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ARTICLE

Compressive and Flexural Strength Property Enhancement for Fibre Reinforced M30, M50 and M80 Grade Concrete Using Foundry Sand (FS) and Crushed Concrete Waste (CCW)

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ABSTRACT

Nowadays, many research works are carried for all grades of concrete to make the concrete most economical and durable there by adding the supplementary cementitious materials and alternative replacement aggregates. In this research work deals with the experimental investigation of mechanical properties of the M30, M50 and M80 grade concrete by replacing the fine and coarse aggregate by foundry sand and crushed concrete waste respectively. Mix design procedures were followed as per IRC44:2017 guidelines and recommendation. Proper dosage of super plasticizer (SP) was maintained in the concrete to make it better performed. In this present investigation, a Poly Propylene fibre (PPF) of 0.3% by weight of the cement is used. Mechanical properties such as Compressive strength and Flexural Strength were determined by preparing the respective mould sizes for specific test and are cured for 7, 14 and 28 days and result obtained for respective days were tabulated and discussed.

1. Introduction

Concrete is the most extensively used construction material (CM) in the world, second to water. Increasing rate of industrialization and urbanization has led to over exploitation of natural resource such as gravel and river sand, which is giving rise to sustainability issues. High Strength Concrete (HSC) and High Performance Concrete (HPC) is the latest catch phrase in concrete technology. The High strength and High Performance Concrete (HSC) is becoming important concrete material for conventional concrete. The High Strength and High Performance Concrete (HSC & HPC) is obtained often, by decreasing the amount of W/C ratio, with the use of special admixture that also improves the workability [Admixtures such as water reducing agents, plasticizers (P), super plasticizers (SP), hyper plasticizers (HP) and hyper- hyper plasticizers (HHP)]. Proper Mix design for concrete plays a major role in getting the desirable concrete in construction field. Proper maintenance of W/C ratio makes the concrete more

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workable and Durable. By restricting the W/C ratio to extremely lesser percentage can achieve more strength in terms by using plasticizers (P) and super plasticizers (SP). Also, Proper gradation of the fine aggregates (FA) and coarse aggregates (CA) as per standard specifications and guidelines also becomes the factors for achieving strength of concrete.

1.1 IRC Recommendations

1.1.1 Salient Features of IRC 44-2017: (Guidelines for Cement Concrete Mix Design for Pavements)

The main objectives of IRC 44-2017 (Third revision) is to design the mixes to arrive at the very economical and practical combinations and the proportions of different ingredients to produce the concrete that will meet the performance requirements of the desirable grade of concrete under specified environmental condition. The main Scope of the IRC 44-2017 is to design the concrete mix as per the requirements by proportioning the concrete making materials in addition of other supplementary cementatious materials.

1.1.2 Salient Features of IRC: SP: 62-2014

The code IRC: SP: 62-2014 deals with the design and construction of cement concrete pavements (CCP) for low volume roads.

This specific code covers the design principles of rigid pavements of the low volume roads of about 3.75m wide (Minimum 3m wide in hills) made up of conventional concrete. Also, in this code the factors governing the design of concrete with respect to the traffic conditions are discussed.

1.1.3 Salient Features of IRC: SP: 46-2013 (Guidelines for Design and Construction of Fiber Reinforced Concrete Pavements-First Revision)

Scope: IRC: SP: 46 discuss about the use of fiber reinforced concrete in concrete pavements and the aspects are differentiated with conventional concrete. Discussed about the steel and polymeric fibers only with short length-60mm discontinuous fibers in the concrete pavements. Discussed about the use of fibers in a cement based matrix such as concrete, Micro-concrete and in use of concrete pavement and related repair structures. Normally, micro fibres of length 20mm gives better performance to control about plastic shrinkage crack in bridge decks, suspended slabs, slab-on-grade, pavements, white topping, wearing coat etc.

