EXPERIMENTAL INVESTIGATION ON POLYPROPYLENE FIBER ADDED WITH NATURAL FIBER IN CONCRETE

[1]Zahoor Ahmad Dar Farhad, [2] Abhishek, [3]Nasir Ali
[1]student,[2]H.O. D Civil Engineering Department,[3]Asst. Prof
[1]Civil Engineering Department,
[1]Galaxy Global Group of Institutions, Ambala, India.

Abstract: Each year thousand tons' wastes are disposed on this land mainly results the degradation of the valuable land. And now a day's our resources are reduced day by day which is common process in nations like India due to increasing growth of urban cities & industrial developments involving construction of development. Currently many investigations are carried out on the using of rubber of tires, waste of plastic, bottom ash, fly ash, copper slag material, quarry dust, waste of tiles, recycled aggregate, etc. As concrete is the best and known material for engineering works. So many researches and studies are being carried in order to progress the strength, durability and quality of concrete. So many attempts are provided for the process of economization comparing with the other material. There are large numbers of fiber used in concrete like natural fibers, steel fibers, synthetic fibers, glass fibers. Lot of efforts are given to get lesser cracks and give improvements in the tensile members of the mix using steel bars and other techniques as well. In this experiment polypropylene and sisal fiber is used for this research knowing the strength behavior of the concrete. Use of Sisal and Polypropylene fiber reinforced concrete is the recent advanced research in cement concrete pavement which removes almost all sorts of the problems in cement concrete pavement. Concrete mix was prepared using same proportion of polypropylene and sisal fiber in the percentage of 0.5%, 1%, 1.5%, 2% and 2.5% for creating the polypropylene and sisal based concrete. Results indicate that compressive strength increases with increase of replacement of polypropylene and sisal fiber with cement and attain maximum value with replacement is 1.5% and then its start decreasing. Comparing the conventional concrete with added newly materials compressive strength, tensile strength, flexural strength adding polypropylene content of 1.5% to the mix increases the above strengths.

Index Terms: Polypropylene Fiber, Sisal Fiber, compressive Strength, Split Tensile Strength, Flexural Strength, Mix Design.

1.Introduction:

As concrete is the best and known material for engineering works. So many researches and studies are being carried in order to progress the strength, durability and quality of concrete. So many attempts are provided for the process of economization comparing with the other material. As we know that normal concrete has high strength and is very feeble in tension so steel reinforcement is necessary for compensating the less tensile strength of concrete with low ductility and has low resistance to cracks. But it does not satisfy to control the cracking actions and durability of the life. The best solution to boost the flexural strength and counter post cracking nature of concrete is simply to use the fibers in concrete. There are large numbers of fiber used in concrete like natural fibers, steel fibers, synthetic fibers, glass fibers. Here our research is on the rigid pavement mainly fissures are generated due the changing loadings, shrinkage and heat. So the accumulation that less spaced and equally circulated fibers in mix would plays a role as a crack resistive which considerably increase the properties of mix. And the type of fiber is called as fiber reinforced concrete.

1.1 Polypropylene fiber: Polypropylene fibers for the first time were used as mixture in 1965 in order to build blast resisting building. The use of fibers has tremendously increased construction for the reason that usage in mix achieves the stiffness, flexural, tensile strength as well as the failure which occurs in the concrete. This fiber is not expensive, richly obtained, as other artificial fibers of a invariable value [8]. This type of fiber is mainly a very new fiber which are produced in huge size and 4th major in quantity after

Polyamides, polyesters etc. This fiber is an inexpensive substance that usually provide lots of benefits physical, mechanical, electrical properties etc which we not found in any other fiber. Generally, in the market we have 2 fibers basically namely fibrillated and monofilament. Polypropylene is a fall in the category called thermoplastic substance. The structure of it is chain of monomer and its single monomer unit is propylene. It is mainly produced from the propylene gas inexistence of titanium chloride.

