Jurnal Kejuruteraan 34(3) 2022: 429-445
https://doi.org/10.17576/jkukm-2022-34(3)-10

Experimental Analysis for Performance of Concrete with Addition of Steel Fibres, SBR and Polypropylene Fibres

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Received 28 May 2021, Received in revised form 5 September 2021
Accepted 3 October 2021, Available online 30 May 2022

ABSTRACT

Sufficient experimentation is observed in literature to examine the brittle behaviour of concrete. Presently, addition of different modified polymer and fibres can be treated as an effective way for improving the behaviour of concrete. Steel fibres are now generally mixed with concrete as because of such fibres sufficient strengths are gained. Fibre Reinforced Concrete acquires high stiffness, strength and durability subjected to different environment. In this experimental investigation it is mixed steel fibres with concrete with various percentages (0.35% to 0.85%) with addition of Polypropylene fibre. The primary objective is first to check whether the employment of steel fibres allows the improvement in strength. Next objective is to verify the effect of a mixing of steel fibres and modified polymer namely SBR. The third objective of the present study deals with the combination of steel fibres with synthetic polypropylene fibres in varying percentages. Preparation of specimen is performed in lab for different contents% of styrene butadiene rubber polymer with the hooked end SF. The experimental program includes cube, cylinder and beam specimens with fabricated in 1% to 10% steel fibres. Further 15% modified polymer-SBR is added in the different mixes. After this 0.15% to 0.25% polypropylene is mixed to M30 and M40 grade of concrete. The volume fraction for fibre having 100 kg/m3 of steel fibres (1.27% Vf) may be effectively employed. It is seen that by varying the %contents of SF's and SBR; strong bond is developed leading to bridge of micro cracks by the polypropylene in RC members.

Keywords: Steel fibres, SBR, polypropylene fibres, flexure strength.

INTRODUCTION

Sufficient research is done on concrete with addition of different fibres over the few decades. Indeed, Un-reinforced cement materials are mostly used for common type of construction. As brittle concrete are prone to cracking when subjected to excessive deformation. This lacuna is overcome by proving the steel reinforcements on tension side to counteract bending stresses induced in structural members. Steel fiber/reinforcement generally imparts the tensile strength to the RC elements but under service loads concrete shows some cracks. Hence it becomes necessary to improve concrete behavior under flexure and tension. Under diverse loading condition use of hybrid fibres may be treated as effective way to enhance RCC performance. It is observed that by using fibre/volume fraction in between 0.25 to 0.50% the flexure strength is greatly enhanced. Some other researchers have given the same conclusion based on use of hybrid and combination fibres. The shear resistance of beams without stirrups may also be improved by such hybrid fibres. With increasing the fibre's volume the nominal stress and the ultimate shear strength can be sufficiently gained. Under fire resistance, a combined steel fibres, Styrene Butadiene Rubber (SBR) and polypropylene fibres in proper percentage effectively used for spalling prevention leading to avoid macroscopic damage.

Different cementatious materials with its uses; Cook and Uher (1974) studied the performance of FRC under thermal conductivity effects. Berke and Dallaire (1994) observed the influence of mixing lighter rate of polypropylene fibre on structural properties of concrete due to which on plastic shrinkage cracks are reduced. Fracture due to bending and Fatigue resistance with addition of Steel-Fibres in RC Structures is investigated by Chang and Chai (1995). Steel FRC- Fiber reinforced concrete and its influence on different manufacturing technologies varies depending upon fibre content and is given by Tountanji and Bayasi (1997). Steel fibre's as a reinforcement is effective at low temperatures under flexural behavior which is stated by Pigeon and Cantin (1998). Nataraja et al (1999) predicted exact stress-strain curve for SFRC subjected to compressive loading. Khuntia et al (1999) studied shear properties of high-strength FRC beams with and without stirrups in comparison to that of normal beams. Vandewalle et al (2001) provided test and design methods for steel fibre reinforced concrete under uni-axial tension test. Kwak et al (2002) also showed the effect of shear strength of steel fibre-reinforced concrete beams without stirrups. Balaguru and Najm (2004) emphasized on behaviour of FRC with its mixture proportions for which they considered high fibre volume fractions. Lau and Anson (2006) worked on high performance SFRC under the influence of excessive temperatures.

Japan Concrete Institute Standard (2006) provides the procedures for BM curve of FRC. Dancygier and Savir (2006) observed bending behaviour of High Strength FRC considering the lesser reinforcement proportion. Dinh et al (2010) put forth shear strength capacity of SFRC beams without stirrups. Li et al (2010) observed the enhancement in properties due to substitution of polymer modified fibres. Kang et al (2011) observed the characteristics like bending strength due to fibre distribution with ultra high strength concrete. Soutsos et al (2012) worked on FRC made with steel and synthetic fibres to study the flexural performance. Minelli and Plizzari (2013) provided that SF as shear reinforcement can be effectively used. Chalioris (2013) tested SFRC beams undergoing cyclic deformations leading to shear force. di Prisco et al (2013) also studied FRC and its improved properties. Fib Model Code 2010 principles, models and test validation are also given. Wankhade and Landage (2013) provided some work on NDT of RC structures. Buendia et al (2013) gave the properties and use of synthetic polypropylene fibres for RCC structures. Wille et al (2014) examined tension behaviour of UHPFRC under ultra strain hardening.

Kaikea et al (2014) employed combined mineral admixtures and SF for FRC concrete. Jen et al (2016) put forth self consolidating hybrid FRC to understand composite behaviour and its properties. Lee et al (2016) experimentally studied the flexural behaviour of concrete with addition of macro type polypropylene. Wankhade et al (2016) presented a combination of SBR and steel fibres to affect concrete property and its advantages. Amin and Foster (2016) examined shear capacity of SFRC beam with stirrup as a shear reinforcement. Lee et al (2017) observed bending behavior of FRC for concrete strength and fibre volume. Yermak et al (2017) observed effectiveness of SF and polypropylene fibres on the characteristics of concrete under excessive thermal environment to examine different structural properties which includes spalling and transfer. Yoo and Banthia (2017) worked on structural characteristics of UHPFRC subjected blast and impact loading. Li et al (2018) evaluate comparative behaviour of SF and high performance polyethylene fibre reinforced concrete slabs with wire mesh under blast loading. Yoo and Moon (2018) gave influence of steel fibres on the flexural characteristics of RC beams with lesser R/F ratio. Nguyen et al (2018) designed carbon fibre as a multiphase reinforcement using topology optimization to reduce cracks. Doan et al (2019) also enlightened the design of buckled constrained material structural optimization and its aspects.

OBJECTIVE OF RESEARCH

This study aims at the employment of combined steel fibres, SBR and Polypropylene fibres to study the flexure capacity of concrete beams. Various percentages of these fibres are taken to verify experimentally the performance of concrete. The main motive was at first to check whether the implication of steel fibres imparts the betterment in compression and flexural strength. The second objective is to examine the effect of a combination of steel fibres and modified polymer namely SBR. The third objective of the present study deals with the combination of steel fibres with synthetic polypropylene fibres in varying percentages. Preparatio of laboratory specimens is done for different % of styrene butadiene rubber polymer with addition of the hooked end SF. The experimental program includes cube, cylinder and beam specimens with fabricated in 1% to 10% steel fibres. Further 15% modified polymer-SBR is added in the different mixes. After this 0.15% to 0.25% polypropylene is mixed to M30 and M40 grade of concrete for better performance of concrete under flexure.

The volume fraction for fibre having 100 kg/m3 of steel fibres (1.27% Vf) may be effectively employed. This will improve the quality and performance of concrete as compared to a conservative design. Also using high fibre quantity, problems of concrete workability can be caused. Hence in the present study we used different percentages of these fibers (Vf[1%) and polymer while concentrating the workability. Modified polymer plays an essential role in workability and uniform distribution of fibres also.