2. Literature Review

Sriram Aaleti, A.M [1] et al (2019) investigated the usage of a thin layer of ultra-HPC overlaying a normal strength concrete (NC) deck. They analysed the behaviour of the HPC by considering the performance and the durability. Also examined the UHPC and normal concrete composite deck for strength, roughness and curing conditions on the shear transferring behaviour of the concrete such as ultra- HPC and conventional concrete were determined.

Wadekar [2] et al (2016) carried out the experimental study to assess mechanical properties of high strength fiber reinforced concrete of grade M80 Mpa. They use the material for investigation such as silica fume, fly Ash and three types of fibers such as hooked end steel, flat steel fiber and Crimped steel fiber. Replacement was done for silica fume as 50percent and for fly ash it is 20 percent. For this investigation, maintained W/C ratio about 0.25. Each type of fiber of volume fraction is taken from 0.5% to 4.0 % with an increment of 0.5% by weight of cement material.

Jayachandra [3] et al (2015) conducted an experimental study on the possessions of concrete by using foundry sand as replacement of fine aggregate in high strength concrete (HSC). In this review it was found that replacement of sand by foundry sand by certain initial percentages gives a marginal increase in hardened properties of normal strength concrete. Annexation of foundry sand helps in enhancing the hardened properties of concrete to a margin of 25%.

Puneeth H C [4] et al (2018) conducted an experimental study on strength properties of Recycled Construction and Demolition Waste in concrete is investigated with five different replacement ratios including 20%, 40%, 60%, 80%, and 100%. The replacement of recycled materials was replaced for CA in M30 and M40 grade of concrete. From this study, it is found that an effective replacement of 45.75 % & 23.35% of RCA for M30 and M40 grade respectively.

Milind V. Mohod [5], et.al (2015) conducted an experimental study on the effects of addition of various proportions of PPF on the properties of High strength concrete (M30 and M40 mixes). The main aim of the investigation program is to study the effect of PPF mix by varying content such as 0%, 0.5%, 1%, 1.5% & 2% and finding the optimum PPF content. It was concluded that the increasing percentage volume of fiber added into the concrete would lead the workability decreased.

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3. Materials

From the above listed materials, priority of the materials is selected based on the many factors and the role in to consideration. The following materials are selected for the preparation of concrete, they are:

3.1 Cement

In this experimental work, OPC-43 & 53 grade was used and also two types of by-product materials were selected. The property of cement that was used conforms to the requirements of IS: 8112-1989 as shown in Table 1.

Table 1. Properties of Cement used

SL	Properties	Test results	IS : IS: 8112-1989 Requirements
1	Specific gravity	3.1	No Standard Valve
2	Standard consistency (%)	30	
3	Fineness (m2/kg)	300	Not less than 225
4	Setting time(mm)		
	a)Initial Setting time	59	Not less than 30
	b)Final Setting time	365	Not more than 600
5	Compression strength (Mpa)		
	For 43grade:- 3 days	23.6	23
	7 days	35.8	33
	28days	46.2	43
	For 53grade:- 3 days	33.2	33
	7 days	48.9	43
	28days	55.1	53

3.2 Fine Aggregate (FA)

3.2.1 River Sand and Foundry Sand (RS & FS)

RS & FS materials can be taken as surface Clean and Dry sand is used and locally available material. The various properties of RS & FS are listed below Table 2.

Table 2. Properties of Fine Aggregate

SL	Properties	Test results	IS : 383 Requirements
I	**Foundry sand**		
1	Specific gravity	2.46	2.2-2.7
2	Bulking of Sand	4%	-
3	Silt Content	Nil	Less than 8%
4	Abrasion Test	0.235	
5	Particle Size Distribution	2.7	Fine:FM:2.2 - 2.6 Medium:F.M:2.6-2.9 Coarse: F.M:2.9-3.2
II	**River sand**		
1	Specific gravity	2.45	2.2-2.7
2	Bulking of Sand	6%	-
3	Silt Content	4	Less than 8%
4	Particle Size Distribution	3.2	Fine:FM:2.2 - 2.6 Medium:F.M:2.6-2.9 Coarse: F.M:2.9-3.2

