International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

Effect of Different Percentages of Polypropylene Fibre (Recron 3s) on the Compressive, Tensile and Flexural Strength of Concrete

Ridha Nehvi, Prashant Kumar and Umar Zahoor Nahvi*
Sharda University Greater Noida
*IIT Delhi

***Abstract* - This paper describes the enhancement in the strength of the M35 grade concrete mix by the addition of Polypropylene fibres (recron 3S) in the proportion of 0.0%, 0.1%, 0.2%, 0.3%, 0.4%, and 0.5% by volume of concrete were used in the. The tests were carried out to determine the mechanical properties of concrete upto 7, 14 and 28 days for compressive strength, split tensile strength and flexural strength. Slump test were carried on fresh concrete while compressive strength, split tensile strength and flexural strength were carried on hardened concrete. The slump test results conclude that the workability of the polypropylene fibre mixes goes on decreasing as the fibre content is increased in the concrete mix.0.3% rcron3 s improved tensile strength of concrete from 2.65MPa to 3.4MPa and flexural strength from 5.13MPa to 6.83MPa after 28 days of curing. Increase in concentration of recron 3s beyond 0.3% showed decline in flexural strength from 6.83MPa to 5.7MPa.**

i. INTRODUCTION:

Concrete is not normally designed to resist direct tension. Principal tensile stresses may also result from multi-axial states of stress. Concrete without any fibers will develop cracks due to plastic shrinkage, drying shrinkage and changes in volume of concrete. Normally cracking in concrete occurs when tensile strength exceeds its limiting value.

There are two ways to resist this low tensile strength - by using reinforcement or by pre-stressing

Modern reinforced concrete can contain varied reinforcing materials made of steel, polymers or alternate composite material in conjunction with rebar or not. Reinforced concrete may also be permanently stressed (in compression), so as to improve the behavior of the final structure under working loads.

Polypropylene fibre has been one of the most successful commercial applications. Recron 3s is the New Generation "Secondary Reinforcement" for Construction Industry. Today, concrete is used in a variety of innovative designs because of its many valuable properties such as high compressive strength, stiffness, low thermal and electrical conductivity and low combustibility and toxicity. The recent development of Secondary reinforcement in Concrete in various fields has provided a strong technical base for improving these deficiencies. Recron 3s improves homogeneity of the concrete by reducing segregation of aggregates. It reduces shrinkage cracks/micro cracks, increases abrasion resistance by more than 25% and increases impact and shatter resistance by 100%. The ductility, compressive, tensile and flexural strengths are increased thereby reducing water permeability which helps in preventing correction of primary steel(Praveen and Ankit Sharma ,2013).Therefore present study was carried to determine the suitable percentage of polypropylene (recron 3s) in concrete

ii. LITERATURE REVIEW:

Praveen and Ankit Sharma (2013) suggested that the effect of variation of polypropylene fibres ranging from 0.1% to 0.4% along with 0.8% steel fibres on the behavior of fibrous concrete. The mechanical properties of the concrete such as compressive and tensile strength were investigated. The result showed that addition of polypropylene fibre has a little effect on the compressive strength, but there was significant increase in the tensile strength with increase in fibre volume fraction. Investigation revealed an increase of 47% of split tensile strength and 50% of flexural strength.

Prasad *et al.* (2013) investigated the workability and flexural strength of cement concrete containing silica fume and polypropylene fibers. Properties they studied include workability of the fresh mix and flexural strength of hardened concrete. Silica fume content used was 0%, 5%, 10% and 15% by replacement of equal weight of cement in concrete. Polypropylene fibers were added in 0%, 0.20%, 0.40% and 0.60% by volume fraction of concrete. The experimental test results demonstrated that addition of polypropylene fibers at 0.4% volume fraction showed considerable gain of flexural strength of 4.95 MPa and 7.32 MPa at 7 and 28 days respectively. The behavior of concrete under flexural loads was found to be consistently improved compared with reference mix design. The results showed that the use of 10% silica fume combined with 0.40% fiber volume fraction results in optimum mixture design for applications from the standpoints of workability and flexural strength.

