4. Presentation to Results and Discussions

4.1 Forward presentation to Results and Discussions

In this research, an intensive laboratory investigation, for the effect of adding Polypropylene fiber to local concrete on both fresh and hardened concrete mixes has been conducted .

Currently (State of the Art Report on Fiber Reinforced Concrete), there are two different synthetic fiber volume contents used in applications. They are 0.1 to 0.3 percent, which is referred to as low volume percentage, and 0.4 to 0.8 percent, which is referred to as high-volume percentage. To date, most commercial applications of polypropylene FRC (Krenchel and Shah, 1985; Zollo and R Krenchel, 1991) have used low denier, low volume percentage which were used in this research.

Preliminary tests for local ordinary Portland cement and aggregates were conducted in the research in which were decided in chapter three. Large numbers of experiments tested were prepared concerning workability used slump test, compressive strength of concrete mixes and Flexural test of concrete when adding Polypropylene used remixed method. The ratios of Polypropylene added were 0.0 (as a reference mix), 0.05, 0.10, 0.15, 0.20 , 0.25 and 0.30% or 0 ,1.19 , 2.38 , 3.57 , 4.75 , 5.95 , 7.14 Kg/m^3 after prepared mix design sheet using normal mix using Britches Standard B.S Code (appendix). The present study was focused at low volume percentage of Polypropylene, to know the volume of concrete contents to give concrete grade 25 N/mm^2.

Concrete produced with Premix process , then impressed in water until day of test, concrete ages: 3, 7 and 28 days by prepared with in 63 cubes 9 cubs for each sample and 42 beams 6 for each sample. Test and materials were used as presented according to chapter three. The concrete mix design sheet was attached in appendix.

The fabrication, curing of the test specimens was presented in chapter 3, where the results of laboratory tests were presented and discussed. These include results of testes above all test were done in Concrete laboratory, Gezira University, Sudan.

4.2 Results and Discussions

4.2.1 Results of Row Material Test

4.2.1.1 Results of Sieve Analysis of Aggregates

Table (10): Results of sieve analysis of coarse aggregates test.

B.S sieve	Retained		%Age Passing	ASTM Standard
	Sample			
(mm)	Wt. (g)	(%)		
37.5	0	1997	100	100
25	23	1974	98.85	100
19.5	36	1938	97.05	85 to 100
12.5	772	1166	58.39	0 to 70
9.5	855	311	15.57	0 to 25
4.75	309	2	0.1	0 to 5
Pan	2	0	0	0

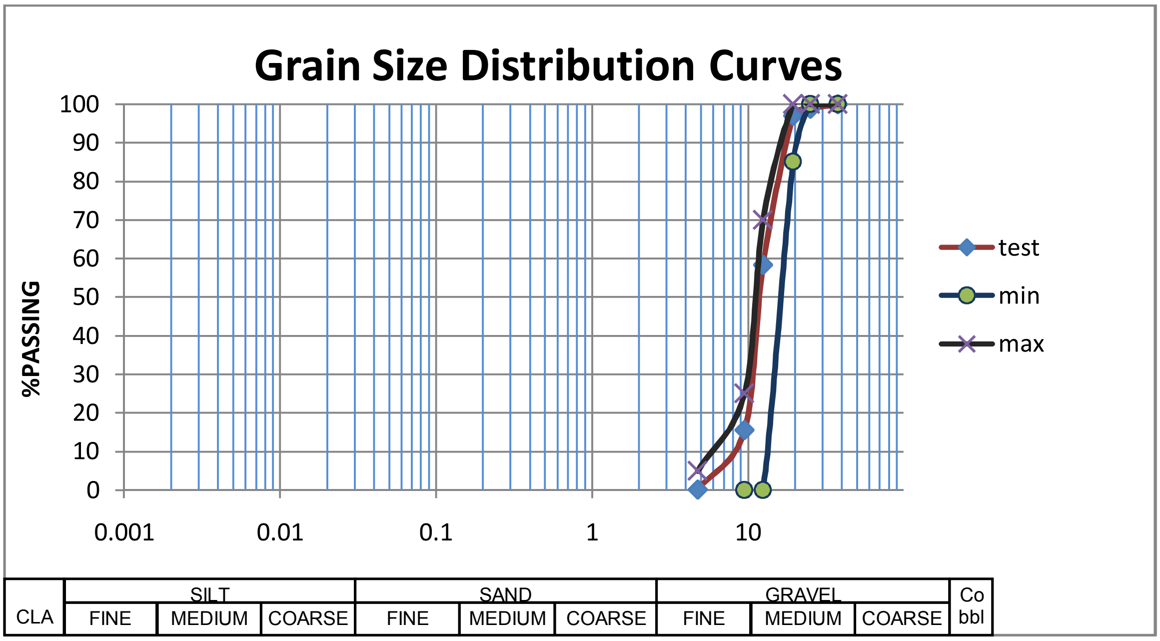


Figure (50): Grain Size of Coarse Aggregate Test.

Table (11): Results of sieve analysis of Fine aggregate test.

B.S sieve (mm)	Retained Sample Wt. (g)	Retained Sample (%)	%Age Passing	ASTM Standard
4.75	0	990	100	100
2.36	76	914	92.4	89 to 100
1.18	104	810	81.8	65 to 100
0.600	305	505	51	45 to 100
0.300	252	253	25.6	25 to 80
0.150	197	56	5.66	5 to 48
0.075	53	3	0.2	0 to 10
Pan	3	0	0	00

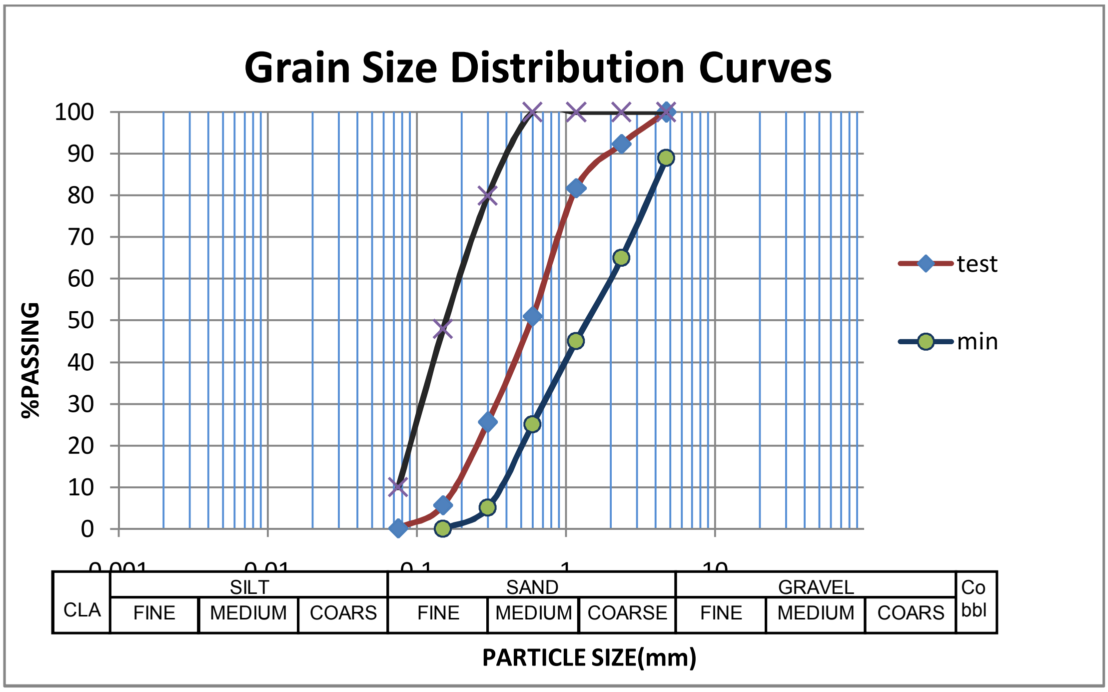


Fig (51): Grain Size of Fine Aggregate Test.

Absorption of Corse Aggregate SSD = 2016/(2016-1238) = 2.6.

4.2.1.2 Results of Cement Test

Table (12): Results of Preliminary Cement Tests.

Test	Results	Requirements of BS 12 1996
Consistency	31	**26 -32%**
Setting Time		
Initial	1:45	**Not less than (45 min)**
Final	3:15	**Not more than 10 hrs.**
Compressive Strength		
2 days		**Equal or Greater than 10 N/mm^2**
1	14.49	
2	16.87	
3	16.08	
Average : **15.813** Mpa		**Equal or Greater than 42.5 N/mm2**
28 days		
1	44.28	
2	42.40	
3	**42.04**	
Average : **42.91** Mpa		

4.2.2 Results of Mix Design

(Appendix)

Table (13): Results of Mix Design.