3.3 Coarse Aggregate (CA)

3.3.1 Natural Aggregate and Crushed Concrete Waste (NA &CCW)

Table 3. Properties of Coarse Aggregate

SL	Properties	Test result	IS : 383 Requirements
I	**Natural Aggregate**		
1	Specific gravity	2.46	2.2-2.7
2	Crushing Strength (%)	26.60	Not Less than 30%
3	Flakiness (%)	5.36	Less than 15%
4	Elongation (%)	14.76	Less than 15%
5	Impact Value	18.82	10-20% Strong
6	Water Absorption (%)	2.37	-----
II	**Crushed Concrete waste**		
1	Specific gravity	2.6	2.2-2.7
2	Crushing Strength (%)	16.3	Not Less than 30%
3	Flakiness (%)	11.4	Less than 15%
4	Elongation (%)	14.8	Less than 15%
5	Impact Value	4.79	<10%Exceptionally Strong
6	Water Absorption (%)	2.75	-----

NA & CCW aggregates are taken passing through 20 mm sieve and retained on 12.5 mm sieve and as given in IS: 383 - 1970 is used for all the specimens. The various properties of NA&CCW are listed below Table 3.

3.4 Water

Casting and curing of concrete specimens were done with the potable water. Water used in the preparation of concrete should be free from dirt and organic matters.

3.5 Super Plasticizer (SP)

To achieve the workability for concrete, super plasticizers are used. In this, poly carboxylic ether is used.

Conplast SP430 should complies with BIS: 9103-1999 and BS: 5075-part3 and ASTM C494.Super plasticizer molecules and cement grains are oppositely charged and hence repel each other and the properties of super plasticizes can be listed below Table 4.

Table 4. Properties of Super Plasticiser

SL	Properties	Test results	BIS: 9103-1999 Requirements
	Conplast SP430		
1	Specific gravity	1.18	1.0-2.0
2	Colour	Light Brown	
3	Plasticizer type	High performance super plasticizer	
4	Air entrainment (%)	1%	Less than 2%

3.6 Poly Propylene Fibers (PPF)

The raw material of polypropylene is derived from monomeric C_3H_6 which is purely hydrocarbon. Its mode of polymerization, its high molecular weight and the way it is processed into fibres combine to give polypropylene fibres very useful properties as explained in below Table 5.

Table 5. Properties of Poly-Propylene Fibers

SL	Properties	Test results
1	Colour	Natural White
2	Length	40mm
3	Cross Section	Rectangular (1x0.5 mm)
4	Density	0.91 kg/m3
5	Specific Surface Area	250 sq. m/kg
6	Water Absorption (%)	Nil
7	Melt Point	1600C
8	Ignition Point	3650C
9	Thermal & Electrical Conductivity	Low
10	Acid Resistance	High
11	Alkali Resistance	100%

4. Experimental Procedures

4.1 Mix Design, Means, Modes and Methods

In this experiment conducted the grades of concrete M-30, M-50, M-80. The mix design was carried out as per IRC 44-2017. The trials have been prepared on these different grades. All locally available materials are used during the preparation of the concrete mix.

4.2 IRC Method of Concrete Mix Design

Primarily it implemented in the design of Concrete Rigid Pavements on Road Construction.

The IRC method of mix design calculated for different grades such as M30, M50 and M80 grade of concrete. The mix proportions of various grades can be listed below Table 6.