Gurunaathan (2014) studied strength of concrete cubes and cylinders cast using M40 grade concrete and reinforced with recron3s, polypropylene fibers and mineral admixtures. Also, hybrid fibers with recron3s and polypropylene have been used in concrete matrix to study its impact on strength and durability properties. The recron3s, polypropylene and hybrid [polypropylene and recron3s fibers of various proportions i.e., 1% of recron3s

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

fiber, 1% of polypropylene fiber (Boasee fiber) and 1% of hybrid fibers each of 0.5% by volume of cement with admixtures of 1% by weight of cement have been used in concrete mixes. The results obtained were analyzed and compared with the control specimen (0% fiber). It clearly shows the compressive strength values for M40 grade without and with fibers. The addition of polypropylene fibers, recron3s fibers into the fly ash and silica fume in different concrete mixes marginally improve the compressive strength at 28 days. The recron3s fiber, polypropylene fiber (Boasee fiber), admixtures are used in concrete to give more compressive strength, split tensile strength when compared to that of nominal concrete. There is an increase from 3% to 9% in split tensile strength for all fiber mixes when compared with that of control mix.

Muhammad Nawazish Husain and Praveen Aggarwal (2015) used Recron 3S to check the usefulness of Recron 3S fibre in improving soil subgrade strength of local silty soil of Kurukshetra. For this purpose a series of experiments were conducted which include Modified Proctor Compaction, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) tests. A total of four samples of soil - fibre mixture were made with fibre content as 0.15%, 0.30%, 0.45% and 0.60% of dry weight of soil. Other tests for index and physical properties like Atterberg limits, Specific gravity and sieve analysis of parent soil were also carried out. Experimental results revealed that addition of Recron 3S fibre increases the CBR and UCS value of the silty soil. It was evident from the results that Recron 3S fibre helped in improving soil subgrade strength of silty soil. CBR test results revealed that CBR value of untreated soil increased from 3.50% to 20.2% with addition of 0.15% Recron 3S fibre. It was also observed that addition of further Recron 3S fibre to the soil in the quantity of 0.30%, 0.45% and 0.60% of dry weight of soil very little further increased the CBR value.

iii. MATERIALS AND METHODS:

The present study was carried out at concrete lab, Department of Civil Engineering, Sharda University, Greater Noida during 2015-16.

1. *Materials Used*

Cement: Ordinary Portland cement of grade 43 confirming to IS 8112-1989 was used. The specific gravity of cement was calculated using Specific Gravity Bottle and was found out to be 3.26

Aggregate material used

Fine aggregate: Natural river sand of size 4.75mm and below confirming to zone 3 of IS 383-1970 were used as the fine aggregate. Following tests were being carried out (Table Natural river sand of size 4.75mm and below confirming to zone 3 of IS 383-1970 was used as the fine aggregate. Following tests were being carried out (Table 1).

Table1: Properties of fine aggregates

Properties	Fine aggregate
Specific gravity	2.65
Water absorption	1.50%

Coarse aggregate

Natural crushed stone with 20 mm size and 10 mm size were used as coarse aggregate. Tests of specific gravity, free surface moisture, water content and water absorption were carried out (Table 2 & 3).

Table 2: Properties of coarse aggregates (20mm)

Properties	Coarse aggregate (20mm)
Specific gravity	2.45
Free surface moisture	1.976
Water absorption	1%
Water content	1.4%

Table 3: properties of coarse aggregates (10mm)

Properties	Coarse aggregate (10mm)
Specific gravity	2.36
Free surface moisture	0.028
Water absorption	0.65%
Water content	1.38%

Water Ordinary portable water was used in this investigation both for mixing and curing.

Recron 3s:

Recron 3s fibre was procured from Kunal Conthem Pvt Ltd Faridabad, Haryana. The diameter of the recron 3s fibre ranged between 34 micron with length of 12mm and having approximate 320 as aspect ratio. Table 4 shows the test results of basic properties of polypropylene fibre.

Table 4: Basic properties of polypropylene fibre (Recron 3s)

S.NO	Property	Value
1.	Diameter	0.4mm
2.	Cut Length	6mm or 12mm
3.	Tensile Strength	4000-6000kg/cm^2
4.	Melting point	>250oc
5.	Elongation	50-70%
6.	Dispersion	3-4
7.	Shape of fiber	Special triangle shape

Concrete Mix Design

Mix proportion used in this study was 1:1.76:3.177 (M35) with water-cement ratio of 0.40.

