Effect of Jute Fibers on Concrete With Partial Replacement of Cement With Microsilica

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Abstract- *Concrete is a versatile material of construction throughout the world for its inherent properties. It is well learnt that concrete is strong in compression and weak in tension. Development of crack in concrete is one of the major problems, which is due to brittleness of concrete and also heat of hydration. In order to improve the tensile property to the concrete, the use of fibers is recommended. In the present study, Jute fibers and Micro Silica are used in the conventional concrete and the compressive, tensile and flexural strengths obtained at 3 days,7 days,14 days, and 28 days are compared with conventional concrete. Micro Silica is replaced at 5%, 10%, 15% and 20% of cement and the optimum is observed at 10% replacement. Then Jute fibers are added at 0.1%, 0.2%, 0.3% and 0.4% of cement. The test results had shown enhanced strengths at 10% Micro Silica and Jute fibers.*

Keywords- Silica fume, Jute Fiber ,Cement, Strength Properties, Tensile Strength

I. INTRODUCTION

In construction industry, strength is a primary criterion in selecting a concrete for a particular application. The concrete used for gaining strength over a long period of time after casting. The characteristic strength of concrete is defined as the compressive strength of a sample that has been aged for 28 days. Neither waiting 28 days from such a test would not serve the rapidity of construction nor would neglecting it serve the quality control process on concrete in large construction sites. Therefore, rapid and reliable prediction of the strength of concrete would be of great significance. For example, it provides a chance to do the necessary adjustment on the mix proportion used to avoid the situation where concrete does not reach the required design strength or by avoiding concrete that is unnecessarily strong and also for more economic use of raw materials and fewer construction failures, hence reducing construction cost.

Usage of Jute fiber is satisfying the flexural values and replacement of silica fumes with respect to cement is giving high early strength properties. Jute fiber is proven performance in various experiments and comes in various lengths to suit applications. By usage of silica fume in practical experiments gives enhanced durability to whole structure and increases the bonding strength completely. By using these materials in practically results from flexural are completely satisfied. In construction of tanks and pavements gives best results in construction industry. Further the chemical reactions and elevated temperatures are studied like very low permeability to chloride and water intrusion to structures.

II. MATERIALS USED

The details of the materials used with their properties are mentioned as follows.

2.1 Cement

Ordinary Portland cement available in the local market of standard brand was used in the investigation. Care has been taken to see that the procurement made from a single batch is stored in airtight containers to prevent it from being affected by the humidity atmospheric and monsoon moisture.

2.2 Fine aggregate

The locally available river sand is used as fine aggregate in the present investigation. The sand is free from clay, silt and organic impurities. The fine aggregate used were should confirmed to the standard specifications as per IS: 2386-1963. The fine aggregate used is river sand confirming to zone –II. It is clean, free from organic matter, silt & clay. The specific gravity of fine aggregate is 2.67 and fineness modulus is 2.674.

2.3 Coarse aggregate

Machine crushed angular granite metal of 20mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, clay particles and organic matter etc... The coarse aggregate is also tested for its

various properties. The coarse aggregate used was also confirmed to the standard specifications.

2.4 Water

The locally available potable water accepted for local construction is used in the experimental investigation after testing. The pH value should not be less than 6.

2.5 Admixtures

High range water the reducing admixtures known as super plasticizers are used for improving or workability for decreased water-cement ratio without decreasing the compressive strength.

2.6 Micro silica

It is a very reactive and effective pozzoloanic material due to its fine particle size and high purity of sio2 (99.5 %) content. It enhances the mechanical properties, durability and constructability in concrete. It is used in the production of high early strength.

2.7 Jute

Jute fiber is a natural fiber with silky luster and golden yellow, so it is called golden fiber. It has tensile strength, low cost, durability and versatility. Jute can be mixed with other natural and synthetic fibers. Jute is a discrete, discontinuous staple fiber that can be used in concrete to control and prevent cracks. It prevents shrinkage cracks in concrete and increases resistance to water penetration, wear and impact. It uniformizes the concrete and also increases compressive strength, ductility and flexural strength while increasing the ability to absorb more energy. The use of uniformly dispersed jute fibers reduces separation, bleed out and also results in a more uniform concrete mixture. Jute is only used for secondary reinforcement. Jute fiber has no significant effect on the compressive strength.