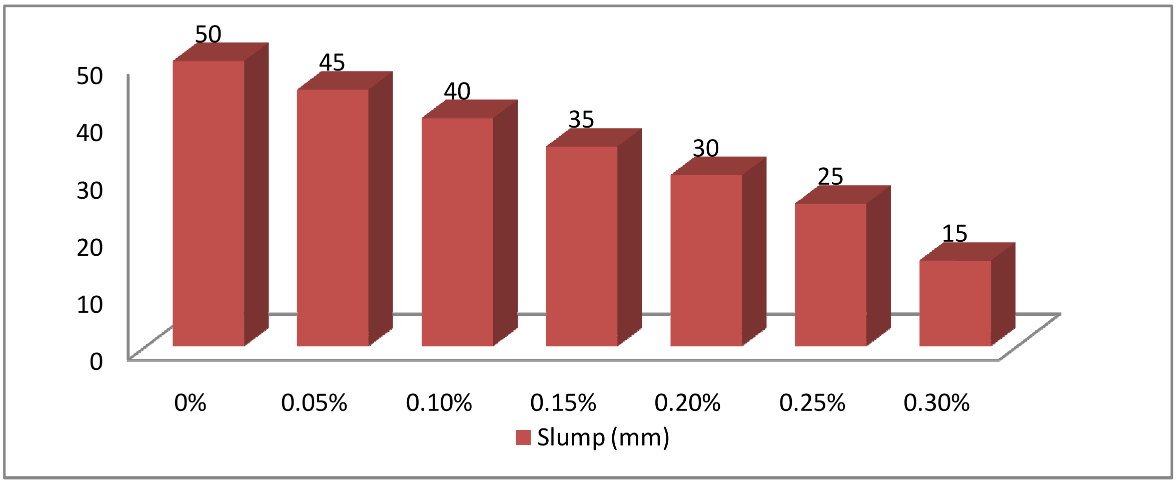
Water Kg or Litters	Cement Kg	Fine Aggregate Kg	Coarse Aggregate Kg	Polypropylene Kg/m^3	Polypropylene %
180	360	665	1175	**0**	**0.00**
180	360	665	1175	**1.19**	**0.05**
180	360	665	1175	**2.38**	**0.10**
180	360	665	1175	**3.57**	**0.15**
180	360	665	1175	**4.76**	**0.20**
180	360	665	1175	**5.95**	**0.25**
180	360	665	1175	**7.14**	**0.30**

4.2.3 Results and discussions of Fresh PpFRC.

4.2.3.1 Results and discussions of Slump Test.

Table (14): Results of Slump give a relationship between PpFRC and workability of concrete.

Slump (mm)	50	45	40	35	30	25	15
Polypropylene Fiber %	0%	0.05%	0.10%	0.15%	0.20%	0.25%	0.30%



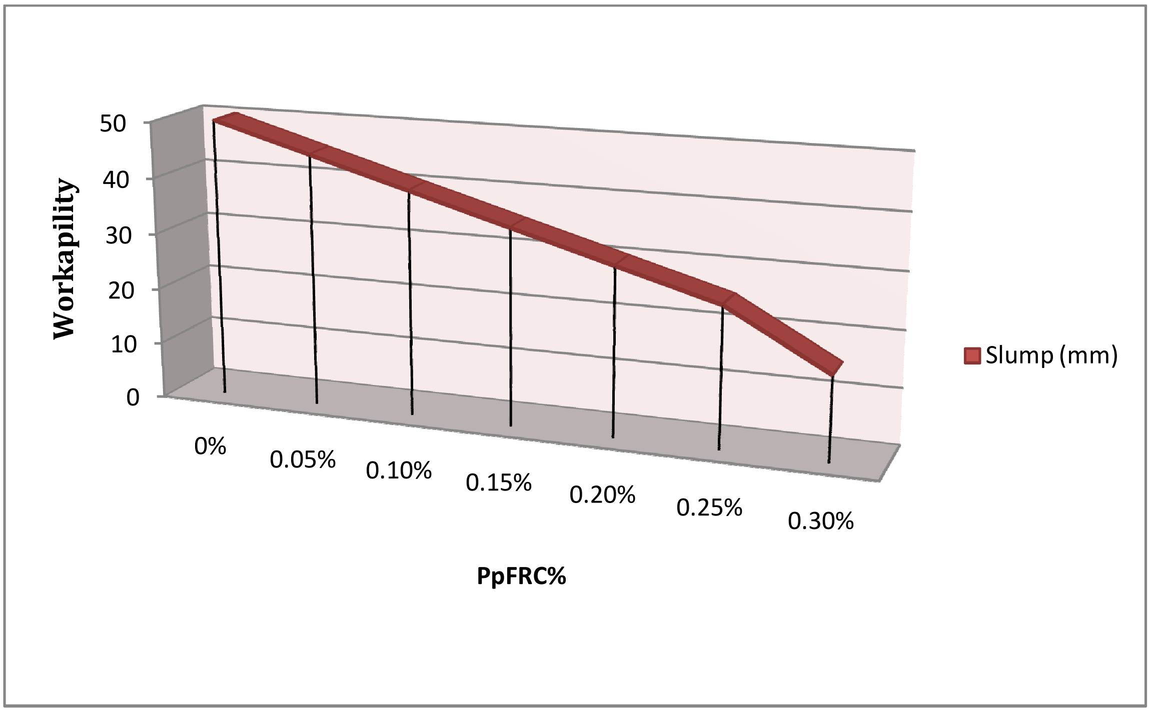


Figure (52): PpFRC and Workability.

Visually we observed that when were added PpF to concrete it become more homogonous and cohesiveness with less blending , segregation and plastic shrinkage crack that is mean PpFRC have enhance performance of concrete .

From chart and table above max slump became in 0.05% which were designed as it, but when the percentage of polypropylene increased the slump was decreased specially at 0.3% which was be lower than the minimum rang at design, we obtain these result to the mix method , during it fiber clot together , also We observed that slump reverse suit to polypropylene percentage added ,on the other hand 0.30% had been the worst, also it hard to handing , that is mean upper percentage of PpFRC cannot used without adding plasticizer .

From this research we observed that for all the concrete mixes having different polypropylene fiber contents the addition of polypropylene fibers (PPF) reduced the flow characteristics as aresal of reduce of workability. These fibers adhere to the cement paste because of their large specific surface area. The concrete mixtures with polypropylene fibers (PPF) result in lower (reduced) bleeding and segregation as compared to basic concrete (without fiber), this is because the PPF help in maintaining the continuum (holding the concrete together or increasing the cohesiveness of concrete) and thus reduces the segregation of the coarse aggregates, also (Shehnila Fatima, 2013) observed to similar conclusion: When fibers are added to the concrete slump will decrease

In the present study we conciliated similar to most research a beginning with ”(Kamran, 2015) which he said “The addition of any type of fibers to concrete reduces the workability”, (W. R. Malisch,1986) found that When fibers are added to the concrete slump will decrease. The Reduction of slump is noticed with increase in fiber content, the mix becomes fibrous which results in difficulty in handling. (Kolli, 2013). also, workability of concrete decreased with increase in polypropylene fiber volume fraction (Kumar, 2013; Dr.T.Ch.Madhavi *et al.,*2014), reported that the workability of concrete decreased with the addition of polypropylene fibers, (Salahaldein Alsadey and Muhsen Salem, 2016) found that The reduction of slump is noticed with increase in polypropylene fiber content, many other research observed to same summary such as: (Divya *et al.,* 2016), whose related that to there is increases in amount of entrapped air voids due to the presence of fibers and therefore increase in air content attributes in reducing workability

4.2.4 Results and discussions of Hardened PpFRC

4.2.4.1 Results and discussions of Compressive Strength

Table (15): Results of compressive strength for control mixes (Polypropylene Fiber = 0.0 %, 0 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2408.6	232.3	10.32	**11.74**
	2410.4	287.6	12.78	
	2388.7	272.8	12.12	
7days	2414.82	374.5	16.64	**17.79**
	2413.93	417.7	18.56	
	2397.93	409.0	18.18	
28days	2426.96	763.0	32.7	**28.36**
	2379.56	540.4	24.02	
	2403.26	638.1	28.36	

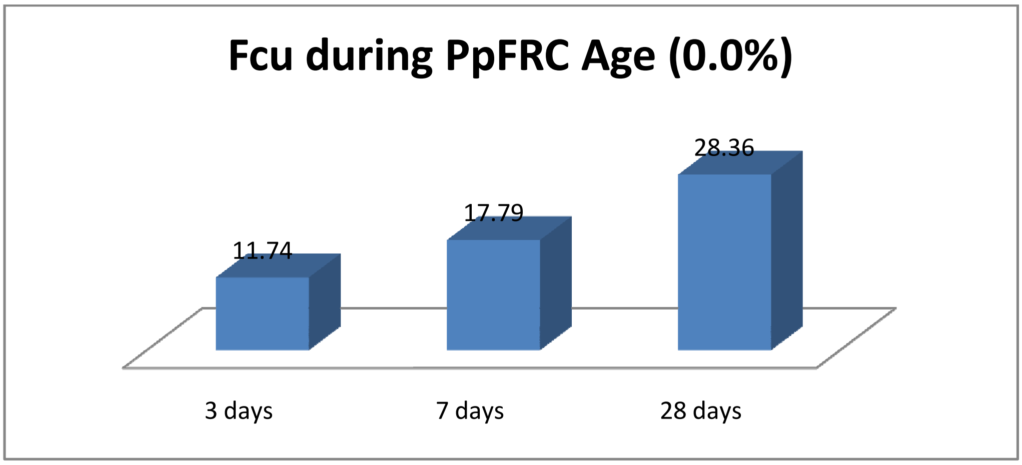


Figure (53): Results of compressive strength for control mixes (Polypropylene Fiber = 0.0 %, 0 Kg/m^3).