2. Methods used

Batching and Mixing of Materials

Weight batching and machine mixing are adopted in this study for concrete production. The percentage of fibers and material weight are shown in Table 5.

Table 5: Mix proportions per cubic meter for compressive strength, tensile strength and flexural strength of concrete

Mix	Polypropylene fibre (kg)	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (kg)
Control mix	0.0	400	704	1271	160
0.1% P.F	0.006	400	704	1271	160
0.2% P.F	0.012	400	704	1271	160
0.3% P.F	0.018	400	704	1271	160
0.4% P.F	0.025	400	704	1271	160
0.5% P.F	0.031	400	704	1271	160

Casting of Specimens:

For compressive strength of concrete, cubes were casted and the mixing was done by hand. For each proportion 9 cubes of each of size 150*150*150mm were casted. Mixing was done by adding coarse- aggregates, followed by 25% of total water. Then fibers and sand was added with 25% of remaining water. After thoroughly mixing of aggregates, cement was added and remaining 50% of water was added. For each mix slump test was conducted to measure workability. Totally 33 cubes were casted including the cubes for control mix and the fibre reinforced concrete. After the mixture was prepared it was compacted on a vibration table. Remolding was done after 24 hours of casting. Specimens were cured in curing tank. Water immersion method of curing was adopted. Cubes were cured for 7, 14, 28 days.

For tensile strength of concrete, 54 cylindrical moulds were casted and the mixing was done by hand. For each proportion 9 cylindrical moulds of size 30cm in length and 7.5 cm in diameter were casted. Mixing was done by adding coarse-aggregates, followed by 25% of total water. Then fibers and sand is added with 25% of remaining water. After thoroughly mixing of aggregates, cement was added and remaining 50% of water was added. Total 33 cylindrical moulds were casted including the cylindrical moulds for control mix and fibre reinforced concrete. Remolding of the cylindrical moulds was done after 24 hours of casting. Specimens were cured in the curing tank. Water immersion method of curing was adopted. Cylindrical moulds were cured for 7, 14, 28 days.

For flexural strength of concrete, 54 beams were casted and the mixing was done by hand. For each proportion 3 beams of size were casted. Mixing was done by adding coarse-aggregates, followed by 25% of total water. Then fibers and sand was added with 25% of remaining water. After thoroughly mixing of aggregates, cement was added and remaining 50% of water was added. Total 33 beams were casted including the beams for control mix and fibre reinforced concrete. Remolding of the beams was done after 24 hours of casting. Specimens were cured in the curing tank. Water immersion method of curing was adopted. Beams were cured for 7, 14, 28 days.

Testing of Specimen

Compressive strength test were carried on cubes whereas split tensile strength test was carried on cylinders and flexural strength test on beams. The compressive strength and split tensile strength tests were done in the compressive testing machine and the flexural strength test was carried out in the universal testing machine.

iv. RESULTS AND DISCUSSIONS

The concrete slump test is an empirical test that measures workability of fresh concrete. The test measures consistency of concrete in that specific batch. It is performed to check consistency of freshly made concrete. The simplicity of the test often allows a wide variability in the manner in which the test is performed. The slump test is used to ensure uniformity for different batches of concrete under field conditions, and to ascertain the effects of plasticizers on their introduction.

The slump test results obtained from the fresh concrete mixes are presented in Figure 1. Results reveal that concrete without fibre recorded maximum slump value (83mm) where as concrete with 0.1% recron 3s recorded the highest slump value (70mm) followed by 0.1% (56mm). The slump test results conclude that the workability of the polypropylene fibre mixes goes on decreasing as the fibre content is increased in the concrete mix.