Table 1. Physical Properties of Polypropylene fiber

Fiber Type	Length (mm)	Diameter (mm)	Tensile Strength(MPa)	Modulus of elasticity(GPa)	Specific Surface(m2/kg)	Density (kg/cm3)
Monofilament	30-50	0.30-0.35	547-658	3.50-7.50	91	0.9
Microfilament	12-20	0.05-0.20	330-414	3.70-5.50	225	0.91
Fibrillated	19-40	0.20-0.30	500-750	5.00-10.00	58	0.95

1.2Sisal Fibers: Sisal is the lingo cellulosic plant it is also founding in America, Africa, and Asia. A sisal plant minimum creates 200-250 leaf and in the past the flowering left the including nearly 700-1400 fiber clew so that must be 0.5-1.0 m. with this leaves have 3 various fibers: design related, segment and xylem fibers. The sisal fiber making 65.8% cellulose, 12% hemi celluloses, 9.9% lignin, 0.3% wax, and these water solutions is also decided. Currently these few decades is using in various types of applications which name is ropes, carpet, twines, mats and handicraft articles and apart from this uses that creating a formation and a biogas production. Because of this better tensile strength, they are also creating a better combination with a significant polymer growing. As the sisal fiber is very low, biodegradable and eco- friendly; nowadays this using for various places. In the present time there is research and also focusing, and the formation that is using so many types of applications and that is compulsory to have few mechanical property and they should have had a stability, for a better tensile strength, low wearing properties. In the beginner researches that is revealing the fibers and growing the thickness in polymers that is increase with the strength and modulus, and that is very noticeable sisal fiber composition of combinations, and the another fiber i.e., nearly 1250 MNm-2 and its strength is 580 MNm-2. This also explaining the processing of the shape which is lees for one of the concrete with elements loss and the other realistic surface and impact on wear against by fiber the roads in Polymers.

Fig1. Sisal fiber

2. Materials and Design Mix Methods:

2.1Basic Materials

Right now, essential property of types of elements, which were utilized because of exploratory work, were distinguished. Some first performance was examining on these materials to check their physical properties and the chemical properties. The essential features of materials utilized all through the exploratory work are as given underneath:

- Cement

- Coarse material
- Sand (fine material)
- Polypropylene fiber
- Sisal fiber

2.1.1 Cement;

Ordinary Portland cement (Opc 53 Grade) (Is 8112-1989) is used for the research work. The properties and its composition are given below;

Table 2-Physical properties of cement

Initial setting time		125 min.
Final setting time		240 min.
Compressive strength	3 days	32.3 N/mm2
	7 days	41.9 N/mm2
	28 days	59.5 N/mm2
Fineness (90 um sieve)		1.7 %
Standard consistency		3.15%

2.1.2 Coarse Aggregate

Concrete is mainly consisting of cement mix and aggregate mix. In the mix of concrete mainly coarse and fine mixture makes up to 75% of the total solidify elements. Therefore, it is so significant that determines the other properties of coarse mixture. Coarse aggregate properties are mainly found through the laboratory test which is given below;

Table.3- Physical properties of Corse aggregates

Aggregate Impact Value	12.4
Aggregate Abrasion Value	16.3
Specific Gravity	2.85
Water Absorption	0.94%
Combined Flakiness Index, Elongation Index	22.9%

2.1.3Fine Aggregate

Locally available sand at the rivers used as an excellent mix. The properties of it were used to decide the distribution size of the mix. The sieve examined is conducted to determine the element size of the fine aggregate. Its features were held as per IS 2386 (part-first). The sieves sizes used for the study of fine aggregate was 4.750 mm, 2.37 mm, 1.180 mm, 600 µm, 300 µm, 150 µm, and 75µm. The result is given in the table.

Table .4-Physical Properties of Fine Aggregates

Aggregate Impact value	12.40
Aggregate Abrasion Value	16.31
Specific Gravity	2.851
Water Absorption	0.94%
Combined Flakiness Index, Elongation Index	22.90%

2.1.4Polypropylene Fiber

The materials of the above fiber are taken from the monomeric units which is simply hydrocarbon. The specific gravity of the fiber is 0.91. The External appearance of fibers is white C. The fiber which are taken generally have a diameter of 30-35microns. The material tensile strength here is 0.67KN/mm^2. Young modulus of elasticity is 4.0KN/mm^2. Absorbency is <0.1%Its fiber cut length is12mm.