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Table 6. Mix Proportion as per IRC 44-2017

Name of mixture	Proportions in Kg/m_3							
	Designation	Cement	Fine aggregate		Course aggregate		Admixture	Water
			NS	FS	NA	CCW		
M30 Grade								
M1	CC		650	0	1198	0		
M2	FS15		552	98	1018	180		
M3	FS30		455	195	838	360		
M4	FS45	360	357	293	658	540	4.5	150
M5	CCW10		585	65	1078	120		
M6	CCW20		520	130	958	240		
M7	CCW30		455	195	838	360		
M50 Grade								
M1	CC		467	0	1405	0		
M2	FS10		420	47	1265	140		
M3	FS20		374	93	1124	281		
M4	FS30	420	327	140	983	422	5.2	126
M5	CCW5		444	23	1335	70		
M6	CCW10		420	47	1265	140		
M7	CCW15		397	70	1195	210		
M80 Grade								
M1	CC		564	0	1329	0		
M2	FS10		508	56	1196	133		
M3	FS15		479	85	1129	200		
M4	FS20	450	451	113	1063	266	5.6	123
M5	CCW10		508	56	1196	133		
M6	CCW20		451	113	1063	266		
M7	CCW30		394	170	930	399		

4.3 Mixing of Samples

The mixing of ingredients is done with proper care and all materials were weighted properly and mixed in the laboratory concrete mixer. The water is added after all materials are feed into in mixer in proper order to enhance workability. In addition to the water super plasticizes (SP) was used in this experiment. To find the optimum dosage of super plasticizer (SP) we conducted Marsh Cone test.

4.3.1 Marsh Cone Test (Flowability Test)

Marsh cone testing method is used for finding the saturation dosage. Observation was made by taking the Super plasticizer (SP) dosage of 0%, 0.25%, 0.5%, 0.75%, 1.0%, 1.25%, 1.5%, 1.75% and 2.0% to the weight of cement into Consideration. Active performance of the cement with Super plasticisers (SP) is discussed in below Table 7.

Table 7. Marsh Cone Test results

SL	Dosage in %	Time in Sec
1	0	37.70
2	0.25	27.50
3	0.50	25.60
4	0.75	26.20
5	1.0	24.50
6	1.25	23.10
7	1.5	22.90
8	1.75	22.90
9	2.0	23.00

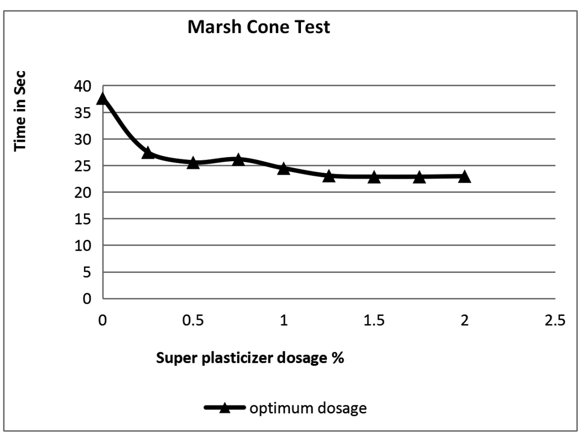

Figure 1. Graph representation of Optimum Dosage of SP

By observing the graph in Figure 1, the optimum dosage of super plasticizer (SP) is taken 1.25%.

4.4 Casting of Specimens

After all the materials are collected and mixed with proper manner. The cubes were filled of size 15 x 15 x 15 cm by partially replacement of FS and C&D waste and also specimens casted for the test on Hardened concrete. Compacted by using table vibrating machine or compacted using the tamping rod for around 25 times. The moulds were levelled properly and casted moulds, beams and cylinders.

4.5 Curing of Specimens

After casting the specimens like cubes, beams and cylinders. All the specimens were kept for 24 hours and then it is removed from mould and kept in curing tank till the testing days up to 7, 14, and 28 days.

4.6 Testing of Specimens

After completion of the curing the testing samples are dry about half an hour. After completely surface drying is done and then testing was done by universal testing machine of each percentage of three cubes. The prepared specimens are tested Mechanical properties of concrete such as Compressive strength (CS), Split tensile strength (STS), Impact test (IT) and Flexural strength (FST) of concrete for 7, 14, and 28 days of curing.