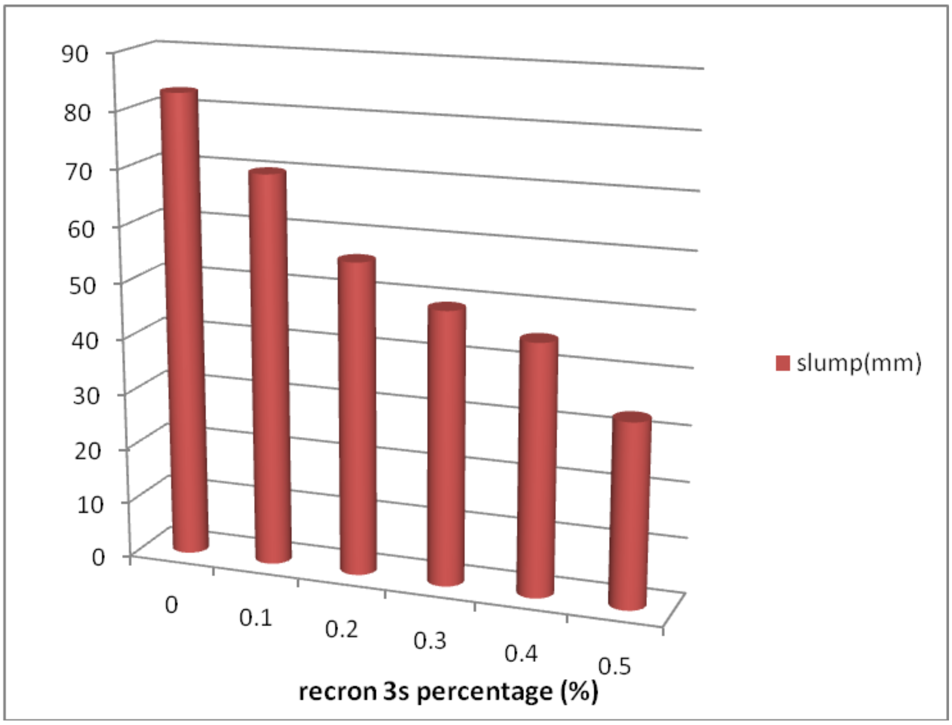

Fig 1: Slump values for different percentages of polypropylene fibre in a concrete mix.

If the material compresses and shortens it is said to be in compression. On an atomic level, the molecules or atoms are forced apart when in tension whereas in compression they are forced together. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a uniaxial tensile load, a uniaxial compressive load was applied. As can be imagined, the specimen is shortened as well as spread laterally. The effect of different percentages of recron 3s fibres on compressive strength of concrete is presented in Table 6 and Figures 2. The compressive strength of concrete goes on increasing with an increase in the fibre content of the concrete mix in 7days, 14days and 28 days.

After 7 days conventional concrete recorded a compressive strength of 21.3MPa whereas after 14 days it got enhanced to 29.5MPa and it was observed to be 32.5MPa after 28 days .Study confirmed that best compressive strength is achieved after 28 days of curing. With increase in concentration of recron 3s from 0.1% to 0.5% the average compressive strength got enhanced from 29.4MPa to 35.6MPa showing an increase of 28%. Maximum strength to the tune of 40.1MPa was recorded after 28 days in concrete mix blended with 0.5% recron 3s recording an increase of 23.4% over conventional concrete whereas after 7 days the increase in compressive strength was achieved to the tune of 37%.

Table 6: Effect of different levels of recron 3s (%) on compressive strength after 7 days,14 days and 28 days curing.

S.No	Percentage Of Recron 3s (%)	Compressive Strength (MPa)			Average Compressive Strength (MPa)
		7 days	14 days	28 days	
1.	0	21.3	29.5	32.5	27.8
2.	0.1	23.95	30.6	33.7	29.4
3.	0.2	25.8	32.3	34.5	30.8
4.	0.3	26.1	33.13	36.45	31.9
5.	0.4	28.83	35.1	38.03	33.9
6.	0.5	29.19	37.4	40.1	35.6