0.00% is the references to compared the effect of PpF in R.C, traditionally concrete grade increase with time until attach (90 – 100)% from fcu at 28 days, which were shown in the above chart.

Table (16): Results of compressive strength for control mixes (Polypropylene Fiber = 0.05%, 1.19 Kg/m³).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2379.85	400.8	17.80	**17.80**
	2400.59	378.7	16.82	
	2367.41	422.6	18.78	
7days	2449.19	433.8	19.28	**20.79**
	2420.74	417.5	18.55	
	2480.00	552.2	24.54	
28 days	2459.26	706.6	31.40	**30.69**
	2398.82	674.6	29.69	
	2429.04	690.53	30.69	

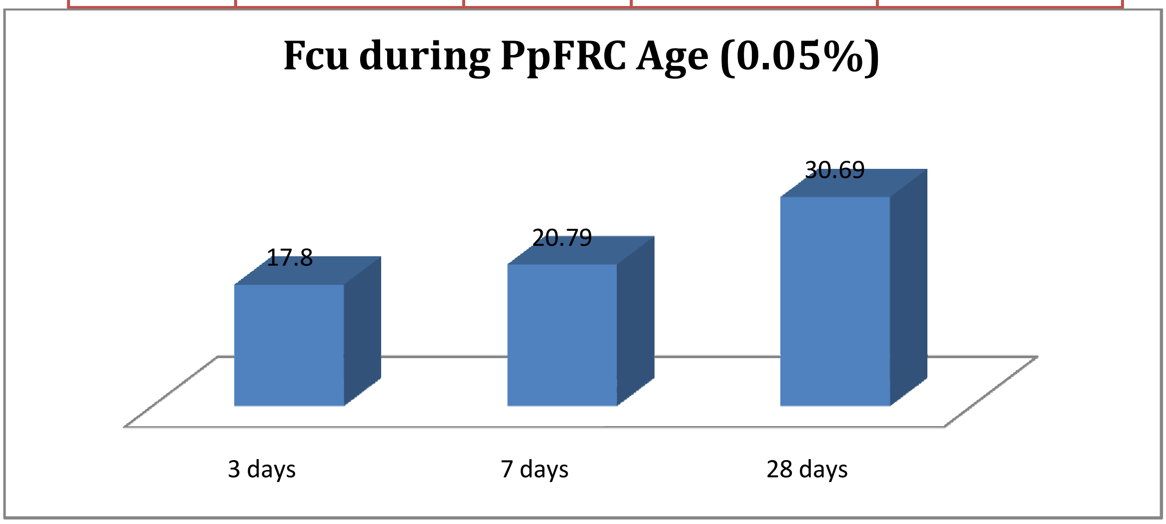


Figure (54): Results of compressive strength for control mixes (Polypropylene Fiber = 0.05%, 1.19 Kg/m) .

PpFRC 0.05% increase the compressive strength 22.76% at 28. PpFRC is the percentage which were recommended in data sheet has good effect on concrete.

Table (17): Results of compressive strength for control mixes (Polypropylene Fiber = 0.10%, 2.38 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2343.71	339.4	15.08	**15.09**
	2343.41	364.3	16.18	
	2351.11	315.3	14.01	
7days	2289.19	475.0	21.10	**19.62**
	2373.04	387.8	17.24	
	2409.78	461.7	20.52	
28days	2403.85	530.4	23.55	**23.96**
	2363.26	572.8	25.45	
	2391	514.7	22.88	

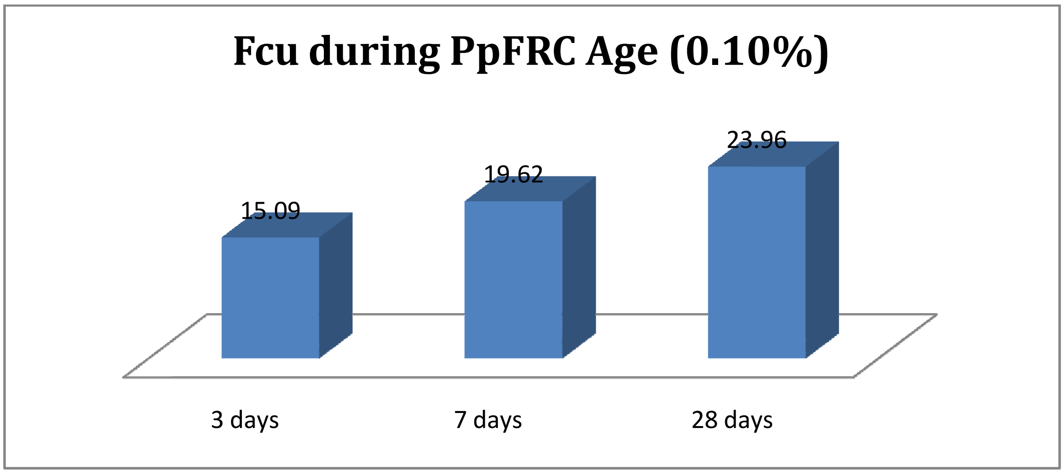


Figure (55): Results of compressive strength for control mixes (Polypropylene Fiber = 0.10 %, 2.38 Kg/m^3).

PpFRC with 0.10% decrease the compressive strength 4.16% at 28 days

Table (18): Results of compressive strength for control mixes (Polypropylene Fiber = 0.15%, 3.57 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2023.70	285.5	12.69	**12.89**
	2389.00	277.6	12.34	
	2308.44	307.3	13.65	
7days	2344.30	394.5	17.53	**16.22**
	2342.22	366.0	16.27	
	2372.74	334.3	14.84	
28days	2347.11	465.6	20.68	**22.14**
	2336.89	498	22.13	
	2363.41	531.2	23.60	

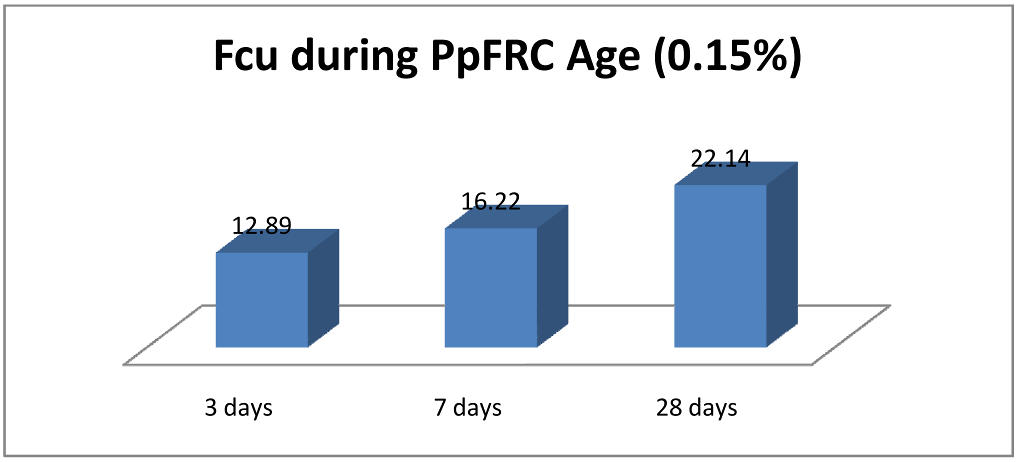


Figure (56): Results of compressive strength for control mixes (Polypropylene Fiber = 0.15%, 3.57 Kg/m^3).

PpFRC 0.15% decrease the compressive strength 11.44% at 28 days

Table (19): Results of compressive strength for control mixes (Polypropylene Fiber = 0.20%, 4.76 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2634.37	331.2	14.72	**14.04**
	2376.00	299.5	13.3	
	2505.19	315.35	14.01	
7days	2309.33	334.5	14.86	**15.65**
	2341.33	404.3	17.97	
	2407.70	317.6	14.11	
28days	2349.04	490	21.8	**21.71**
	2389.3	519.7	23.1	
	2414.82	455.9	20.24	

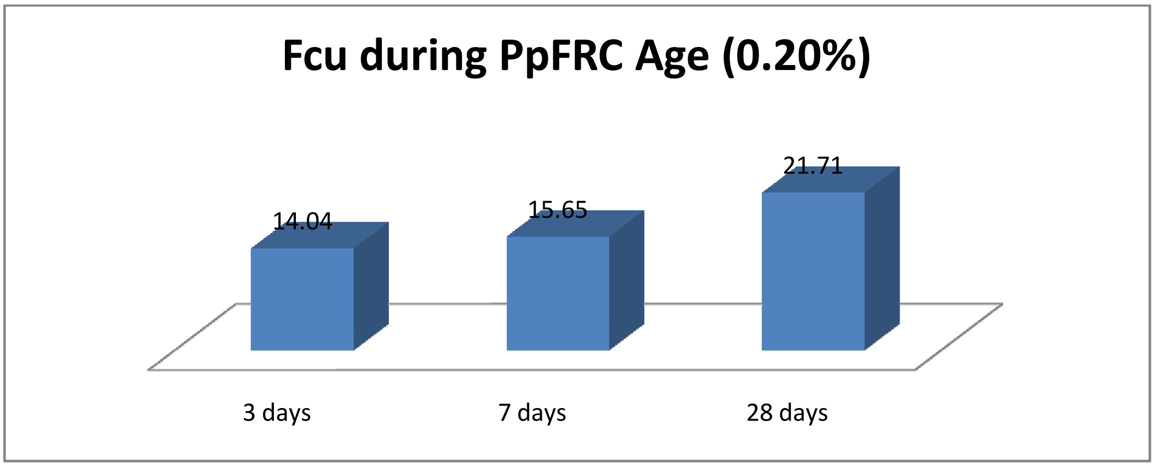


Figure (57): Results of compressive strength for control mixes (Polypropylene Fiber = 0.20%, 4.76 Kg/m^3).