5. Experimental Observations

5.1 Tests for fresh concrete

5.1.1 Slump Test

Slump test is the one of the easy test to carry out the workability of the concrete both in field and laboratory. This type of test is done when the concrete is more workable and the slump value of concrete depends on the W/C ratio.

5.1.2 Compaction Factor Test

Compaction factor test is carried in the laboratory only to determine the compaction factor of the concrete. The concrete of very hard concrete can also determine using this test. Very low workable concrete can also be determined through this test.

5.2 Test for Hardened Concrete

5.2.1 Crushing Strength (CS)

Crushing strength test is carried to determine the

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amount of the compression load taken by the specific dimension of the concrete cube. The cube may be prepared with a standard size of 150mmx150mmx150mm and are cured and tested through compression test arrangement. The crushing strength of the cube can be calculated as compression load acting (P) on the cube to the area (A) of the specimen. The crushing strength of concrete can be expressed in terms of Mpa.

5.2.2 Split Tensile Strength (STS)

Split tensile strength test is carried out to determine the tensile capacity of the concrete sample in its hardened state. It's a method of determining the split tensile of concrete using a cylindrical which splits across the vertical diameter. The cube prepared for split tensile strength of concrete having cylindrical in shape dimensioned 150mm in diameter and 300mm length. The formula used based on IS: 5816-1970 guidelines.

5.2.3 Flexural Strength Test (FST)

Flexural strength test can be carried out through one point or two points loading excluding supports. The mould of size 100mmx100mmx500mm was prepared and cured for respective curing periods. To analyse the Flexural behaviour of the concrete in post cracking stages can be done through this test and can also determine the toughness characteristics of the concrete.

5.2.4 Shear Strength Test (SST)

Shear strength is the most extreme load required to remove an example such that the subsequent pieces or totally certain of each other.

This is experienced lust before a material cracks. The formula used based on IS: 516-1959 guidelines.

5.2.5 Impact Test (Dropping Weight Test) (IT)

The impact test or dropping weight test is one of the methods used to assess the impact properties of polymer. Computation of the impact strength was as follows:

Impact strength of sample= (W * h * n) N-m

Where, W= Weight of hammer=4.5 Kg=45N

H=Height of hammer-0.457m

N=Number of blows.

6. Experimental Results

6.1 Tests on fresh Concrete

6.1.1 Slump Test Results as Per IS 1199:1959

The slump values for various compositions are reported in Table 8 and graphical representation of those values are indicated in Figure 2.

Table 8. Slump values of the concrete

SL	Concrete Type	M30 grade Slump in mm		M50 grade Slump in mm		M80 grade Slump in mm	
		0%PP	0.3%PP	0%PP	0.3%PP	0%PP	0.3%PP
1	M1	48	40	20	17	22	12
2	M2	36	28	15	13	8	5
3	M3	30	25	15	12	0	0
4	M4	22	20	12	10	0	0
5	M5	20	20	14	12	9	0
6	M6	18	16	12	10	0	0
7	M7	18	15	12	8	0	0