COMBINATION OF FIBRES (STEEL FIBRES, SBR AND POLYPROPYLENE)

It is well known that property of modified FRC depends on its content, AR ratios, orientations and volume. The uniformly spread fibre in the concrete mix imparts the considerable enhancement in structural properties of RCC, like fatigue resistance and crack propagation. The combination of super-plasticizer and/or mineral admixtures may develop sufficient workability as fibres are mixed properly to reduce viscosity of mix. In rigid pavements, fatigue resistance fails due to development of micro cracks. Due to mixing of fibres sufficient improvement in the strength is achieved also it resists the crack development. Hence, modified fibre reinforced concrete is more efficient than the normal concrete mixes. Figure- 1 shows Concept of combination of fibres. For M30 (1:1:2) and M40 (1:0.75:1.5) grade of concrete, we observed test results for addition of SBR polymer, polypropylene in combination of steel fibres.

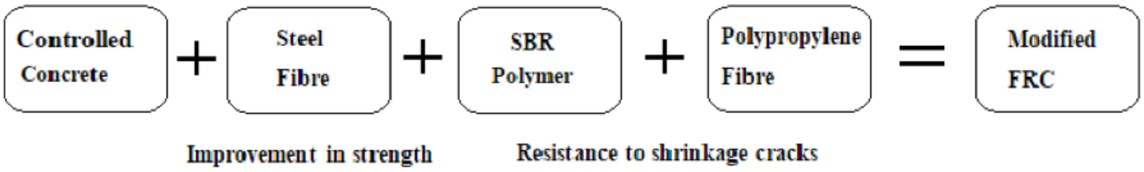

FIGURE 1. Concept of combination of fibres

PMC (POLYMER MODIFIED CONCRETE)

PMC- Polymer modified concrete is also termed as PPCC-polymer Portland cement concrete and LMC-latex modified concrete. This is defined as mixing the organic polymer with Portland cement and aggregate at the intial stage. As the cement are hydrate coalescence of the polymer occur resulting in the co-matrix of polymer with hydrated cement within the concrete. Below given different types of polymer has been developed for use in PMC.

1. Styrene-butadiene copolymer (S-B)
2. Acrylic ester photopolymers (PAE) and copolymers, particular with styrene (S-A)
3. Vinyl acetate copolymer (VAC)
4. Vinyl acetate homo-polymers (PVAC)

Depending upon requirements like service life and cost polymer can be chosen. It is observed that PVAC is not recommended where the PMC is exposed to damped condition. Primarily, mixing and handling of PMC is same as that of conventional to Portland cement concrete (PCC). Lesser mixing time is implied to check the acceptable air content. As because of strong adhesion exhibits by PMC; quite good clean-up of mixing equipment is recommended. Curing of PMC differ from that of PCC for which damped curing is not advised.

STEEL FIBRES

Steel fibres are having cross sections as flat, round, crescent, etc. It is available as straight, wavy and end hook. The length of steel fibres varies from 19-60 mm with AR-aspect ratio (L/d) of 30-100. These fibres are having the tensile strength of 345-1700 N/mm2 whereas Young´s modulus (E) is 205 kN/mm2.

Hence, figure 2 shows typical SF-steel fibres with Length (L) and diameter (d).

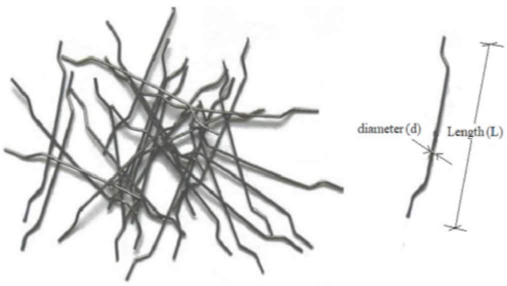

FIGURE 2. Steel fibres

POLYPROPYLENE SYNTHETIC FIBRES

A thermoplastic material i.e. Polypropylene (PP) is fabricated by polymerization process. Under high pressure and temperature these monomer units of polypropylene molecules are catalyst to form a chain. An unsaturated hydrocarbon which contains only carbon and hydrogen atoms is termed as Propylene. Sample of polypropylene fibres are shown in following figure 3.

Polypropylene is amongst the frequently used class of thermoplastics having share growth in market with 6-7% per year. The quantity of polypropylene produced is exceeded by polyethylene and polyvinyl chloride only.

FIGURE 3. Polypropylene fibres

The low cost and desirable properties of polypropylene result in its growth rate. It is considered as lighter than all other thermoplastics (0.9 g/cc). The reason for the applicability of the polypropylene fibres is its versatility as a fiber. It has better properties and is cheaper than other composites. It is easy to manufacture hence and are derived from the very nature. It is used for Crack-free, Leakage-Free and Damp-Free plastering and concrete. Its properties are shown in Table 1.

TABLE 1. Properties of Synthetic Polypropylene Fibres

Sr. No	Properties	Range
1	Colour	White
2	Alkali Resistance	Alkali Proof
3	Melt Point	1650C
4	Specific Gravity	0.91
5	Material	Polypropylene
6	Chemical Resistance	Excellent
7	Acid and Salt Resistance	Chemical Proof
8	Denier	1050
9	Tensile Strength	0.67 kN/m2
10	Youngs Modulus	4.0 kN/m2
11	Ignition Point	60000C
12	Bulk Density	910Kg/m3
13	Loose Density	250-430 Kg/m3
14	Normal Dosage	0.15% to 0.4% by weight of cement
15	Fibre cut length	6 to 40 mm
16	Form	Multifilament

EXPERIMENTAL SET-UP

The experimental set up consists of cubes (150x150x150mm) and beams specimen (700x150x150mm) casted in laboratory. The cubes and beams specimen are composed with various percentages of polymer and fibers (V_f) used in the study. Steel fibres are mixed in proportion of 1 to 10% with the 15% SBR polymer. Cube and beams are casted with Polypropylene fibers varying from 0.15 to 0.25%. We choose close up to 0.25% for optimum dosage because we are adding SBR polymer also. Figure 4 shows a typical beam specimen casted with different reinforcement.

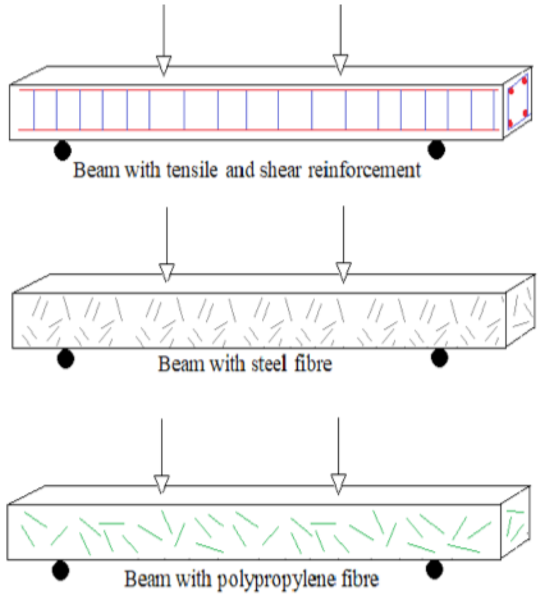

FIGURE 4. Typical beam specimens (700x150x150mm) with different reinforcements subjected to two point loading at L/3 span as per ASTM C78

RESULTS AND DISCUSSIONS

The compression and flexure strength of concrete is tested for normal concrete specimen and constant content of 15% polymer (styrene butadiene rubber) with different percentage of steel fibre from 1% to 10% by weight of cement. The tests are conducted on CTM / UTM and results are shown in table.From the table 1 it is seen that as the percentage of steel fibre with 15 % of constant polymer content concrete, the compression strength is more than polymer concrete and as the percentage of steel fibre (from 1% to 10 %). The specimens are casted as normal concrete and constant content of 15% polymer with variation in steel percentage (1% to 10%) by weight of cement, tests are conducted on UTM and result is given in table.