PpFRC 0.20% decrease the compressive strength 13.16% at 28 days

Table (20): Results of compressive strength for control mixes (Polypropylene Fiber = 0.25%, 5.95 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2342.52	220.9	9.82	**9.44**
	2377.19	228.3	10.15	
	2304.30	187.9	8.35	
7days	2338.96	294.8	13.10	**15.19**
	2309.63	347.0	15.42	
	2386.07	338.9	17.06	
28days	2333.33	4115.2	25.00	**23.85**
	2393.78	395.3	23.55	
	2368.89	432.2	23.00	

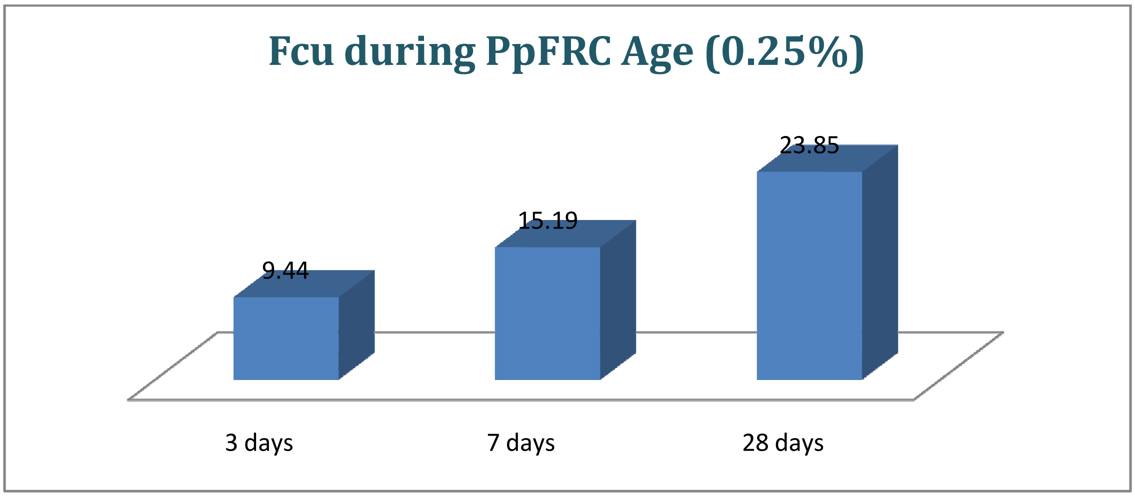


Figure (58): Results of compressive strength for control mixes (Polypropylene Fiber = 0.25%, 5.95 Kg/m^3).

PpFRC 0.25% decrease the compressive strength 26.36% at 28 days.

Table (21): Results of Compressive strength for control mixes (Polypropylene Fiber = 0.30%, 7.14 Kg/m^3).

Age	Density of cube (kg/m^3)	Ultimate Load (kN)	Compressive strength (N/mm^2)	Mean Compressive strength (N/mm^2)(fcu)
3 days	2425.8	338.7	15.05	**15.65**
	2386.96	406.2	18.05	
	2424.59	311.9	13.86	
7days	2472.89	364.6	16.20	**21.25**
	2423.70	628.8	27.94	
	2366.52	441.3	19.61	
28days	2379.26	549.6	24.42	**26.51**
	2446.52	597.1	26.52	
	2438.22	631.4	28.06	

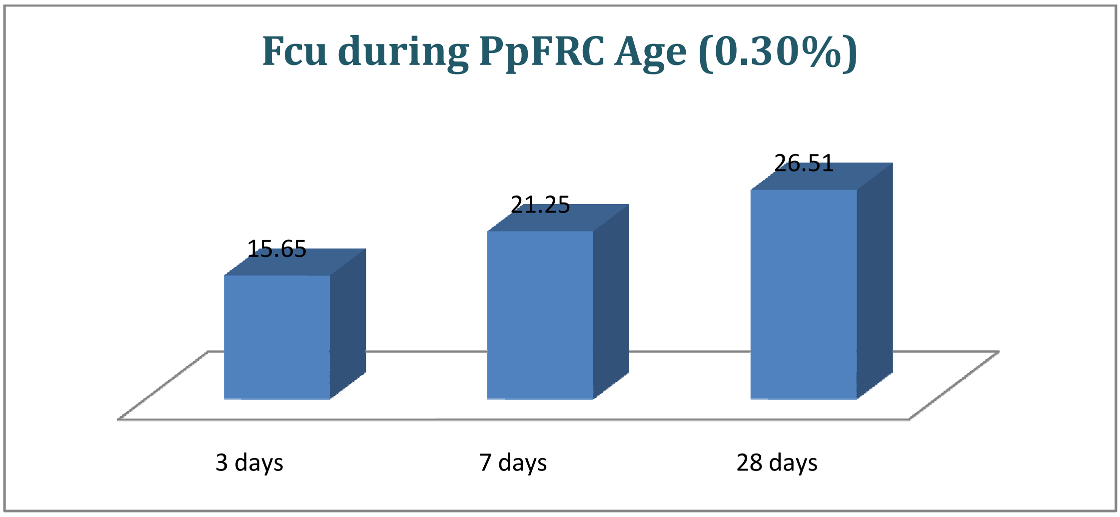


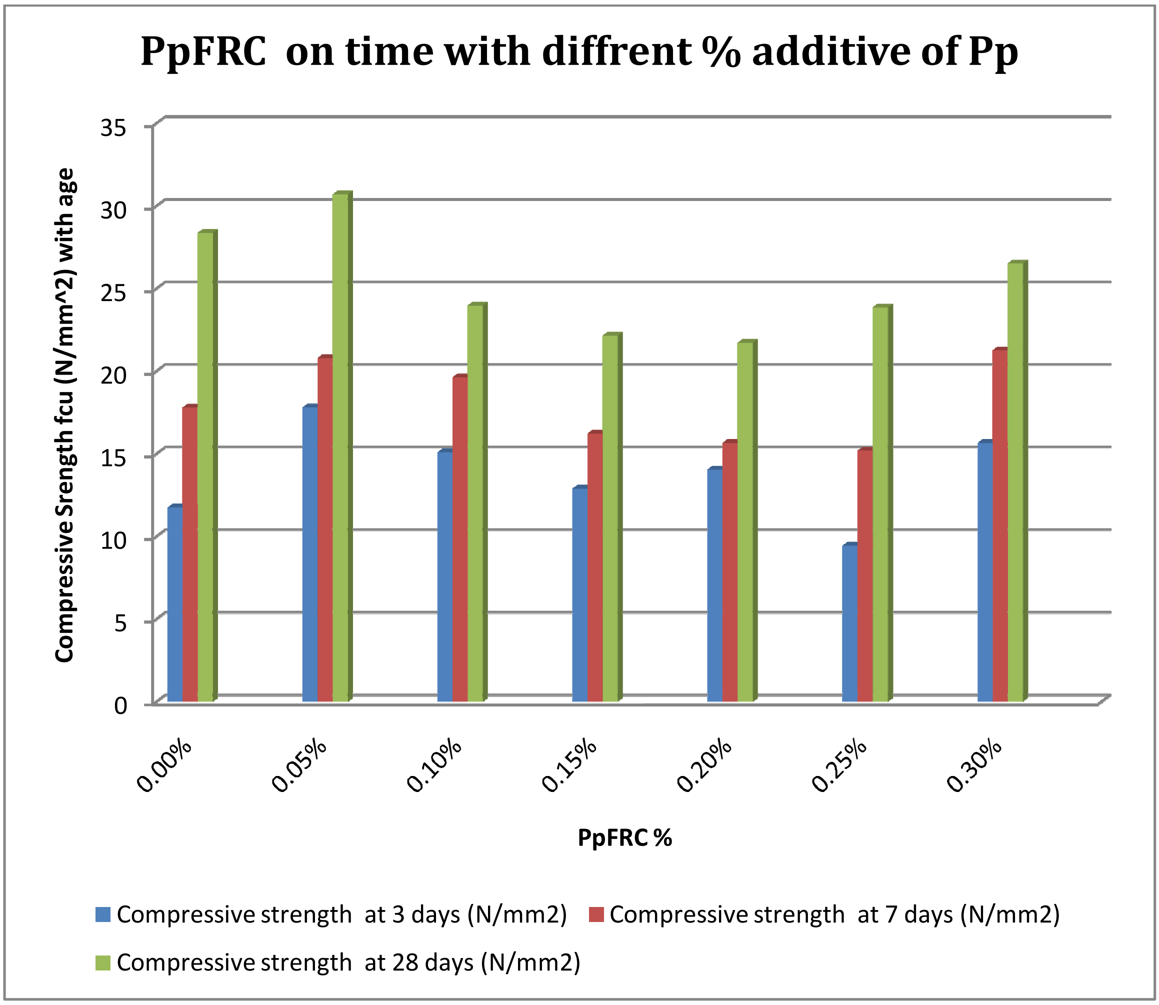
Figure (59): Results of Compressive strength for control mixes (Polypropylene Fiber = 0.30%, 7.14 Kg/m^3).