III. ROLE OF JUTE

Cracks play a crucial role in changing concrete structures to permeable elements and therefore have a high risk of corrosion. Cracks not only reduce the quality of the concrete, make it aesthetically unacceptable, but also invalidate the structure. Therefore, it is important to reduce the crack width, which can be achieved by adding polypropylene fibers to the concrete. Split tensile strength is 2.5 times higher than conventional concrete. The flexural strength is increased by 2.5 times that of conventional concrete. Reduce inherent plastics and dry shrinkage cracks.. It controls plastic settling. It improves the post-peak ductility of the concrete. Improve moisture and abrasion resistance. Increase impact/crush resistance. Reduce water penetration and concrete permeability. Increase the toughness of hardened concrete. It reduces the damaging effects of the freeze-thaw cycle. It improves the long-term durability of concrete. Therefore, the addition of fibers in the cement concrete matrix bridges these cracks and limits their further opening. In order to achieve greater deflection in the beam, additional force and energy are required to pull or break the fiber. In addition to maintaining the integrity of the concrete, the process also increases the load carrying capacity of the structural members rather than cracking.

Specifications of Jute

Property Value

Cut length 6 mm or 12 mm
Shape of fiber special for improved holding of cement aggregates Tensile strength 20000-22000 kN/m2
Ignition point - 1930C
Specific heat – 1360 J/Kg/K

IV. MIXING PROPORTIONS

At first a nominal mix for M25 grade concrete was prepared in the general procedure and three sets of each mould like cube, cylinder and prisms were casted and are tested for compressive strength, split tensile test and flexure test respectively. To the mix obtained above a replacement of Silica fume is done at 5%, 10%, 15%, and 20% and they are tested for the above said tests and the test results are tabulated below in table 1,2,3.

4.1 Results of Strength Parameters

The compressive, split tensile and flexural strength values are shown in Tables 4.7, 4.8 and 4.9

Table 4.7: Compressive Strength Values for Micro Silica Concrete

S.no	Micro Silicas (%)	3 days Compressive strength (MPa)	7 days Compressive strength (MPa)	14 days Compressive strength (MPa)	28 days Compressive strength (MPa)
1	0	11.91	32.67	48.47	49.05
2	5	12.46	33.32	48.92	50.17
3	**10**	**13.52**	**36.2**	**51.28**	**52.04**
4	15	12.18	33.15	48.6	49.42
5	20	11.41	32.18	47.82	47.9

4.1.1 Split Tensile strength

Table 4.8: Split Tensile Strength Values for Micro Silica Concrete

S.no	Micro Silicas (%)	3 days Split Tensile strength (MPa)	7 days Split tensile strength (MPa)	14 days Split tensile strength (MPa)	28 days Split tensil strength (MPa)
1	0	1.61	2.52	3.65	4.08
2	5	1.81	2.85	4.05	4.28
3	**10**	**1.95**	**2.98**	**4.51**	**5.21**
4	15	1.63	2.42	3.67	4.04
5	20	1.45	2.35	3.55	3.85

4.1.2 Flexural Strength

Table 4.9: Flexural Strength Values for Micro Silica Concrete

S.no	Micro Silicas (%)	3 days Flexural tensile strength (MPa)	7 days Flexural tensile strength (MPa)	14 days Flexural tensile strength (MPa)	28 days Flexural tensile strength (MPa)
1	0	3.15	4.02	4.27	5.11
2	5	3.27	4.18	5.12	5.32
3	**10**	**3.38**	**4.52**	**5.35**	**5.86**
4	15	3.25	4.11	4.87	5.21
5	20	3.11	4.05	4.51	4.85

So the optimum percentage of Micro Silica is 10% for all strength parameters at all ages as shown above. Fixing the Micro Silica content as 10%, the optimum content of the Jute fibers is determined using various combinations like 0.1%, 0.2%,0.3% & 0.4%and the test results are tabulated below in table no 4.10,4.11 and 4.12.