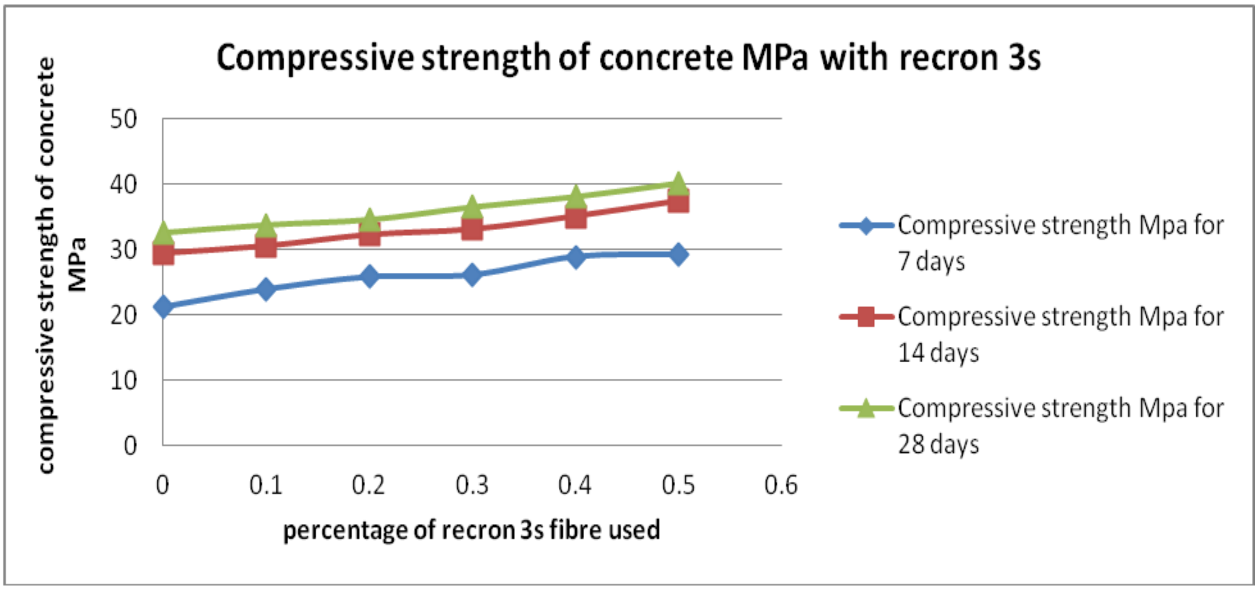

Fig 2: Comparative study on Compressive strength (MPa) of concrete with recron 3s reinforcement after 7days, 14days and 28 days of curing.

Tensile strength is the resistance of a body to elongation. It is the maximum longitudinal stress a material can bear with fracture or permanent deformation. It is also known as tension. Tensile strength is in important property because concrete structures are highly vulnerable to tensile cracking due to various kinds of effects and applied loading itself. However, the tensile strength of concrete is very low as compared to the compressive strength. Therefore fibres are being added to the concrete to help it resist the direct tensile stresses and hence prevent cracking at very low stresses. Perusal of Table 7, and Figures 3 revealing impact of different concentration of recron 3s on tensile strength of concrete exhibited significant superiority of 0.3% recron 3s in improving tensile strength of concrete from 2.65MPa to 3.4MPa showing an increase of 28.3 % over conventional concrete. Increase in concentration in recron 3s (>0.3%) revealed negative impact on average tensile strength and recorded decline by 47%. Study confirmed that concrete mixed with 0.5% recron 3s exhibited lowest average tensile strength (2.31MPa) compared to plain concrete (2.65MPa). 28 days curing recorded maximum tensile strength irrespective of different levels of recron 3s. Maximum tensile strength after 28 days (3.61MPa) was recorded with 0.3% recron 3s showing an increase of 16.4% over plain concrete.

Table 7: Effect of different levels of recron 3s (%) on tensile strength after 7 days,14 days and 28 days curing

S.No	Percentage of recron 3s used in M35 grade of concrete (%)	Tensile strength of concrete MPa recorded			
		7 days	14 days	28 days	Average tensile strength (MPa)
1.	0	2.03	2.82	3.1	2.65
2.	1	2.16	3.02	3.14	2.8
3.	2	2.35	3.14	3.41	3.0
4.	3	2.58	3.28	3.56	3.14
5.	4	2.21	3.09	3.48	2.93
6.	5	2.05	2.11	3.01	2.4