The strength is estimated using following relation

Flexure strength, $\sigma = \dfrac{PL}{bd^2}$

Where,

σ = Compression strength

P = Maximum load at which beam is failed, in N

b = Width of beam in mm

d = Depth of beam in mm

L = Span of beam

Improvement in the compressive strength of the concrete is observed after employment of steel fibre up to 2%. From above graph and table it is observed that with adding the polymer; the tensile strength is greatly improved as compare to normal concrete. After addition of the steel fibre content (from 1% to 10 %). in polymer concrete; there is an increase in the tension strength. Such beam specimens are tested under flexure as shown in figure 5.

FIGURE 5. Beam specimens under flexure

TABLE 2 Different strength of concrete with addition of combined steel fibres and SBR Polymer with M30 Grade

Sr. No.	Mix Proportion	Compression strength (MPa)	Split Tensile strength (MPa)	Flexural strength (MPa)
1	CC (Controlled Concrete)	38.06	2.34	7.00
2	CC+15% SBR	37.98	2.80	7.20
3	CC+15% SBR +1% Steel fibre	37.95	3.50	7.45
4	CC+15% SBR +2% Steel fibre	37.57	3.57	7.98
5	CC+15% SBR +3% Steel fibre	37.19	3.64	8.05
6	CC+15% SBR +4% Steel fibre	36.82	3.71	8.64
7	CC+15% SBR +5% Steel fibre	36.45	3.79	8.88
8	CC+15% SBR +6% Steel fibre	36.09	3.86	9.20
9	CC+15% SBR +7% Steel fibre	35.73	3.94	9.58
10	CC+15% SBR +8% Steel fibre	35.37	4.02	10.17
11	CC+15% SBR +9% Steel fibre	35.01	4.10	10.29
12	CC+15% SBR +10% Steel fibre	35.50	4.60	10.40

TABLE 3 Different strength of concrete with addition of combined steel fibres and SBR Polymer with M40 Grade

Sr. No.	Mix Proportion	Compression strength (MPa)	Split Tensile strength (MPa)	Flexural strength (MPa)
1	CC (Controlled Concrete)	46.31	3.08	7.47
2	CC+15% SBR	46.22	3.70	7.78
3	CC+15% SBR +1% Steel fibre	44.83	3.77	8.05
4	CC+15% SBR +2% Steel fibre	44.74	3.85	8.62
5	CC+15% SBR +3% Steel fibre	44.65	3.92	8.69
6	CC+15% SBR +4% Steel fibre	44.56	4.00	9.33
7	CC+15% SBR +5% Steel fibre	44.47	4.08	9.59
8	CC+15% SBR +6% Steel fibre	44.38	4.16	9.94
9	CC+15% SBR +7% Steel fibre	44.30	4.25	10.35
10	CC+15% SBR +8% Steel fibre	44.21	4.33	10.98
11	CC+15% SBR +9% Steel fibre	44.12	4.42	11.11
12	CC+15% SBR +10% Steel fibre	44.00	5.04	11.20

TABLE 4 Compressive strength of 0.15 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=50)

Sr. No	Mix	Days	Variation in % of steel fibre	Comp Strength (Exp)	Days	Variation in % of steel fibre	Comp Strength (Exp)
1	M30	7 days	0.35	24.80	28 days	0.35	42.28
2	M30	7 days	0.45	24.95	28 days	0.45	42.85
3	M30	7 days	0.55	25.00	28 days	0.55	43.11
4	M30	7 days	0.65	25.45	28 days	0.65	43.25
5	M30	7 days	0.85	25.89	28 days	0.85	43.51

Table 2 and table 3 shows compression strength, split tensile strength and flexural strength of concrete with addition of combined steel fibres and SBR Polymer in different percentages with M30 and M40 Grades of concrete.

Further table 4 exhibits the compressive strength of cubes with 0.15 % polypropylene and steel fibres in different percentage (M30 with Aspect ratio steel fibre=50). Addition of polypropylene in lower percentages increases the flexural strength by about 52% and the compressive by about 33%. Hence further combinations and its results are given by figure 6 to figure 17 considering various percentages of polypropylene and steel fibres. Also aspect ratio of steel fibers is taken as AR50, AR55 and AR60. Flexural strength characteristics are shown in table 5 to table 8 for beam specimens with 0.15 % and 0.25 % of polypropylene and steel fibres in different percentage and aspect ratios (AR50, AR55, AR60). Further combinations and its results are given by figure 18 to figure 29 considering various percentages of polypropylene and steel fibres with aspect as AR50, AR55 and AR60.

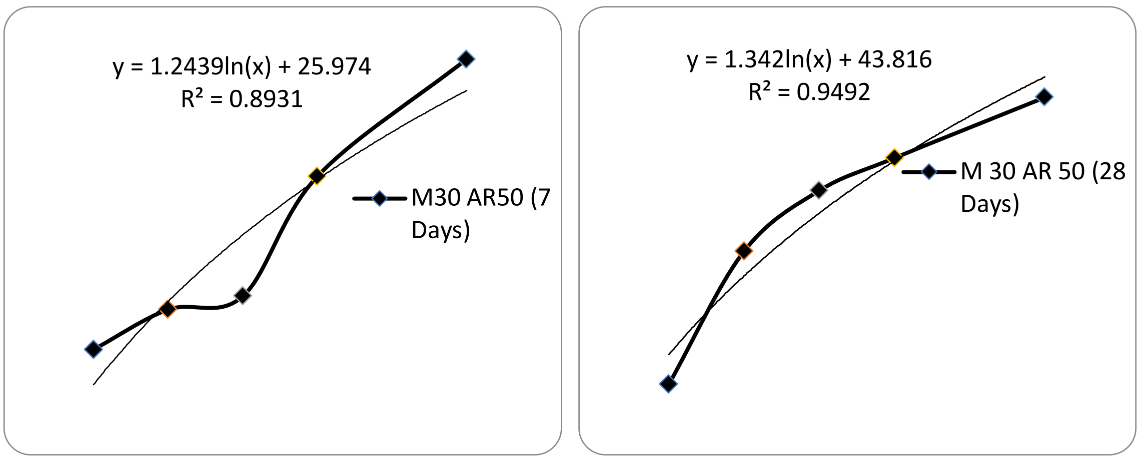

FIGURE 6 Compressive strength of M30 grade conc. with 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=50)

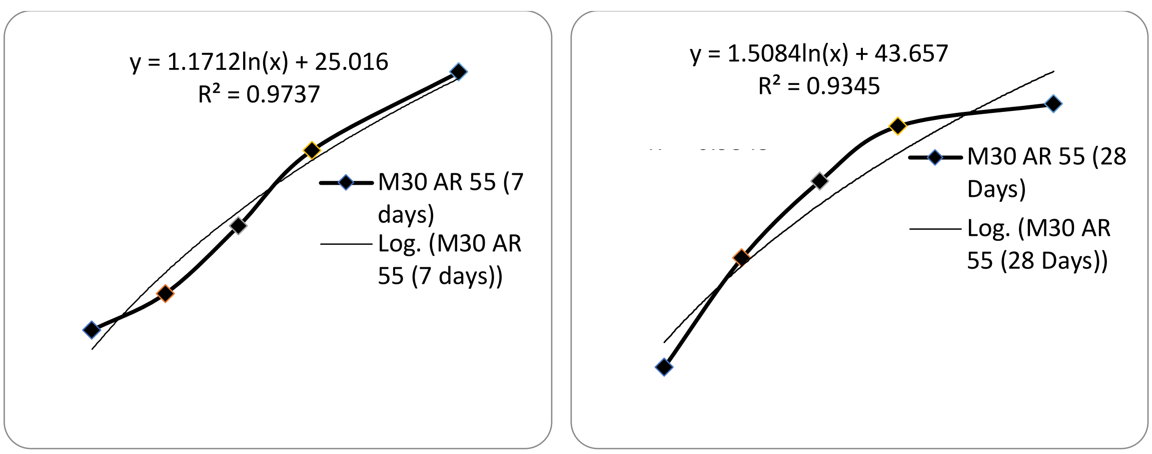

FIGURE 7 Compressive strength of M30 grade conc. with 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=55)