Table 4.10: Compressive Strength Values for Jute fiber Based Concrete With 10%Micro Silica

S.no	Jute fibers (%)	3 days Compressive strength (MPa)	7 days Compressive strength (MPa)	14 days Compressive strength (MPa)	28 days Compressive strength (MPa)
1	0.1	13.2	34.02	49.17	51.07
2	0.2	13.42	35.81	51.23	52.17
3	**0.3**	**14.65**	**37.26**	**59.85**	**57.09**
4	0.4	13.02	33.41	47.28	49.07

Table 4.11: Split Tensile Strength Values for Jute Fiber Based Concrete With 10% Micro Silica

S.no	Jute fibers (%)	3 days Split tensile strength (MPa)	7 days Split tensile strength (MPa)	14 days Split tensile strength (MPa)	28 days Split tensile strength (MPa)
1	0.1	1.65	2.54	3.86	4.19
2	0.2	1.88	2.75	4.22	4.66
3	**0.3**	**2.02**	**3.25**	**4.37**	**5.26**
4	0.4	1.64	2.58	3.79	4.07

Table 4.12: Flexural strength values for Jute fiber based concrete with 10% Micro Silica

S.no	Jute fibers (%)	3 days Flexural tensile strength (MPa)	7 days Flexural tensile strength (MPa)	14 days Flexural tensile strength (MPa)	28 days Flexural tensile strength (MPa)
1	0.1	3.47	4.16	5.22	6.14
2	0.2	3.46	4.26	5.41	6.25
3	**0.3**	**3.54**	**4.70**	**6.76**	**7.04**
4	0.4	3.36	4.18	5.57	6.79

From the tables 4.9, 4.9 and 4.10 represents the compressive strength, split tensile strength and flexural strength respectively. It is found that at 10% optimum Micro Silica and 0.3% addition of Jute fibers for all the strength properties are increasing with further increase the strengths are decreasing. So the optimum level of Jute fiber is 0.3% of cement content.

4.2 GRAPHS & DISCUSSIONS

4.2.1 Compressive strength Graphs and Discussions

The graphical representation and discussions of obtained results are shown below

The Compressive strength of concrete at all ages are graphically represented in Figure 4.13.

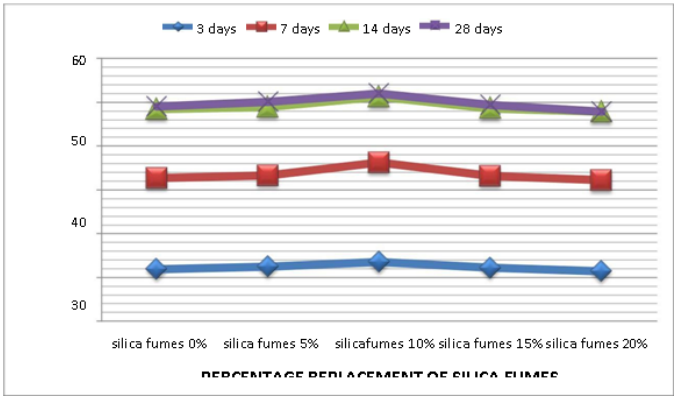

Fig 4.13: Compressive strength values for Micro Silica concrete

It is found that the compressive strength is increased at 10% of Micro Silica replacement to cement at all ages. The strength at 3 days is13.52MPA, at 7 days is 36.2MPA, 14 days is 51.28MPA and 28 days is 52.04MPA

4.2.2 Split Tensile Strength Graphs and Discussions

The graphical representation and discussions of obtained results are shown below

The split tensile strength of concrete at all ages are graphically represented in Figure 4.14.

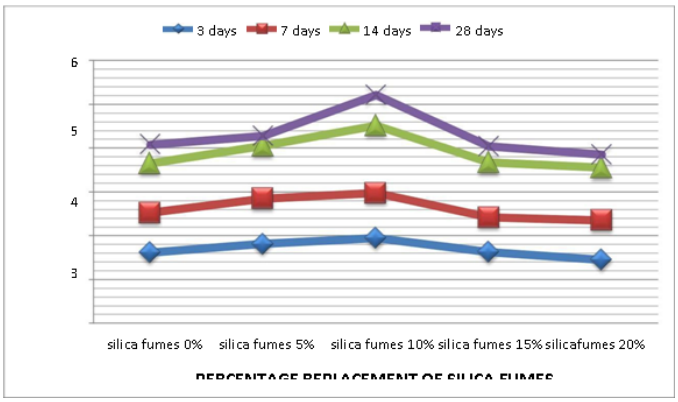

Fig 4.14: Split tensile strength values for Micro Silica concrete

It is found that the split tensile strength compressive strength is increased at 10% of Micro Silica replacement to cement at all ages. The % increase of strength at 3 days is 20MPA, at 7 days is 16.535MPA, 14 days is 15.21MPA and 28 days is 27.83MPA