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 11, November-2016

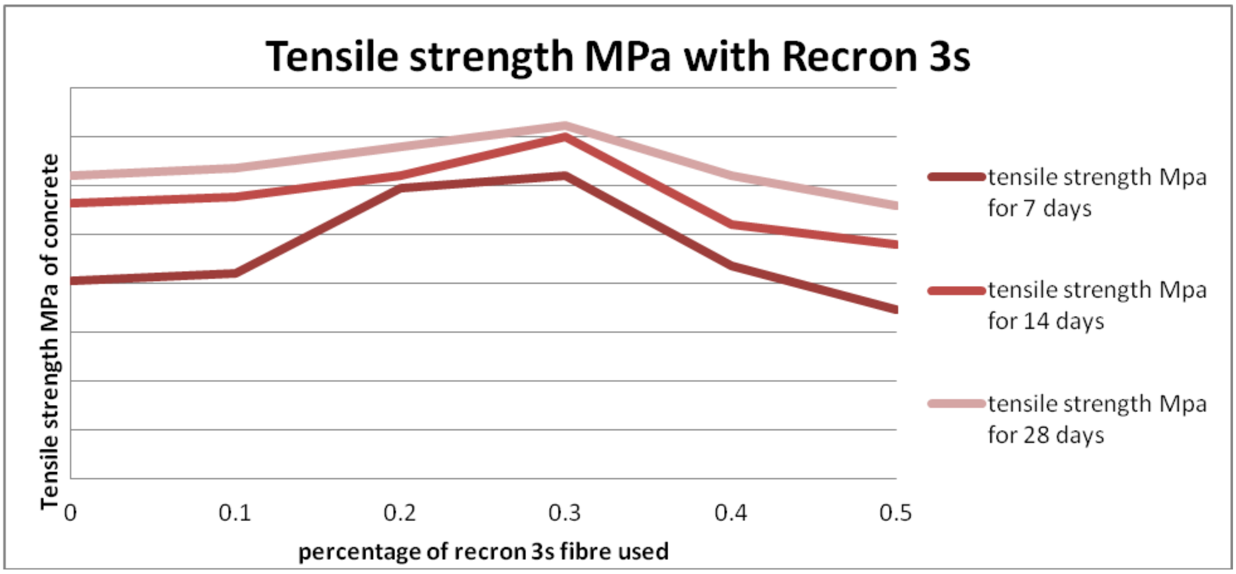

Fig 3: Comparative study on Tensile strength (MPa) of concrete with recron 3s reinforcement after 7days, 14days and 28 days of curing

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength, a material property, defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. Flexural strength MPa after 7days, 14days and 28 days for concrete mix blended with different levels of recron 3s are presented in Table 8 Figures 4 Highest flexural strength of concrete (6.83MPa) was recorded with 0.3% recron 3s compared to conventional concrete mix showing an average flexural strength of 5.45MPa. Best combination recorded an increase of 25.32% in flexural strength. Highest value of flexural strength (8.25MPa) was recorded with 0.3% recron 3s after 28 days that arouse from 5.13MPa observed after 7 days. Increase in concentration of recron 3s beyond 0.3% showed decline in flexural strength from 6.83MPa to 5.7MPa.

Table8: Effect of different levels of recron 3s (%) on flexural strength after 7 days, 14 days and 28 days curing

S.No	Percentage of recron 3s used in M35 grade of concrete (%)	Flexural strength of concrete MPa recorded			
		7 days	14 days	28 days	Average flexural strength (MPa)
1.	0	4.85	5.51	6.01	5.45
2.	0.1	4.98	6.06	6.66	5.9
3.	0.2	5.11	6.86	7.02	6.33
4.	0.3	5.13	7.1	8.25	6.83
5.	0.4	4.7	6.4	7.15	6.08
6.	0.5	4.5	6.04	6.78	5.7