PpFRC 0.30% increase the compressive strength 6.04% at 28 days, this percentage is a critical point which up to high volume of fiber content

The tests conducted by researchers showed that the compressive strength, tension strength and bending strength increased with higher fiber volume, while concrete liquefaction decreased (Saeid *et al.,* 2012).

Table (22): Compressive strength of PpFRC in Low Volume Percentage.

Age	3 days	7 days	28 days	
Pp FRC	Compressive strength fcu (N/mm^2)			(%) Increase or Decrease from fcu
0.0 % 0.00 Kg /m^3	11.74	17.79	28.36	+ 13.41
0.05% 1.18 Kg /m3	17.80	20.79	30.69	+ 22.76
0.1% 2.38 Kg /m3	15.09	19.62	23.96	- 4.16
0.15% 3.57 Kg /m^3	12.89	16.22	22.14	- 11.44
0.20% 4.76 Kg /m^3	14.04	15.65	21.71	- 13.16
0.25% 5.95 Kg /m^3	9.44	15.19	23.85	- 26.36
0.3% 7.14 Kg /m^3	15.65	21.25	26.51	+ 6.04



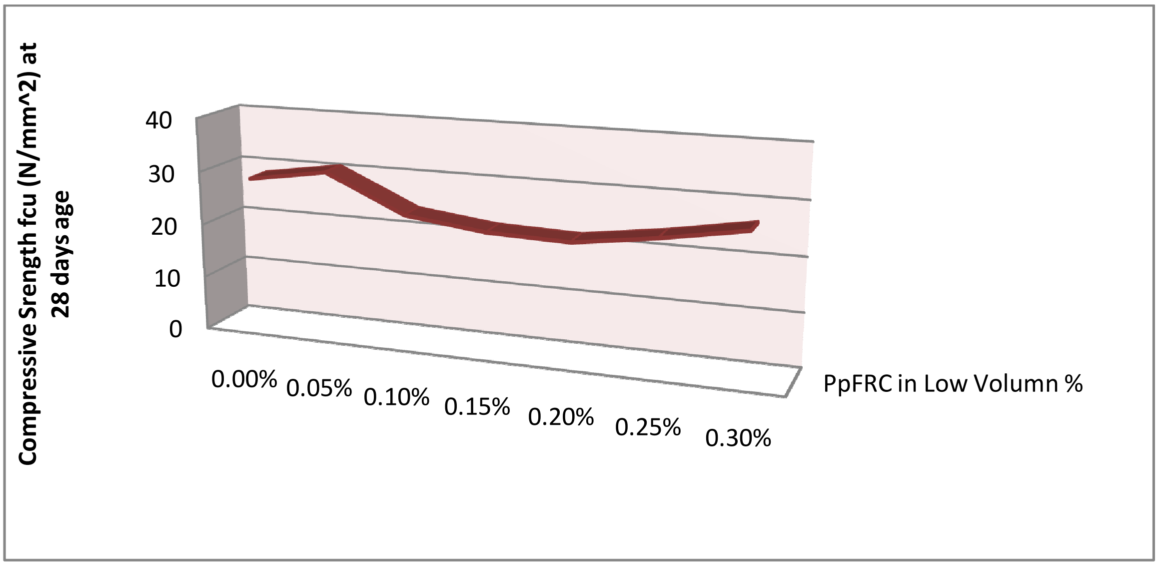


Figure (60): Compressive strength and PFRC in Low Volume Percentage.

From the chart above we observed that the some increase in percentage of polypropylene used increases of compression strength specially in early age but had decreased in compressive strength at 28 days gradually until 0.2% these is retain to decreases in slump without enough quantities of polypropylene which is necessary to decreases crack similar to (Hamed *et al*., 2016) which observed that the compressive strength decreased up to 1.5 % fiber content. But whence the polypropylene had become in concrete with suitable quantities it observed that the compressive retain up and increases step by step grow with develop on polypropylene, addition of fibers to concrete makes it a homogeneous and isotropic material, it becomes more ductile and increases the resistance against crack growth. When concrete cracks, the randomly oriented fibers start functioning, arrest crack formation and propagation, and thus improve strength gradually to 0.30%. From the above we observed that percentage of the fiber have a great value to decided the PpF function when these percentage increases above 0.15% grow to high volume fiber contain PpFRC increases the compressive strength by than control the crack which have an a good impact at failed mode but it difficult to used without plasticizer because of boor workability.

Generally , we observed that we have no sufficient effect of PpF in compressive strength , but we have 8% enhanced in compressive strength when we add 0.05% volume from PpF , which is the best percentage ,

From this research we observed similar to some researchers showed that the compressive strength, tension strength and bending strength increased with higher fiber volume, while concrete liquefaction decreased (Saeid *et al.,* 2012). The increase of fiber content slightly increases the ductility of axially loaded specimen., also (Zollo, 1984) said

“ Reports on compression strength, splitting tensile strength, and flexural strength tests generally result in the conclusion that significant improvement in these strength properties will not be observed in mature specimens when synthetic fibers are applied at relatively low (0.1 to 0.2) volume percentages “.

In general from these study we observed that, the samples with fibers content of 0.05% ,1.18 kg/m3and 0.3% ,7.14 kg/m3 showed optimum results in comparison with other samples in this study these percentage had progress the compression strength by 22% and 6%, also that consolation equivalent with (Saeid *et al*., 2012) which said “ According to the results of compressive strength tests, the concrete compressive strength increased proportionately with the increase in volume ratios of propylene fibers, the highest strength values were seen in the volume ratios of1.5 kg/m3 and 2 kg/m3”. (State-of-the-Art Report on Fiber Reinforced Concrete). Other researchers said “The optimum percentage of polypropylene to be added to the concrete mix to increase the compressive strength lies around 0.25%. “(Anthon and Abimbola, 2014). Which have progress in the compression strength in this research. Dr.T.Ch.Madhavi *et al*., (2014) also observed that the compressive strength increased gradually from 0.15% to 0.3% fiber content. Most of research observed a similar result of these study concluded by (Kolli, 2013) which said “ The Compressive strength and splitting tensile strength tests reveals that, the strengths were increased proportionately with the increase in volume ratios of Polypropylene Fibers with reference to the controlled mix without fibers .

4.2.4.2 Result and discussions of Flexure Strength

Table (23): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.0 %).

Age	Density of cube (kg/m^3)	Flexure strength fb (N/mm^2)	Mean Flexure strength Fb (N/mm^2)
7days	2330.00	4.39	**4.43**
	2350.00	4.50	
	2345.00	4.40	
28days	2563.23	6.22	**6.06**
	2500.12	7.47	
	2557.09	4.50	

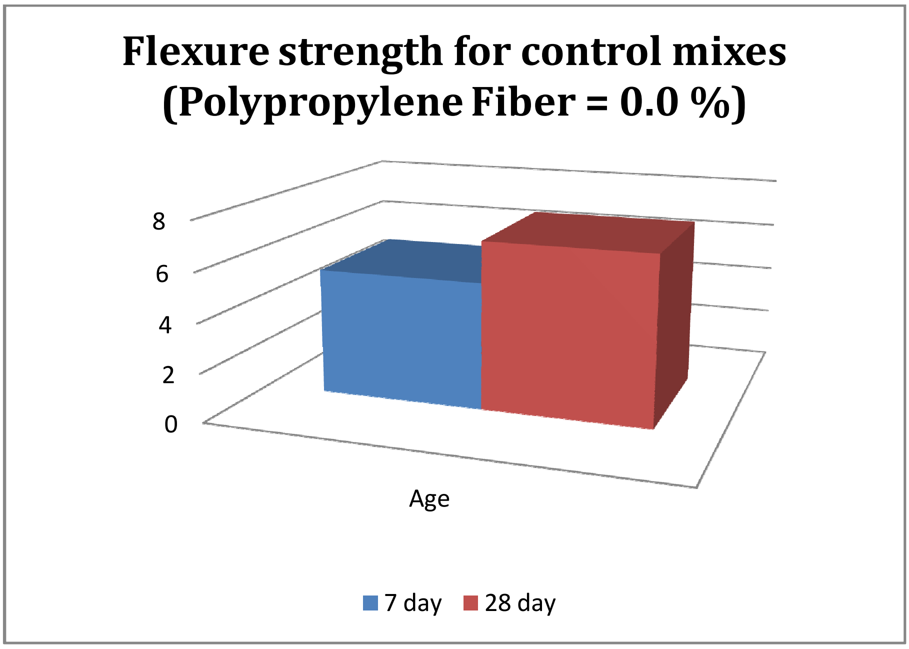


Figure (61): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.0 %, 0.00 Kg/m^3).