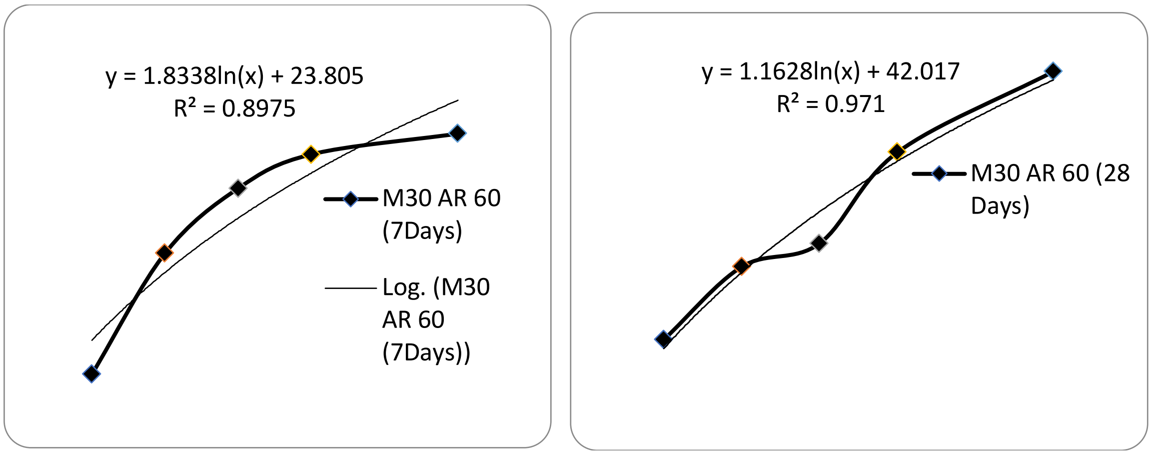

FIGURE 8 Compressive strength of M30 grade conc. with 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=60)

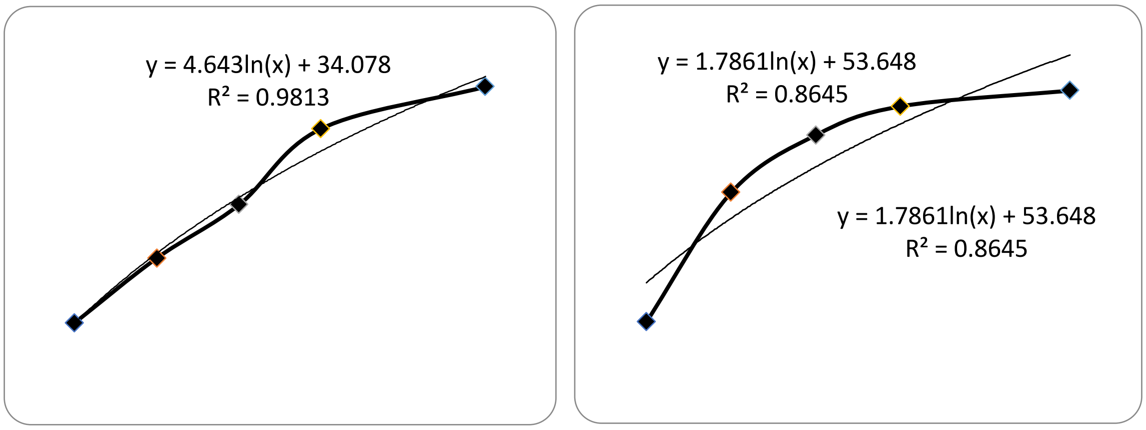

FIGURE 9 Compressive strength of 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=50)

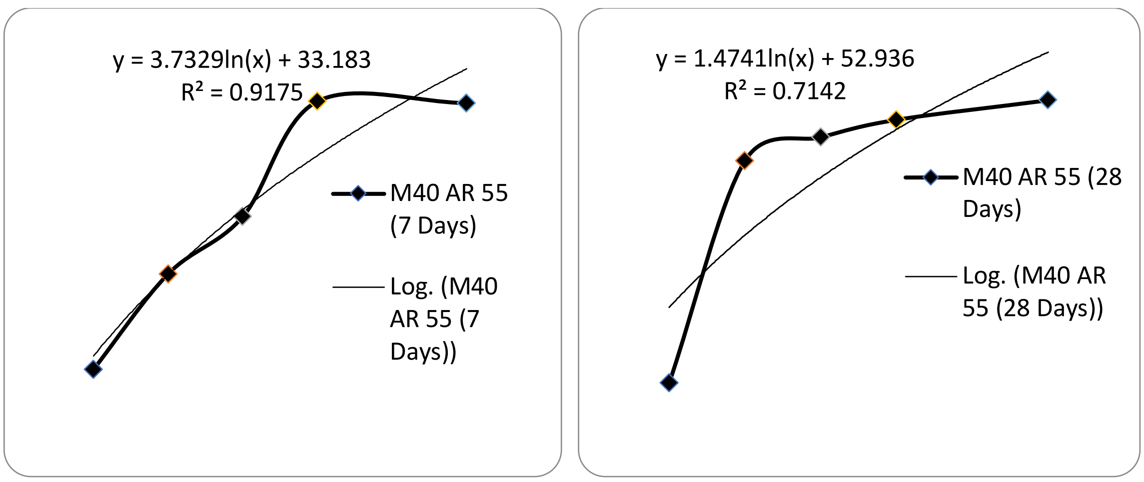

FIGURE 10 Compressive strength of 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=55)

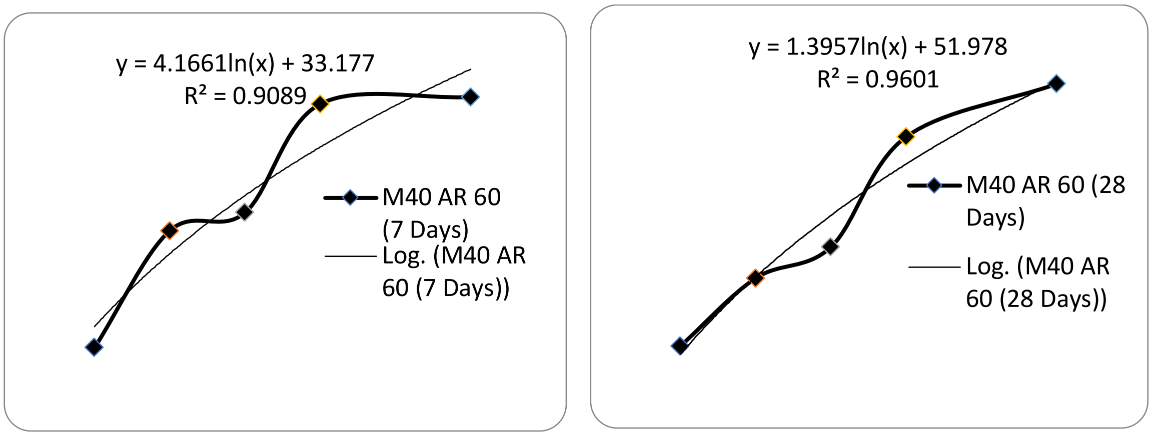

FIGURE 11 Compressive strength of 0.15 % polypropylene and steel fibres with different percentage (Aspect ratio steel fibre=60)

