindicate the strength characteristics of fiber mix material and performance of building material as concrete, mortar, bricks etc.

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