Bending strength in these percentage is as reference's to anther with Pp additive generally it should be 0.2-0.12 from fcu or Squ(0.85Fcu) *0.94 in these cases it is approve.

Table (24): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.05%).

Age	Density of cube (kg/m^3)	Flexure strength (N/mm^2)	Mean Flexure strength (N/mm^2)
7days	2380.00	3.67	**3.79**
	2400.00	3.800	
	2385.00	3.91	
28days	2400.00	5.93	**5.97**
	2469.25	6.04	
	2381.00	5.93	

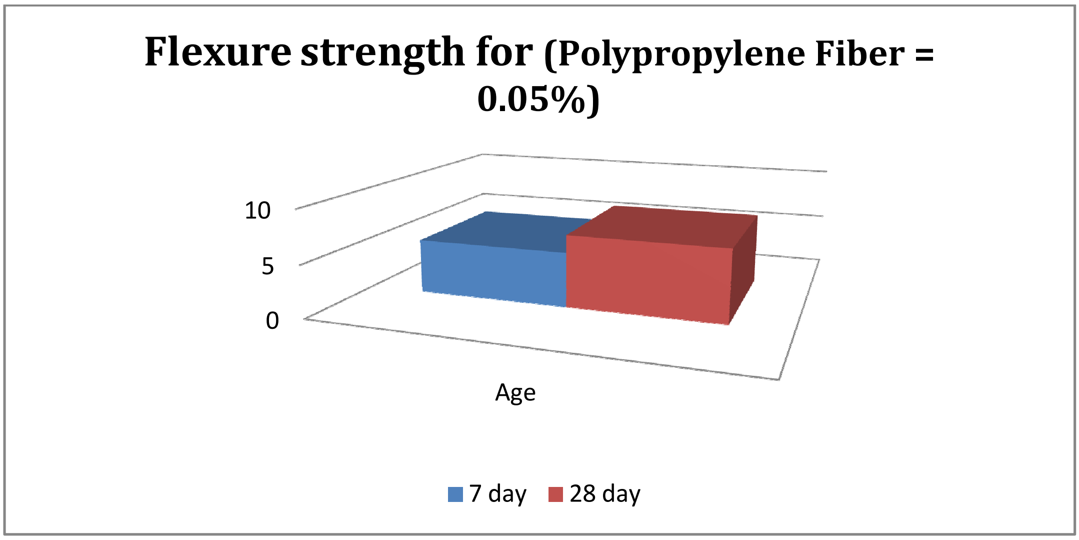


Figure (62): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.05%, 1.18 Kg/m^3).

Bending strength also approve but it observed that its decrees

Table (25): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.10%).

Age	Density of cube (kg/m^3)	Flexure strength (N/mm^2)	Mean Flexure strength (N/mm^2)
7days	2343.42	4.15	**4.48**
	2500.00	4.74	
	2542.2	4.6	
28days	2544.24	5.78	**5.9**
	2373.01	6.06	
	2478.47	5.87	

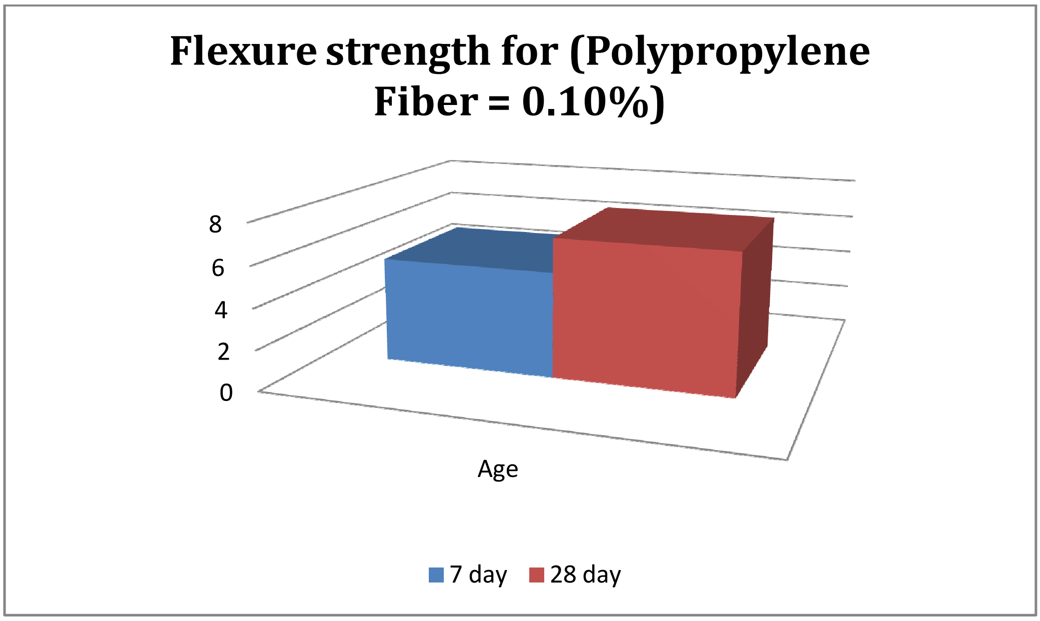


Figure (63): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.10%, 2.38 Kg/m^3).

Table (26): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.15%).

Age	Density of cube (kg/m^3)	Flexure strength (N/mm^2)	Mean Flexure strength (N/mm^2)
7days	2558.2	4.15	**4.46**
	2533.66	4.50	
	2500.00	4.74	
28days	2490.83	5.81	**5.59**
	2381.50	5.63	
	2373.25	5.33	

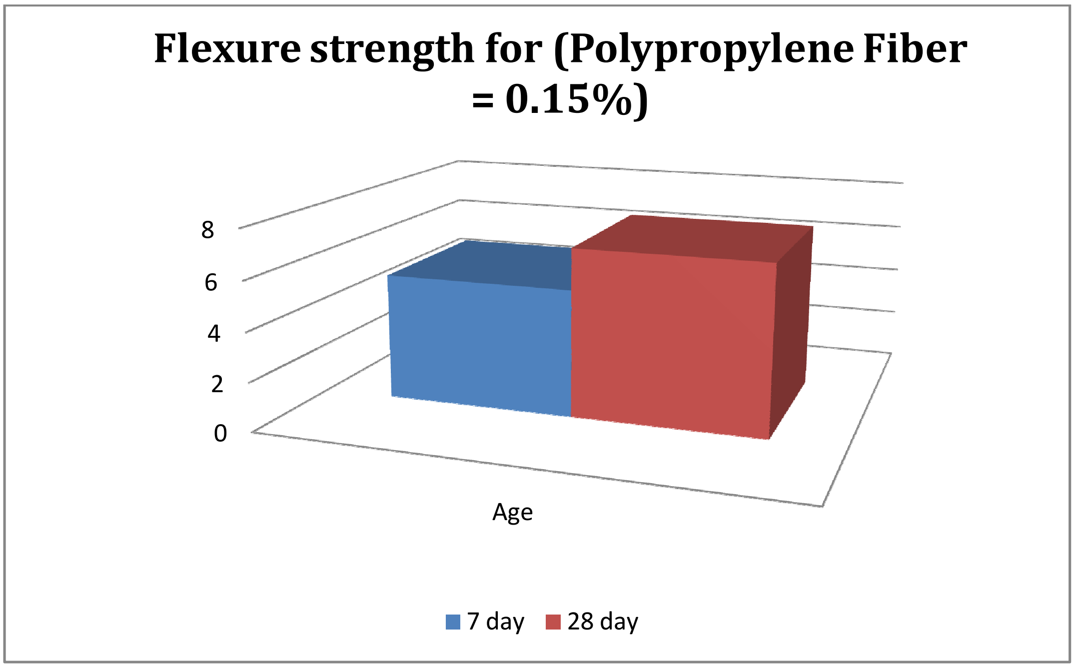


Figure (64): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.15%, 3.57 Kg/m^3).

Table (27): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.20%).