2.1.5Sisal fibers

These were added in varying percentage, such as 0%, 0.5%, 1%, 1.5%, 2% and 2.5%.

2.2Design Mix Methods

Table 5. Mix proportioning

Mix No.	W/C ratio	Cement (kg/m^3)	Polypropylene fiber, %	Sisal fibre, %	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)
M - 1	0.45	395	0%	0%	593	1185
M – 2	0.45	391.05	0.5%	0.5%	593	1185
M – 3	0.45	387.1	1%	1%	593	1185
M – 4	0.45	383.15	1.5%	1.5%	593	1185
M – 5	0.45	379.2	2%	2%	593	1185
M – 6	0.45	375.25	2.5%	2.5%	593	1185

2.3Specimen Detailing

Table. 6-Total number of specimen for experiment

Mix No.	W/C	Polypropylene fiber	Sisal fibre	Cement	Cube	Cylinder	Beam
1.	0.45	0%	0%	100%	6	6	6
2.	0.45	0.5%	0.5%	99%	6	6	6
3.	0.45	1%	1%	98%	6	6	6
4.	0.45	1.5%	1.5%	97%	6	6	6
5.	0.45	2%	2%	96%	6	6	6
6.	0.45	2.5%	2.5%	95%	6	6	6
Total Specimen = 108							

3Results & Discussions

3.1Compressive Strength

By the replacement of polypropylene and sisal fiber in mix compressive strength was increase up to 1.5% replacement and then after its start to decrease up 2.5% replacement. Compressive strength increases up 5.39% by replacing cement content with polypropylene fiber & Sisal fiber.

Table.7--Results of Compressive Strength

Mix No.	7 days (N/mm^2)	28 days (N/mm^2)	Hasan et. al. (2019)
M - 1	22.80	36.50	35.42
M – 2	23.17	36.70	45.12
M – 3	23.34	37.30	32.24
M – 4	24.14	38.47	15.25