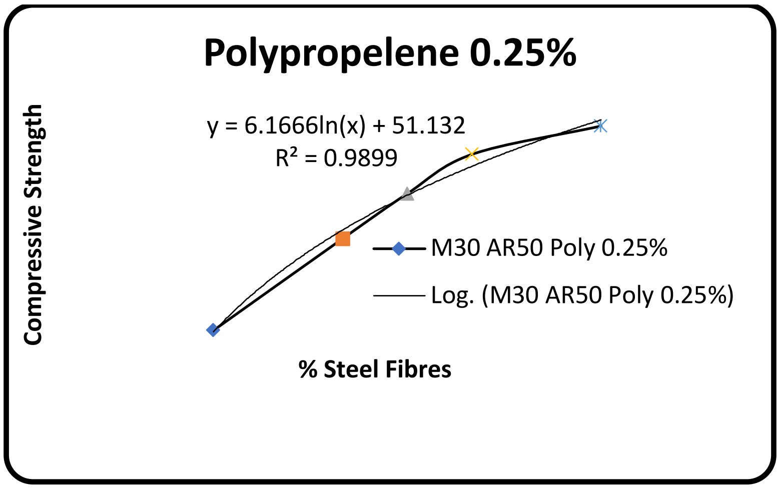

FIGURE 12 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=50)

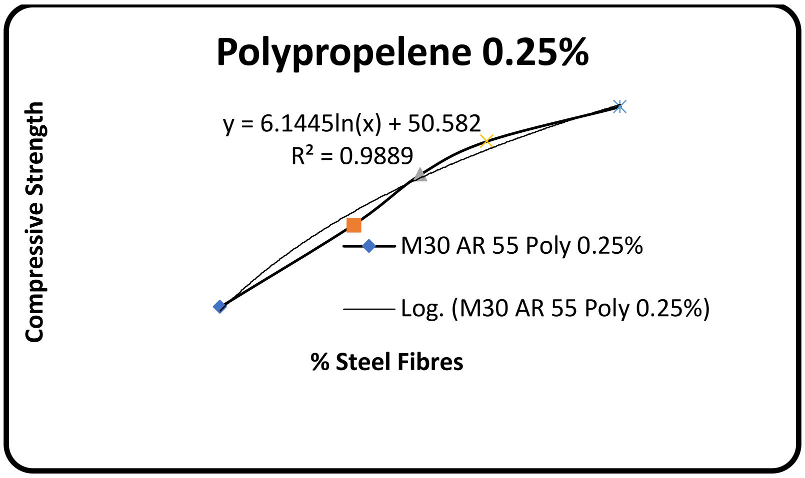

FIGURE 13 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=55)

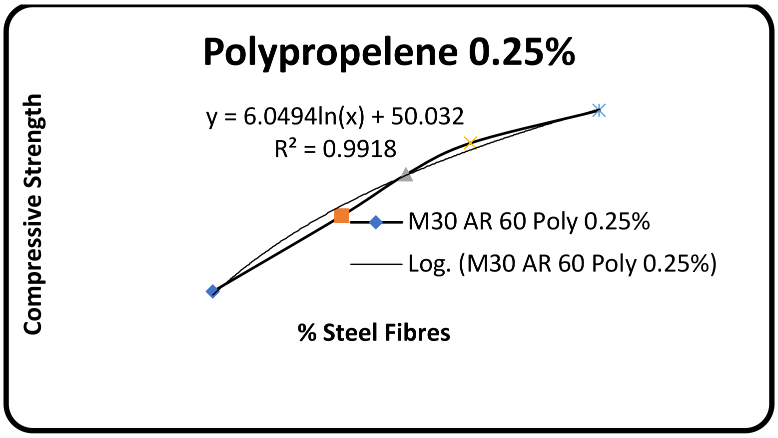

FIGURE 14 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=60)

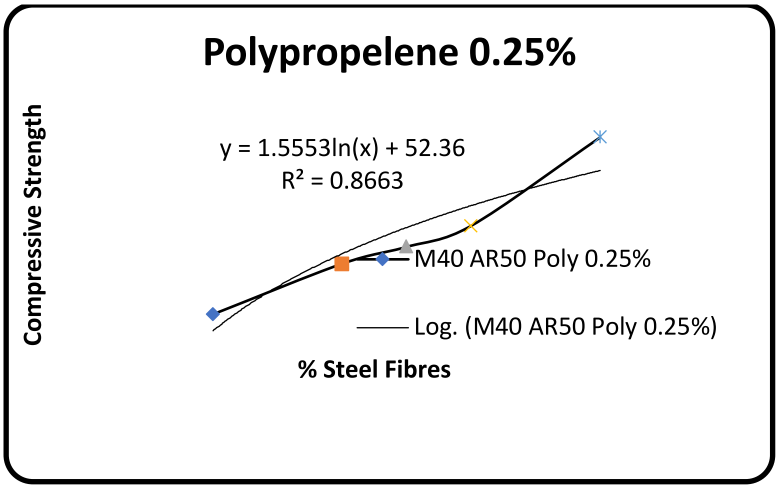

FIGURE 15 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=50)

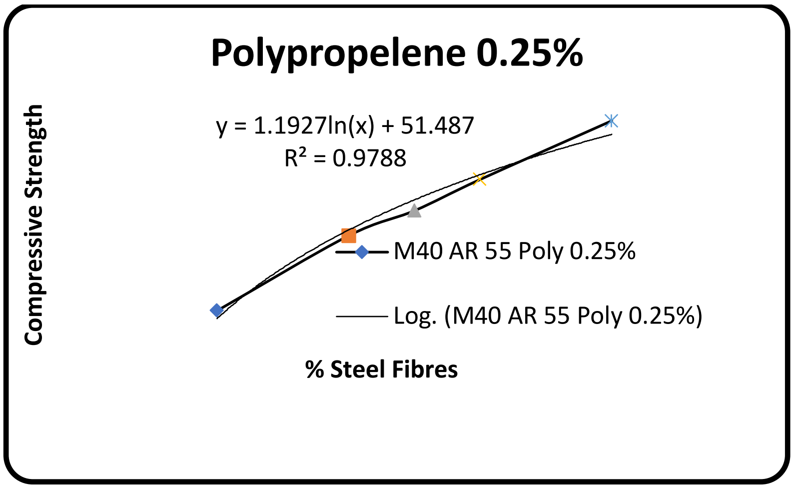

FIGURE 16 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=55)

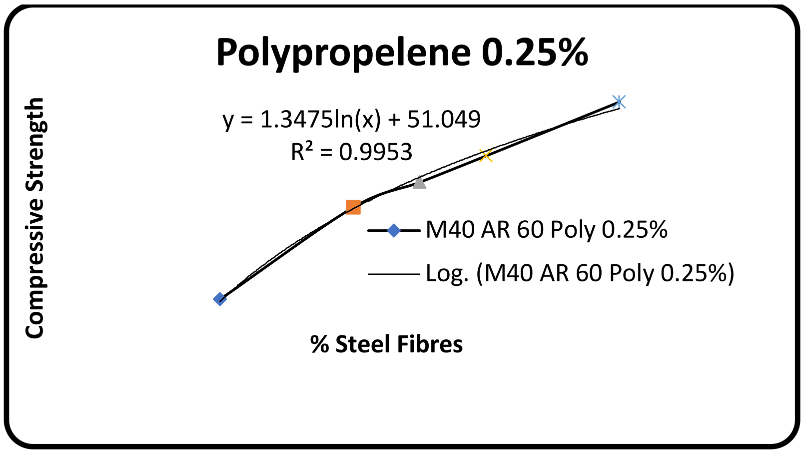

FIGURE 17 Compressive strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=60)

Flexural strength characteristics are shown in table 5 to table 8 for beam specimens with 0.15 % and 0.25 % of polypropylene and steel fibres in different percentage and aspect ratios (AR50, AR55, AR60). Further combinations and its results are given by figure 18 to figure 29 considering various percentages of polypropylene and steel fibres with aspect as AR50, AR55 and AR60.