4.2.3 Flexural Strength Graphs and Discussions

The graphical representation and discussions of obtained results are shown below

The Flexural strength of concrete at all ages are graphically represented in Figure 4.15

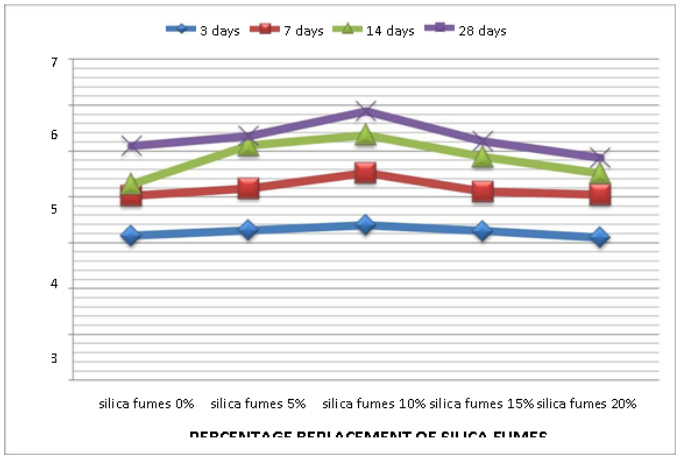

Fig 4.15: Flexural tensile strength values for Micro Silica concrete

It is found that the flexural strength is increased at 10% of Micro Silica replacement to cement at all ages. The % increase of strength at 3 days is 7.051MPA, at 7 days is 11.083MPA, 14 days is 21.271MPA and 28 days is 14.677MPA

4.2.4 Compressive strength Graphs and Discussions Addition of Jute fibers

The graphical representation and discussions of obtained results are shown below

The Compressive strength of concrete at all ages are graphically represented in Figure 4.17

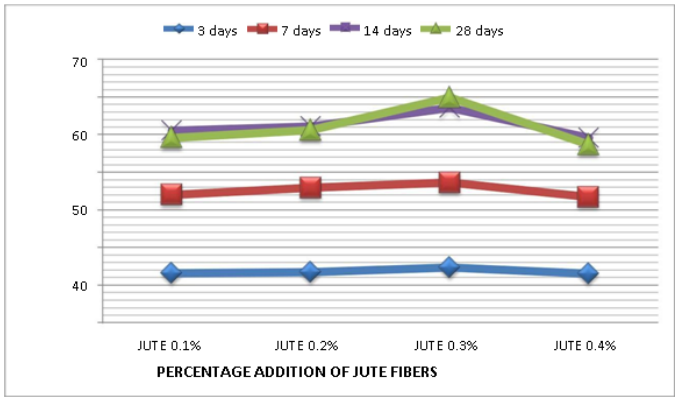

Fig 4.17: Compressive strength values for Jute fiber based concrete with 10% Micro Silica

It is found that the compressive strength is increased at 0.3% of Jute fibers replacement to cement at all ages. The % increase of strength at 3 days is 10.673MPA, at 7 days is 9.435MPA, 14 days is 21.639MPA and 28 days is 5.913MPA

4.2.5 Split Tensile strength Graphs and Discussions Addition of Jute fibers

The graphical representation and discussions of obtained results are shown below

The split tensile strength of concrete at all ages are graphically represented in Figure 4.18.

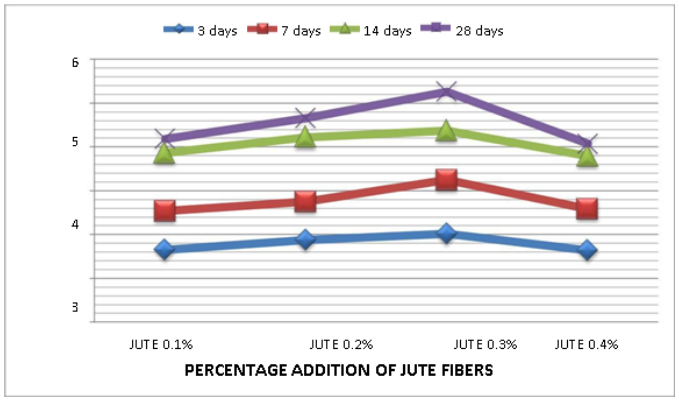

Fig4.18: Split tensile strength values for Jute fiber based concrete with 10% Micro Silica

It is found that the split tensile strength is increased at 0.3% of Jute fiber replacement to cement at all ages. The % increase of strength at 3 days is 22.280MPA at 7 days is

27.380MPA, 14 days is 11.855MPA and 28 days is25.536MPA.