M – 5	24.00	37.90	11.36
M – 6	23.43	36.60	-

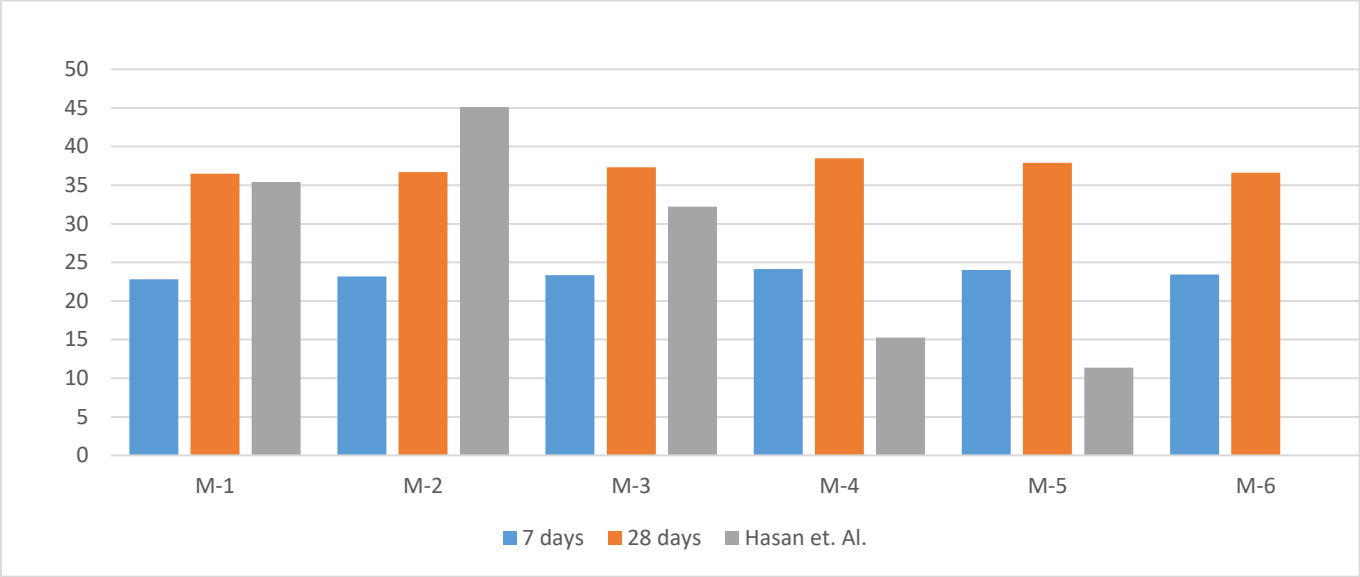

Fig .2. Compressive Strength

3.2 Split Tensile Strength

By the replacement of polypropylene and sisal fiber in concrete tensile strength was increase to 1.5% replacement and then after its start to decrease up to 2% to 2.5% replacement. Split strength increase up to 5.60 % by replacing 1.5% of cement with polypropylene fiber and sisal fiber.

Table.8—Split tensile strength results

MixNo.	7 days (N/mm^2)	28 days (N/mm^2)	Hasan et. al. (2019)
M - 1	2.76	4.10	3.5
M – 2	2.83	4.26	3.56
M – 3	2.86	4.30	3.68
M – 4	2.95	4.33	2.05
M – 5	2.90	4.31	1.85
M – 6	2.80	4.20	-

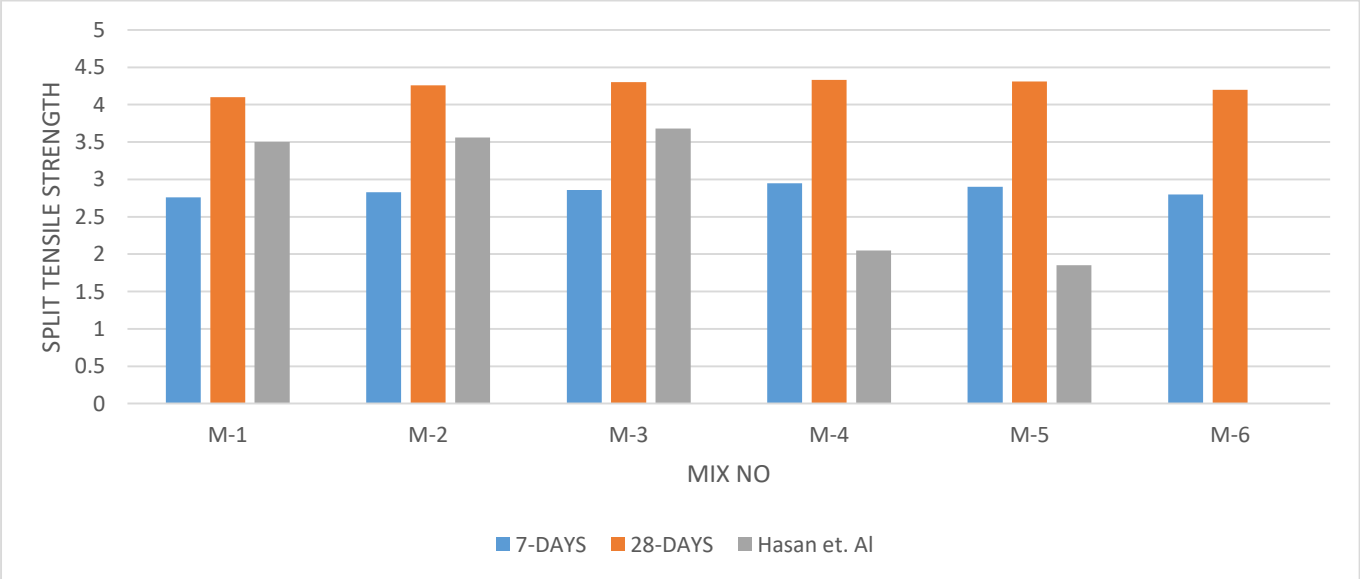

Fig.3.Split Strength Results

3.3Flexural Strength Results

By replacing polypropylene fiber in mix flexural strength was increase up to 1.5% replacement and then after its start to decrease up to 2% to 2.5% replacement. Flexural strength increases up to 48.49 % by replacing 1.5% of cement content with PP fiber and sisal fiber.