TABLE 5 M30 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage

Sr. No	Mix	Variation in % of steel fibre	Flexural Strength		
			Aspect ratio steel fibre=50	Aspect ratio steel fibre=55	Aspect ratio steel fibre=60
1	M30	0.35	7.8	7.72	7.64
2	M30	0.45	8.3	8.22	8.21
3	M30	0.55	8.6	8.4	8.32
4	M30	0.65	8.7	8.61	8.53
5	M30	0.85	8.83	8.74	8.68

TABLE 6 M30 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage

Sr. No	Mix	Variation in % of steel fibre	Flexural Strength		
			Aspect ratio steel fibre=50	Aspect ratio steel fibre=55	Aspect ratio steel fibre=60
1	M30	0.35	8.64	8.50	8.40
2	M30	0.45	8.68	8.61	8.44
3	M30	0.55	8.75	8.70	8.53
4	M30	0.65	8.97	8.75	8.58
5	M30	0.85	9.02	8.93	8.75

TABLE 7 M40 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage

Sr. No	Mix	Variation in % of steel fibre	Flexural Strength		
			Aspect ratio steel fibre=50	Aspect ratio steel fibre=55	Aspect ratio steel fibre=60
1	M40	0.35	8.40	8.31	8.10
2	M40	0.45	8.60	8.62	8.55
3	M40	0.55	8.89	8.84	8.75
4	M40	0.65	9.00	8.91	8.89
5	M40	0.85	9.10	8.94	8.85

TABLE 8 M40 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage

Sr. No	Mix	Variation in % of steel fibre	Flexural Strength		
			Aspect ratio steel fibre=50	Aspect ratio steel fibre=55	Aspect ratio steel fibre=60
1	M40	0.35	8.88	8.75	8.5
2	M40	0.45	8.95	8.91	8.6
3	M40	0.55	9	8.91	8.8209
4	M40	0.65	9.1	9.009	8.91891
5	M40	0.85	9.25	9.1575	9.065925

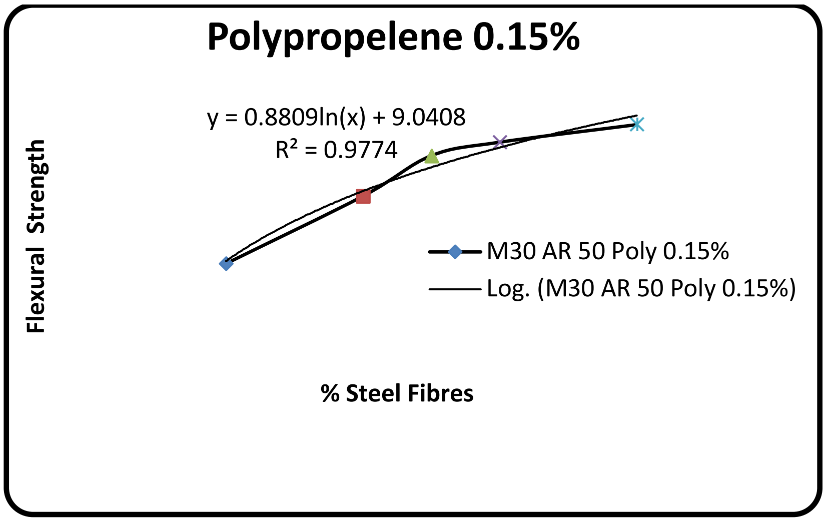

FIGURE 18 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=50)

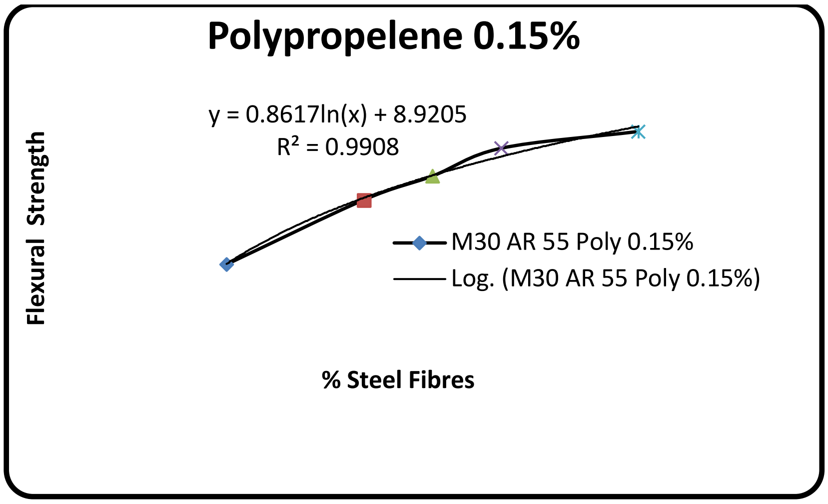

FIGURE 19 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=55)

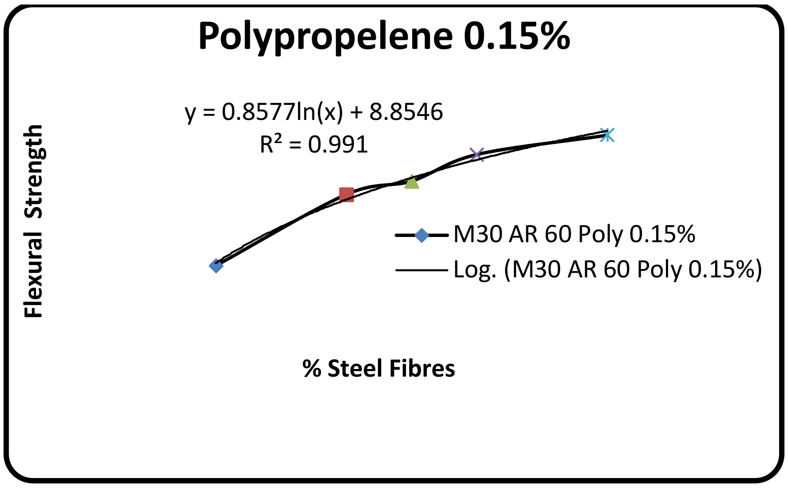

FIGURE 20 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=60)

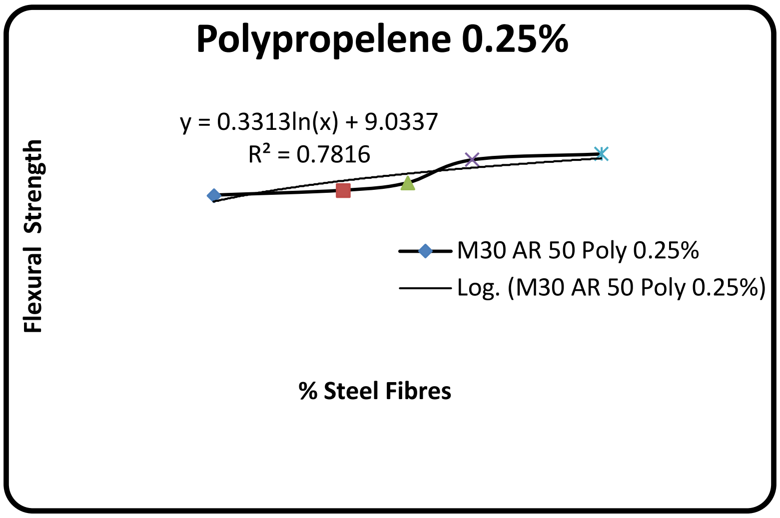

FIGURE 21 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=50)