Age	Density of cube (kg/m^3)	Flexure strength (N/mm^2)	Mean Flexure strength (N/mm^2)
7days	2365.7	5.04	**4.5**
	2639.11	4.55	
	2550.00	3.91	
28days	2509.09	6.22	**5.97**
	2515.39	5.75	
	2527.19	5.93	

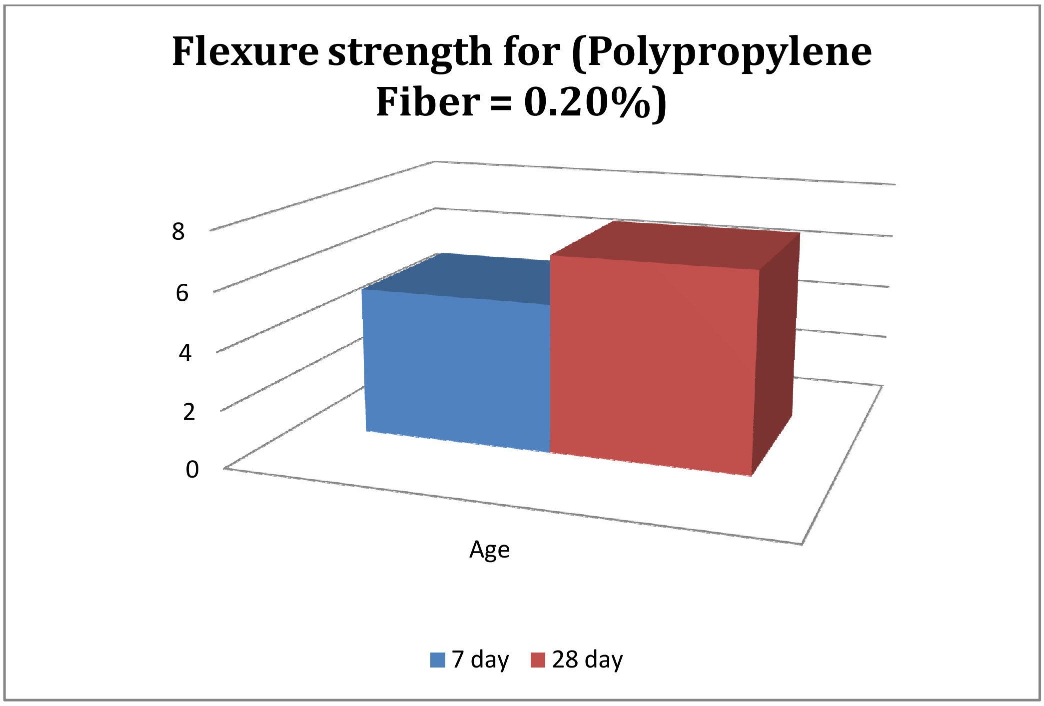


Figure (65): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.20%, 4.76 Kg/m^3).

Table (28): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.25%).

Age	Density of cube (kg/m^3)	Flexure strength (N/mm^2)	Mean Flexure strength (N/mm^2)
7days	2362.18	4.15	**4.37**
	2400.00	4.56	
	2534.87	4.44	
28days	2405.90	6.49	**6.44**
	2358.22	6.31	
	2382.06	6.52	

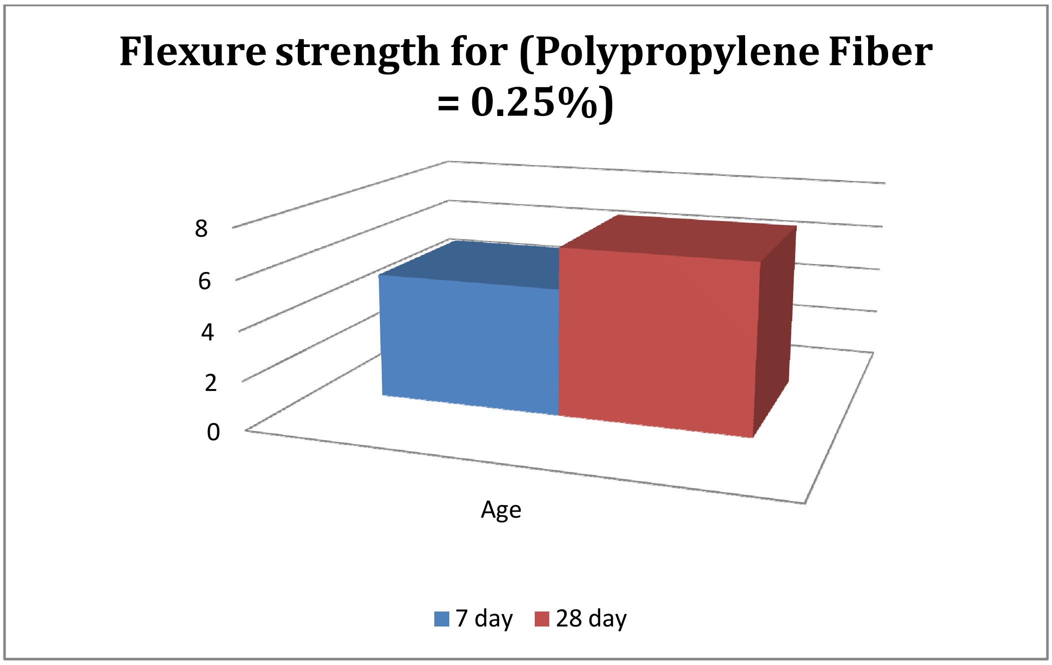


Figure (66): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.25%, 5.95 Kg/m³).

Table (29): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.30%).

Age	Density of cube (kg/m³)	Flexure strength (N/mm²)	Mean Flexure strength (N/mm²)
7days	2527.35	5.57	**5.19**
	2538.51	4.74	
	2525.00	5.25	
28days	2496.97	6.76	**6.78**
	2612.77	7.11	
	2358.38	6.47	

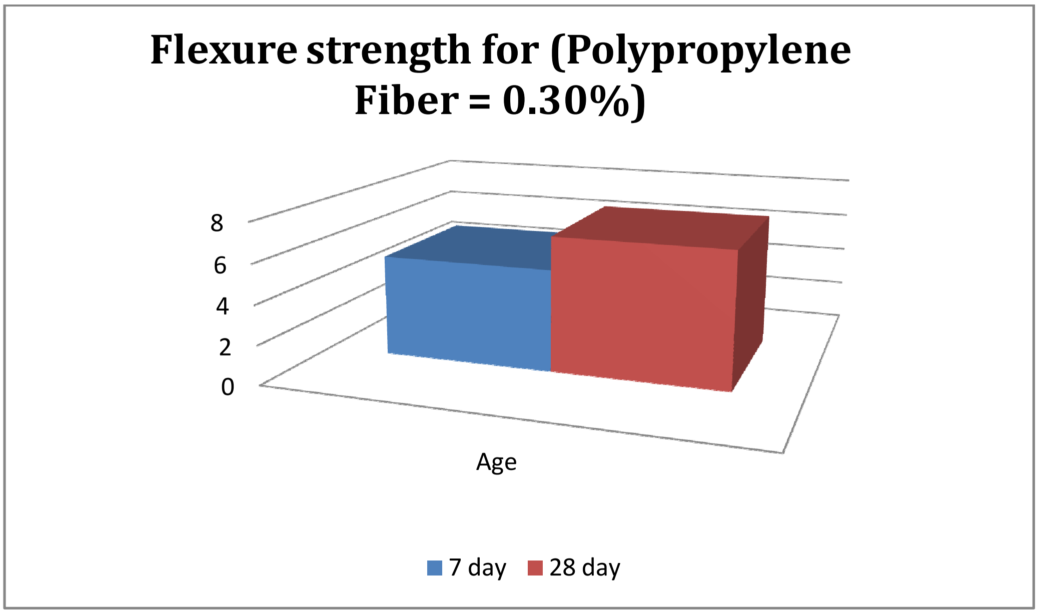
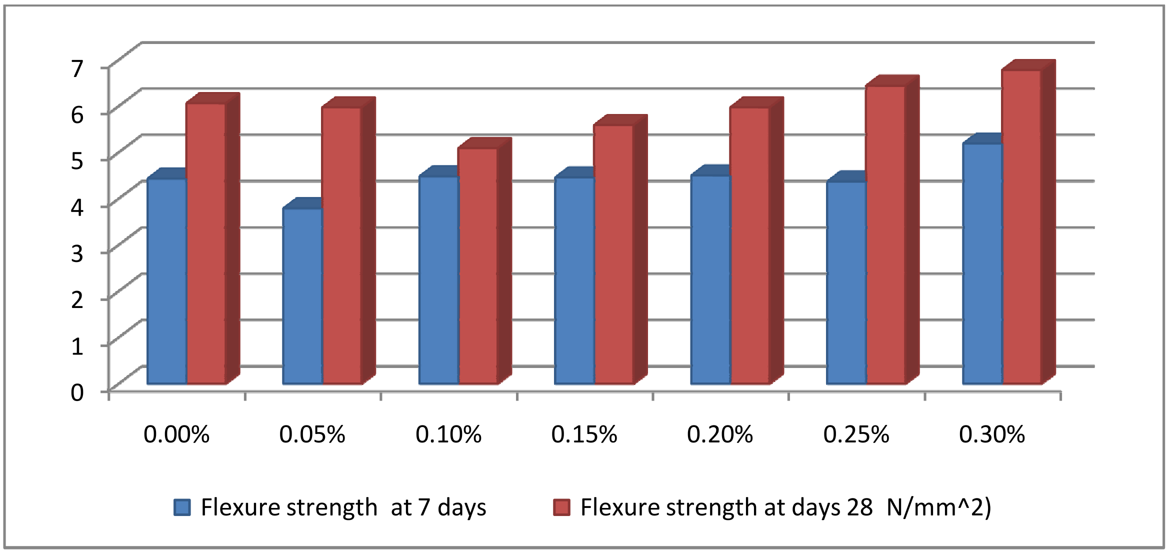
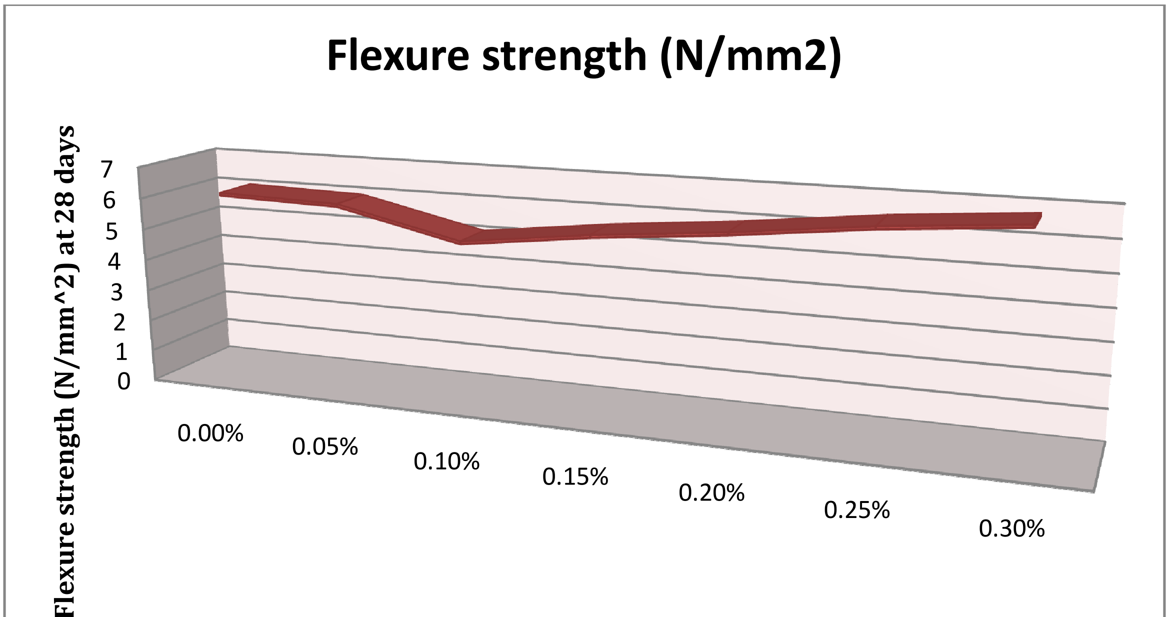