Table.9--Results of Flexural strength

Mix No.	7 days (N/mm^2)	28 days (N/mm^2)	Hasan et. al. (2019)
M - 1	3.96	4.31	4.52
M– 2	3.88	5.70	4.36
M – 3	4.00	6.00	4.12
M – 4	4.40	6.40	4.03
M – 5	4.14	6.20	1.12
M – 6	4.00	6.00	-

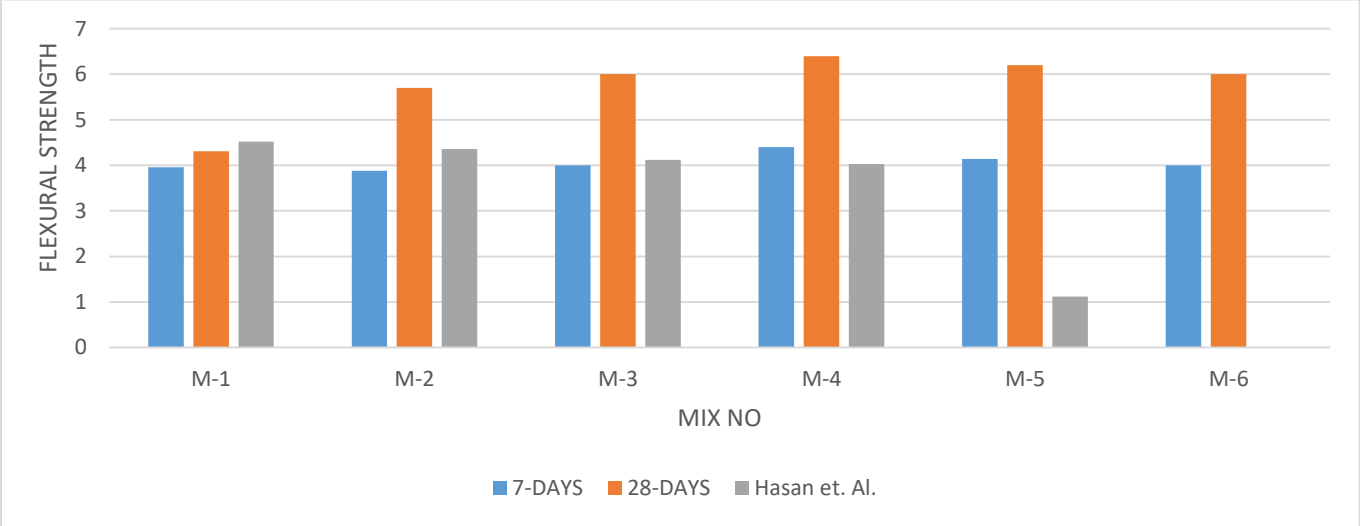

Fig.4. Flexural Strength

4. Conclusion

1. Compressive strength increase with increased of replacement of polypropylene and sisal fiber with cement and attain maximum value with replacement is 1.5% and then its start decreasing.
2. Compressive strength increases up to 5.39% when cement is replaced with polypropylene and sisal fiber at1.5%.
3. Tensile strength increase with increased of replacing of polypropylene and sisal fiber with cement and attain maximum value with replacement is 1.5% and then its start decreasing.
4. Tensile strength increases up to 5.60 % when cement is replaced with polypropylene and sisal fiber at 1.5%.
5. Flexural strength increase with increased of replacement of polypropylene and sisal fiber with cement and attain maximum value with replacement is 1.5% and then its start decreasing.
6. Flexural strength increases up to 48.49% when cement is replaced with polypropylene and sisal fiber at 1.5%.
7. Comparing the conventional concrete with added newly materials compressive strength, tensile strength, flexural strength adding polypropylene content of 1.5% to the mix increases the above strengths.
8. While replacing cement with polypropylene and sisal fiber, achieved increase the strength at optimal dosage 1.5 %, which reduced consumption of cement up to some extent.

9. It is notable that increase in strengths is mainly because of using of polypropylene and sisal fiber content in the mix proportions.
10. The problem to overcome low tensile strength of concrete is mainly done by adding polypropylene and sisal fiber in the mix.
11. Polypropylene and sisal fibers reduce the water permeability, shrinkage, settlement to the mix.

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