4.2.6 Flexural Strength Graphs and Discussions Addition of Jute fibers

The graphical representation and discussions of obtained results are shown below

The Flexural strength of concrete at all ages are graphically represented in Figure 4.19

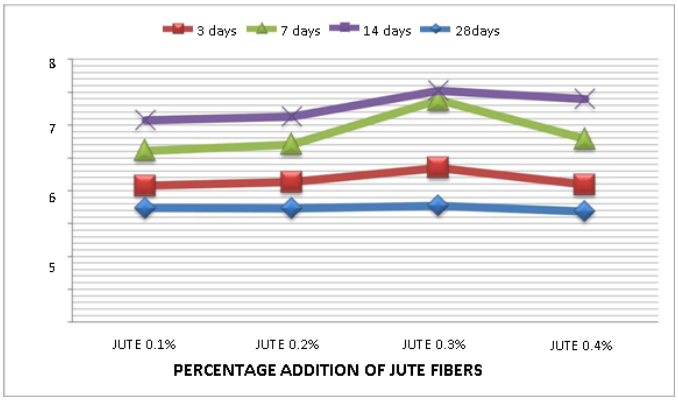

Fig 4.19: Flexural Strength values for Jute fiber based concrete with 10% Micro Silica

It is found that the split tensile strength is increased at **0.3%** of Jute fiber added to cement at all ages. The % increase of strength at 3 days is 4.985MPA, at 7 days is 14.841MPA, 14 days is 27.286MPA and 28 days is 14.542MPA

V. CONCLUSION

Micro silicon powder and jute fiber are mixed with cement concrete can well after filling in cement granular space, make the slurry more dense, it also combined with free Ca (OH), the formation of stable calcium silicate hydrates cao, the 2CaO 、SiO 2 、H 2 O, , saying a compound gel strength higher than that of Ca (OH) crystals, mainly displays in. The strength tests was conducted on cubes, cylinders, beams for Compressive Strength, Split tensile Strength and flexural Strength respectively by mixing of. Jute fiber and Micro Silica.

Based on the investigation the following conclusions Were drawn they are:

- Early strength: Silica fume concrete shortens induction period and has the characteristics of early strength.
- Increased density: 5-18 times better anti-seepage performance and 4 times more chemical resistance.
- Natural fiber (jute) is low cost, light weight and easy to obtain compared to other fibers.
- A significant increase in maximum strain was observed due to the increased ductility of natural fibers.
- As can be seen from the results, the best replacement percentage for cement using Micro Silica is 10%. When no jute fiber is added.
- Use 0.3% jute fiber and 5% to 10% micro-twist is the best combination to meet the demand.
- The use of jute reduces microcracking and permeability, which reduces maintenance costs and increases durability. It was found that the use of jute fibers reduced segregation.
- Compressive strength also shows that micro-powder powder increased by 17.06% compared to conventional concrete.
- The split tensile strength of jute fibers using Micro Silica was increased on 10% Micro Silica and 0.3% Jute fibers.
- Split tensile strength also indicates that micro-powder powder is 24% more than conventional concrete.
- The flexural strength of jute fiber using Micro Silicas increases when 10% replaces Micro Silica and 0.3% Jute fiber
- The flexural strength also shows an increment of 14.83 % Micro Silica to the conventional concrete.
- The research work on pozzolanic materials and fiber along with pozzolana is still limited. But it promises a great scope for future studies. Following aspects are considered for future study and investigation.
- Percentage and actual fineness of Micro Silicas require as partial cement replacement for good strength development.
- While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two piece geometry. But due to addition of Jute fibers in concrete cracks gets ceased which results into the ductile behavior of fibered concrete.

VI. FUTURE SCOPE STUDY

Normally we use fibers in concrete to control cracking due to both plastic shrinkage and drying shrinkage. However, when the cost factor comes into play, fiber cost is on an average three times more than reinforcing steel.

In Future we can use different grades of concrete mixes and we can do different types of tests on present study.

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