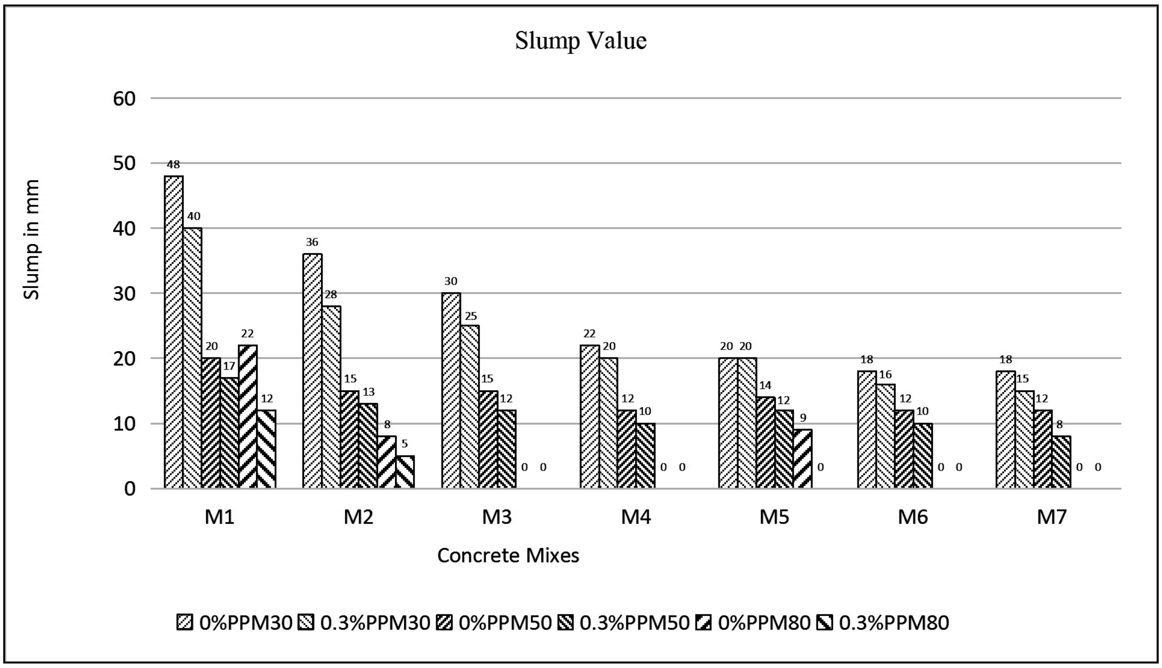

Figure 2. Graphical representation of slump test results

In above Figure 2, it can be observed that the various concrete mixes such as M1 to M7 gives the respective slump valves. In mix M1 gives the more slump valve about 48mm for without PPF and 40mm for with PPF and in the same manner for FS & CCW replaced materials are also calculated the workability will be decreases with the grade of concrete.

6.1.2 Compaction Factor Test as Per 1199:1959

The workability in terms of compaction factor for various compositions is reported in Table 9 and graphical representation of those values is indicated in Figure 3.

Table 9. Compaction factor values of the concrete

SL	Concrete Type	M30 grade Compaction factor		M50 grade Compaction factor		M80 grade Compaction factor	
		0%PP	0.3%PP	0%PP	0.3%PP	0%PP	0.3%PP
1	M1	0.95	0.94	0.88	0.86	0.84	0.67
2	M2	0.94	0.92	0.85	0.84	0.73	0.63
3	M3	0.94	0.93	0.84	0.81	0.69	0.62
4	M4	0.92	0.91	0.83	0.81	0.65	0.58
5	M5	0.91	0.90	0.80	0.78	0.76	0.63
6	M6	0.90	0.88	0.80	0.77	0.72	0.62
7	M7	0.90	0.86	0.78	0.77	0.71	0.62