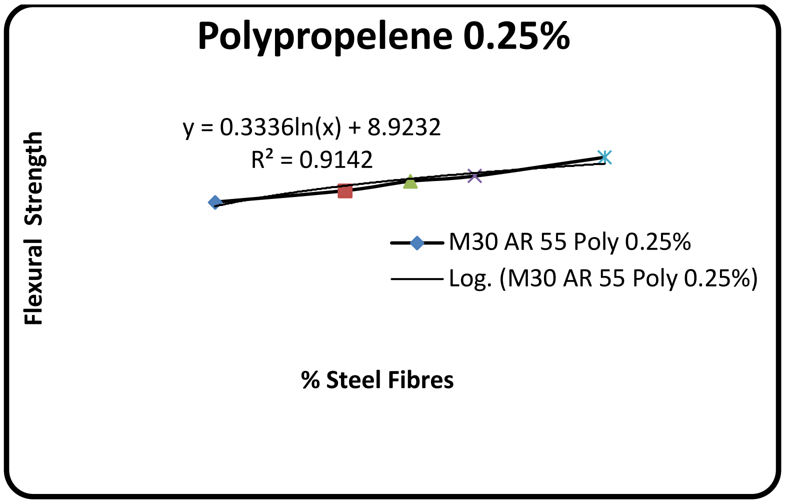

FIGURE 22 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=55)

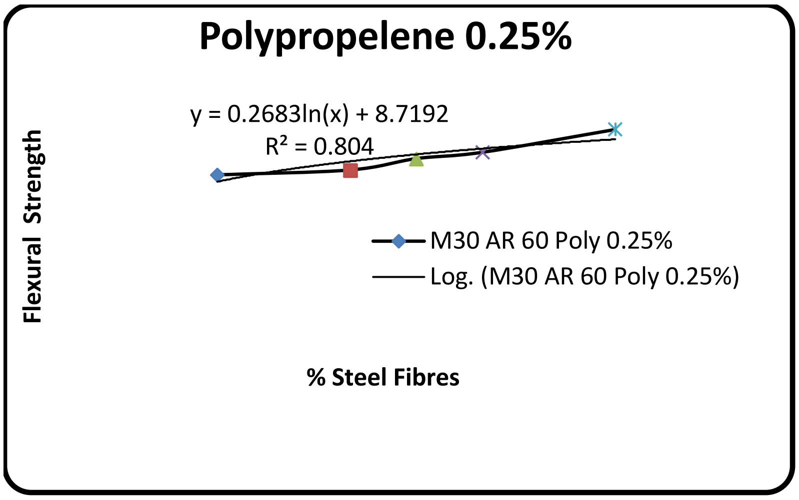

FIGURE 23 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M30 with Aspect ratio steel fibre=60)

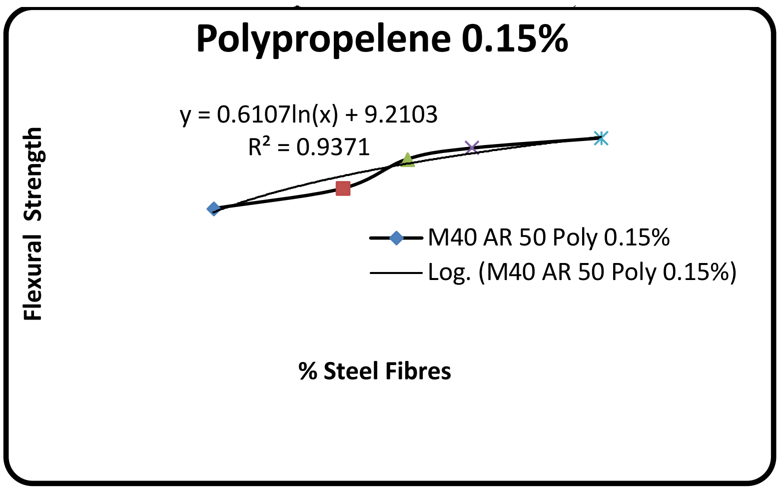

FIGURE 24 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=50)

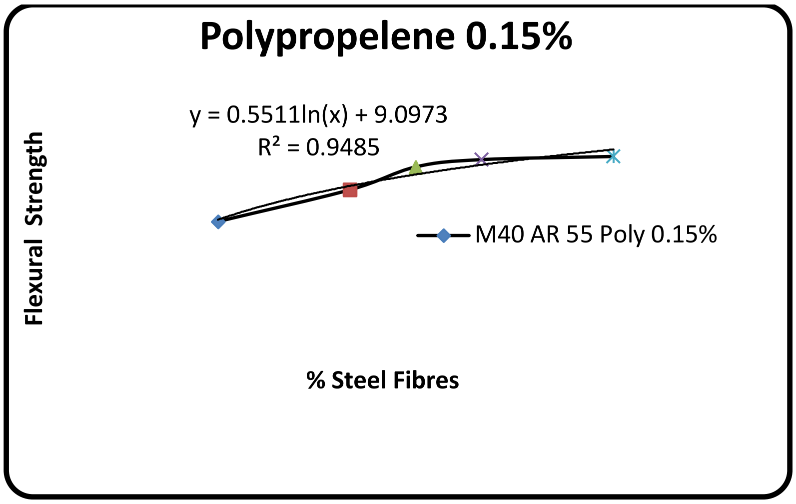

FIGURE 25 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=55)

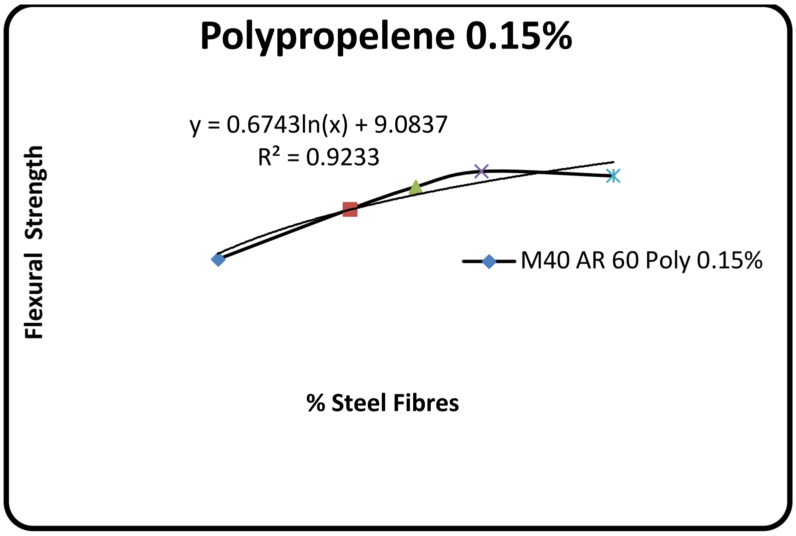

FIGURE 26 Flexural strength of 0.15 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=60)

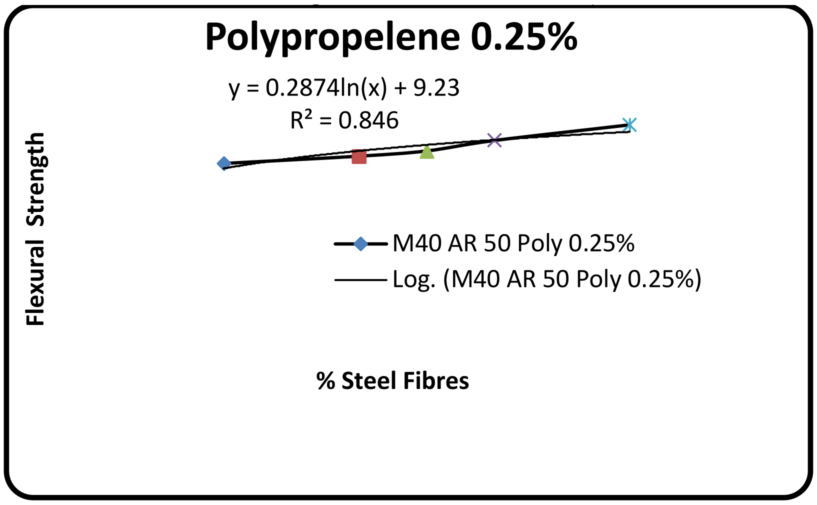

FIGURE 27 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=50)