Figure (67): Results of Flexure strength for control mixes (Polypropylene Fiber = 0.30%, 7.14 Kg/m³).

Table (30): Flexure strength and PpFRC in Low Volume Percentage

Age	7 days	28 days	
%	Flexure strength (N/mm^2)		(%) Increase
0.00%	4.43	6.06	32
0.05%	3.79	5.97	19.4
0.1%	4.48	5.09	1.8
0.15%	4.46	5.59	11.8
0.20%	4.5	5.97	19.4
0.25%	4.37	6.44	28.8
0.3%	5.19	6.78	35.6





	0.00%	0.05%	0.10%	0.15%	0.20%	0.25%	0.30%
Flexure strength (N/mm2)	6.06	5.97	5.09	5.59	5.97	6.44	6.78

Figure (68): Flexure strength and PFRC in Low Volume Percentage.

Generally , we observed that adding PpF enhanced flexure strength , these increase of flexure strength retain to high mechanical properties of PpFRC , it become more ductility , bonding together , resistance the crack and more durability , flexure strength increase about 12% 8% when we add 0.30% volume from PpF , which is the best percentage ,

From chart above we observed some decreases in flexure strength in small % of PpF that is retain to the quantities of the fiber which is not enough to catch the crack and increases the strength that is equivalent to compression strength in same small percentage of PpF, for 2.0 percent by volume fibrillated polypropylene FRC, the compressive strength was low due to the higher air content and, hence, the flexural strength was also low. Similarly, for 1.0 and 1.5 percent fibrillated polypropylene fiber volumes, but the flexure strength developed by increases of Pp % in PpFRC during time, however, the addition of polypropylene fibers has a significant effect on the mode and mechanism of failure of concrete cylinders in a compression test, The fiber concrete fails in a more ductile mode. This is particularly true for higher strength fiber concretes (T.Ch.Madhavi *et al.,* 2014).

From the present study we observed that fibers improve the fracture properties of concrete also (T.Ch.Madhavi *et al.,* 2014) reported that fiber addition has significant control on the failure modes of concrete and random orientation of fibers improve the fracture properties of concrete.

We agree with (T.Ch.Madhavi *et al.,* 2014; Divya S *et al*., 2016; A. Saadun *et al*., 2016) whose which reported that the flexural strength increases with addition of fiber content, also (Anthony and Abimbola, 2014) the flexural strength of concrete increases by as much as 65% when low percentage fractions (0.25%) are added it is observed that the optimum dosage of polypropylene fiber is between 0.25% and 0.5% both for compressive strengths and for flexural strengths. There is about 80% increase in flexure strength by adding 0.20% fibers in concrete after which strength starts reducing with further increment in fiber ratios (Saeed *et al*.,2006; Hamed *et al.,* 2016). In that point we had a similar result to (Ramakrishnan *et al.,* 1987) Performance Characteristics and Fatigue of Polypropylene Fiber Reinforced Concrete,SP-105,(American Concrete Institute, 1996) whose reported that the modulus of rupture determined at 7 and 28 days was slightly greater for fibrillated polypropylene FRC at fiber contents of 0.1 to 0.3 percent by volume.

4.3 Modular of Failure:

Figure (69): Modular of Failure of PpFRC .

Photos above from as Laboratory test is sample from appendix which shown that Pp F tied the concrete together against fall even after break down with load it doesn't be spaces but still one piece until load increased to take it down. After the initial cracking has started, the fibers across the cracks will often be able to carry more load than other weak zones in the matrix. Therefore new cracks will continue to form in the brittle matrix. When many cracks have formed the fibers will have plastic deformations by being drawn out of the concrete matrix. The ultimate failure will happen when the fibers get completely drawn out of the concrete. This way the FRC will have a much more ductile behavior than regular concrete, and will have some residual capacity after the stress-strain diagram has reached its peak. Plastic shrinkage cracks were reduced compared to the control concrete by addition of 0.1–0.3% fiber. With an increase in the non-metallic fiber (polypropylene) content, the crack width significantly reduce for up to 0.25% fiber and cracks almost eliminated with 0.3% fiber addition. (G.M. SadiqulIslam and Sristi Das Gupta, 2016) also (Zollo *et al.*, 1986) reported plastic shrinkage reductions for polypropylene contents ranging from 0.1 to 0.3 percent by volume, this help to understand the reason of high quality in PpFRC failed mode (Zollo *et al.,*1986).

From this research we observed that PpFRC have a gradual and ductile failure in polypropylene fiber reinforced concrete similar to (T.Ch.Madhavi *et al.,* 2014) which found same conclusion. So the use of fibers helps in reducing the explosive type failure for concrete element (Abdul-Wahab *et al*., 1984; Craig *et al*., 1984).

However in PPFRC cubs and beams, after the occurrence of the first crack, a drop is observed in the load-deflection curve as the load is released and transferred from the matrix to the fibres, and afterwards that the element continues to with stand a portion of the load with increasing deformations and widening of the cracks . The PPFRC Cubs and beams continue to resist load with increasing deformations by virtue of the elongation of the randomly distributed discrete fibres and ultimately fails at large deformations as the fibres reach their maximum.

From the present study we observed that we agree with (Anthony and Abimbola, 2014) “Addition of fibers improves the post peak ductility performance, pre-crack tensile strength, fracture strength, toughness, impact, flexural strength resistance, fatigue performance etc. It have proved useful to controlling crack growth by inhibiting plastic and drying shrinkage from taking place there by reducing the permeability of concrete” also “It is significantly improves the crack control as it reduces the crack widths and crack spacing in the concrete which in turn reduces the ingress of water and chemicals that are known to be harmful to concrete thereby improving the long term serviceability and durability of built structures” (Jun and Frank, 2016).

4.4 Summary of Research

The primary objective of this study was to evaluate the effect of PpF with in Sudanese local concrete, also to Know the optimal quantity of polypropylene fibers for improved behavior and properties of concrete. The addition of low percentage volume of polypropylene fiber in the concrete mix showed positive effects on flexure strengths of concrete with increases of PpFRC percentage , the best percentage is 0.30% . On the other hand ,the best percentage of PpF on compressive strength0.05% but generally PpF have no sufficient effect on compressive strength, on fresh concrete we observed that workability were decrease with increase in PpF content , above that , PpF reduce blending , segregation and plastic shrinkage crack of fresh concrete. Failure become ductility and gradually with in time.