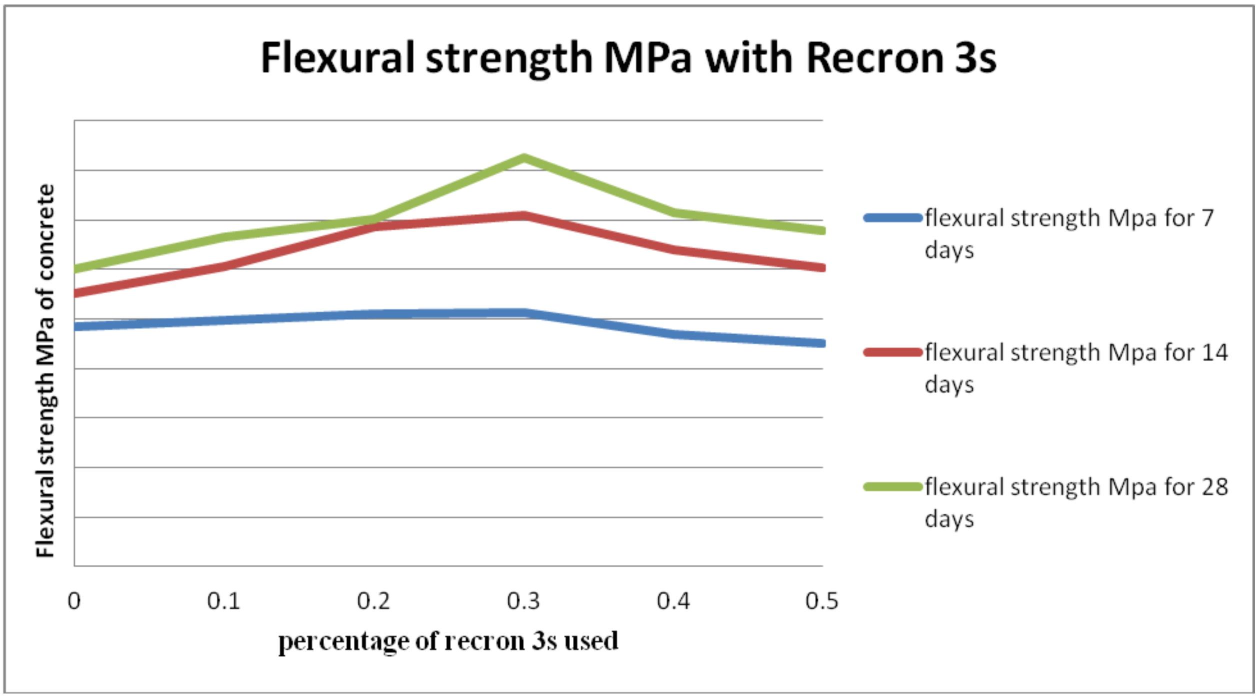

Fig 4: Comparative study on Flexural strength (MPa) of concrete with recron 3s reinforcement after 7days, 14days and 28 days of curing.

CONCLUSION:

1. The workability of the fibre reinforced concrete has been found to decrease with an increase in the concentration of recron 3s fibre in the concrete mix.
2. Recron 3s recorded positive influence on enhancing compressive, tensile and flexural strength with superiority of 0.3% recron 3s.
3. 28 days curing recorded maximum strength irrespective of different levels of natural and artificial fibres under study.
4. Study revealed significant superiority of 0.5% recron 3s exhibiting highest compressive strength of 40.1 MPa after 28 days of curing with an average strength of 35.6MPa. 3% Recron 3s was observed to improve compressive strength by 23.38% after 28 days of curing.
5. Study of conventional concrete mix viz-a-viz concrete mix blended with artificial fibres revealed superiority of fibres in improving the tensile strength. For recron 3s there has been constant increase in average tensile strength up to 0.3% to the tune of 16.45% after 28 days.
6. Study of conventional concrete mix with concrete mix reinforced using fibres revealed superiority of 0.3% recron 3s showing an increase of flexural strength by 37.27% after 28 days of curing
7. Incorporation of Recron 3s fibre in concrete enhances the continuity and integrity of concrete thereby increasing long-term tensile strength, which is beneficial to the safety and durability of concrete structures.
8. The addition of a low volume fraction of recron 3s fibres inhibits micro cracking, bleeding and increase cement hydration in fresh concrete, thereby reducing surface permeability and reduction in formation and growth of micro cracks in concrete. Hence, it offers low permeability which in turn contributes to better durability and corrosion resistance.
9. Usage of recron 3s fibers will reduce the cost of maintenance by reducing the micro-cracks and permeability and hence the durability will increase. It is found that use of recron 3s fibre reduces the segregation

LITERATURE SITED:

[1] Praveen and Ankit Sharma.2013."Structural Behavior of Fibrous Concrete Using Polypropylene Fibers", International Journal for research in applied sciences and engineering technology..3(3) pp-1279-1282.

[2] Prasad, M., Rajive, C and Grover, Rakesh.2013.A comparative study of polypropylene fiber reinforced silica fume concrete with plane cement concrete. International Jr of engineering research and science & technology. 12(4):127-136.

[3] Gurunaathan,K., Seenibasan,G. and Thirugnanam,G.S.2014.Experimental study on strength and durability properties of fiber reinforced concrete. Proceedings Of The Int Conference on Advances In Civil, Structure and Mechanical Engineering.

[4] Muhammad Nawazish Husain and Parveen Aggarwal.2014. "Application of recron 3s fiber in improving silty subgrade behavior IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE).12(2). e-ISSN: 2278-1684, p-ISSN:2320-334X,"