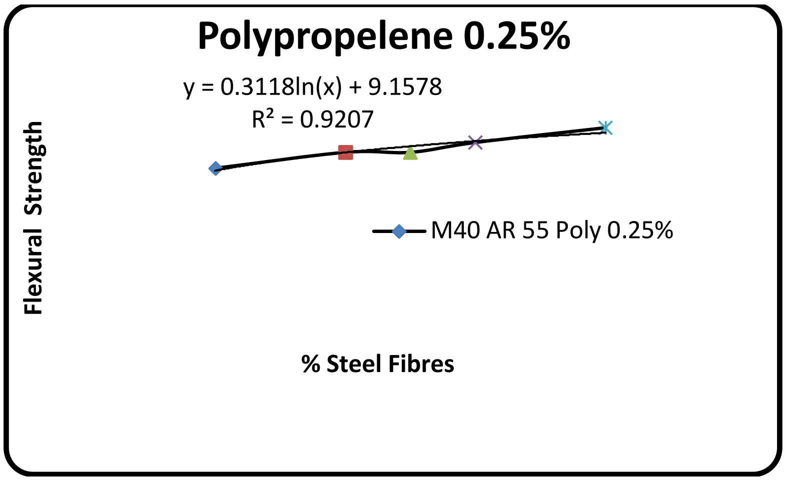

FIGURE 28 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=55)

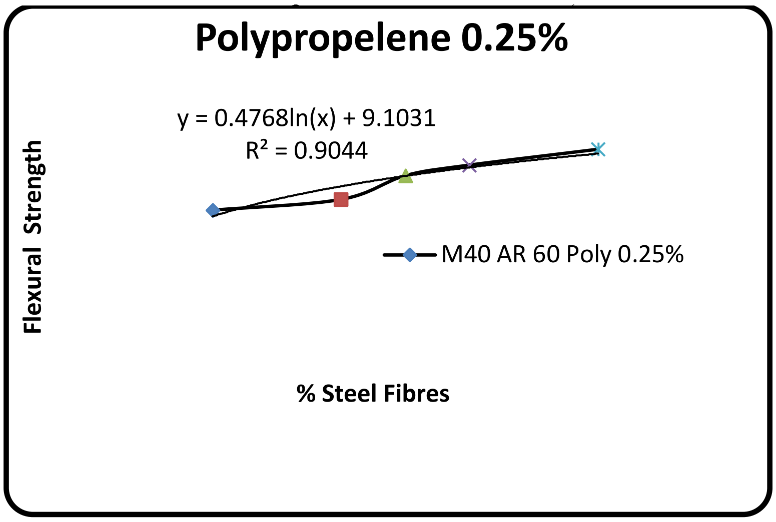

FIGURE 29 Flexural strength of 0.25 % polypropylene and steel fibres with different percentage (M40 with Aspect ratio steel fibre=60)

Crack pattern and various modes of failure of beams under flexure containing fibres are shown in figure 30.

FIGURE 30 Different modes of failure and failure pattern with Polypropylene fibers in higher Vf=0.25

CONCLUSION

Improvement of performance of concrete can be achieved with hybrid / proper collection of fibers. Workability of such hybrid concrete is improved than controlled (non-reinforced) concrete by such practices. As per result, compressive strength of FRC is decreased with the addition of polymer and steel fibre whereas flexural strength is improved. For the addition of polypropylene fibres significant increases in flexural strength is determined. For addition of combined SBR polymer and steel fibres; 15 % SBR is taken and steel fibres are varied in different percentages. For addition of combined Polypropylene and steel fibres; 0.15 % to 0.25% polypropylene is taken and steel fibres are varied in different percentages, as illustrated.

1. It is observed that with addition of SBR polymer there is 1% to 6% decrease in the compressive strength as compare to controlled concrete for M30 grade.
2. It is observed that with addition of polymer there is 1% to 5% decrease in the compressive strength as compare to controlled concrete for M40 grade
3. Split tensile strength is observed to be increased by 16.42% to 49.13% as we increase SBR polymer and steel fibres for M30 grade.
4. Split tensile strength is observed to be increased by 20% to 63.64% as we increase SBR polymer and steel fibres for M40 grade.
5. 3% to 48.5% increase in flexural strength is observed with addition of SBR polymer and steel fibres for M30 grade.
6. 4.09% to 49.93% increase in flexural strength is observed with addition of SBR polymer and steel fibres for M40 grade.
7. Compressive strength and flexural strengtjh of M30 and M40 grades of concrete is obsevred for 0.15 % and 0.25% polypropylene and steel fibres with different percentage. For this aspect ratio steel fibre are taken as 50, 55 and 60.
8. For M30 grade of concrete with addition of 0.15% poplyproylene fibre comp. strength is decreased by 0.59% with aspect ratio 55 compared to AR50. Whereas 2 to 3% decrease in Comp strength is observed for M30 grade of concrete if we incresase aspect ratio to 60.
9. For M40 grade of concrete with addition of 0.15% poplyproylene fibre comp. strength is decreased by 1.24% with aspect ratio 55 compared to AR50. Whereas 1.3 to 1.8% decrease in comp strength is observed for M40 grade of concrete if we incresase aspect ratio to 60.
10. For M30 grade of concrete with addition of 0.15% poplyproylene fibre flexural strength is increased by 1.01% with aspect ratio 55 compared to AR50. Whereas 1.69 to 3% incrcrease in flexural strength is observed for M30 grade of concrete if we incresase aspect ratio to 60 for variation in % of stesl fibres.
11. For M30 grade of concrete with addition of 0.25% poplyproylene fibre flexural strength is increased by 2.45% with aspect ratio 55 compared to AR50. Whereas 2.99 to 4.35% incrcrease in flexural strength is observed for M30 grade of concrete if we increase aspect ratio to 60 for variation in % of stesl fibres.
12. For M40 grade of concrete with addition of 0.15% poplyproylene fibre flexural strength is increased by 1.75% with aspect ratio 55 compared to AR50. Whereas 2.74 to 3.5% incrcrease in flexural strength is observed for M30 grade of concrete if we increase aspect ratio to 60 for variation in % of stesl fibres.
13. For M40 grade of concrete with addition of 0.25% poplyproylene fibre flexural strength is increased by 1.46% with aspect ratio 55 compared to AR50. Whereas 3.9 to 4.2% incrcrease in flexural strength is observed for M30 grade of concrete if we increase aspect ratio to 60 for variation in % of stesl fibres.
14. Recommendation for future work: further work can be extended for combination of synthetic fibres with steel and SBR considering high fibre volume fractions. Improvement in performance of concrete for various aspect ratio can also be studies with development of present work.

ACKNOWLEDGEMENT

The authors would like to thank Bajaj Reinforcements LLP- Manufacturer of Polypropylene Fibres & Macro And Micro Synthetic Fibres. (https://www.bajajreinforcementsllp.in), Plot No. D-5/1, Hingna Industrial Estate, Hingna MIDC, Nagpur - 440028, Maharashtra, India for giving their product polypropylene fibres for testing to our laboratory to carry out this research..

DECLARATION OF COMPETING INTEREST

None

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