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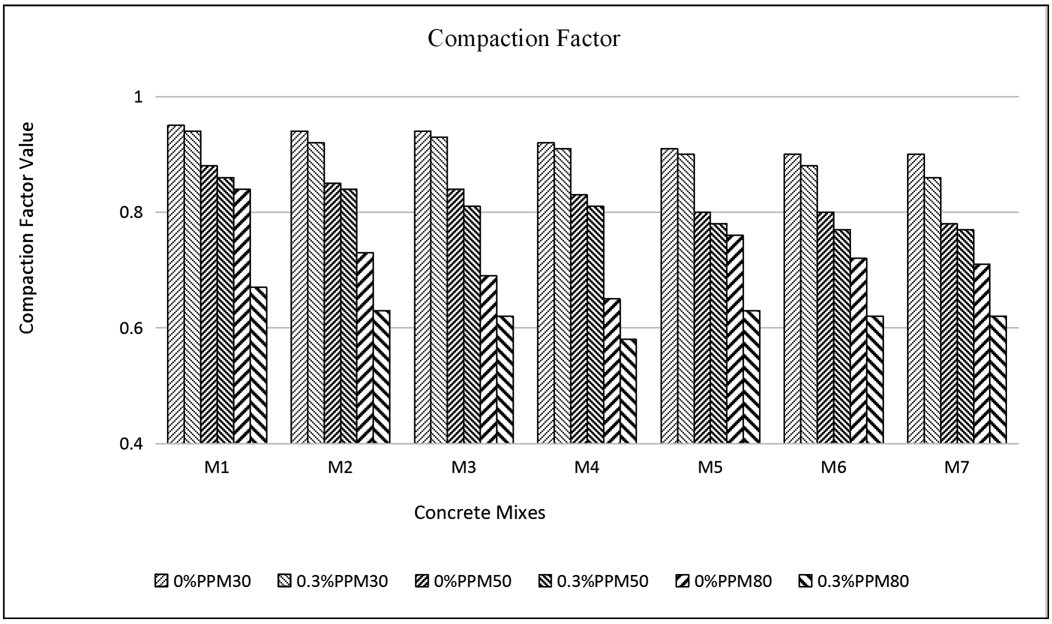

Figure 3. Compaction Factor Test results

Table 10. Crushing strength result of FS &CCW for 7, 14 and 28 Days of curing

Grade	Mix	FS						Mix	CCW					
		0% PP			0.3% PP				0% PP			0.3% PP		
		7 Days	14 Days	28 Days	7 Days	14 Days	28 Days		7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
M30	M1	26.07	36.14	40.88	27.99	37.47	48.29	M1	26.07	36.14	40.88	27.99	37.47	48.29
	M2	25.32	32.14	34.81	30.84	38.36	47.99	M5	22.66	32.88	36.29	23.55	24.59	40.88
	M3	29.92	36.44	41.66	34.66	39.85	53.47	M6	26.22	38.51	44.88	29.62	39.69	51.10
	M4	23.84	27.55	31.99	30.07	36.14	38.81	M7	21.18	23.70	38.69	20.29	34.07	39.99
M50	M1	39.70	56.59	61.48	44.29	58.22	65.18	M1	39.70	56.59	61.48	44.29	58.22	65.18
	M2	38.96	55.40	62.37	44.55	58.66	66.07	M5	41.77	57.48	62.66	45.33	58.51	64.29
	M3	43.25	57.77	64.59	47.55	60.29	68.88	M6	42.37	58.37	64.29	46.37	60.44	66.07
	M4	42.22	56.44	62.51	45.33	58.96	65.77	M7	41.18	56.44	61.03	42.96	57.33	64.29
M80	M1	61.92	85.33	96.74	64.14	86.81	101.03	M1	61.92	85.33	96.74	64.14	86.81	101.03
	M2	64.00	86.07	98.07	65.92	88.59	104.59	M5	61.48	84.44	95.11	63.55	86.37	101.03
	M3	65.62	87.70	101.14	67.25	91.20	106.22	M6	59.70	83.85	93.92	60.59	84.88	99.40
	M4	57.18	86.61	89.33	66.66	87.25	95.84	M7	59.11	82.81	93.18	60.59	82.37	97.33

In above Figure 3, it can be observed that the various concrete mixes such as M1 to M7 gives the respective compaction factor valves from these valves it can be observed that for M30 grade of concrete it various from 0.78-0.88. M50 grade of concrete it various 0.86-0.94. M80 grade of concrete various 0.71-0.84 and also after adding the PPF to the same mixes the compaction factor will be decreases.

6.2 Tests on Hardened Concrete to Find Optimum Replacements of FS & CCW

6.2.1 Crushing Strength Test Results for Partially Replacement FS and CCW

The crushing strength results for FS & CCW of various percentage replacements for 7, 14 and 28 days are detailed in Table 10 and the graphical representation of each test

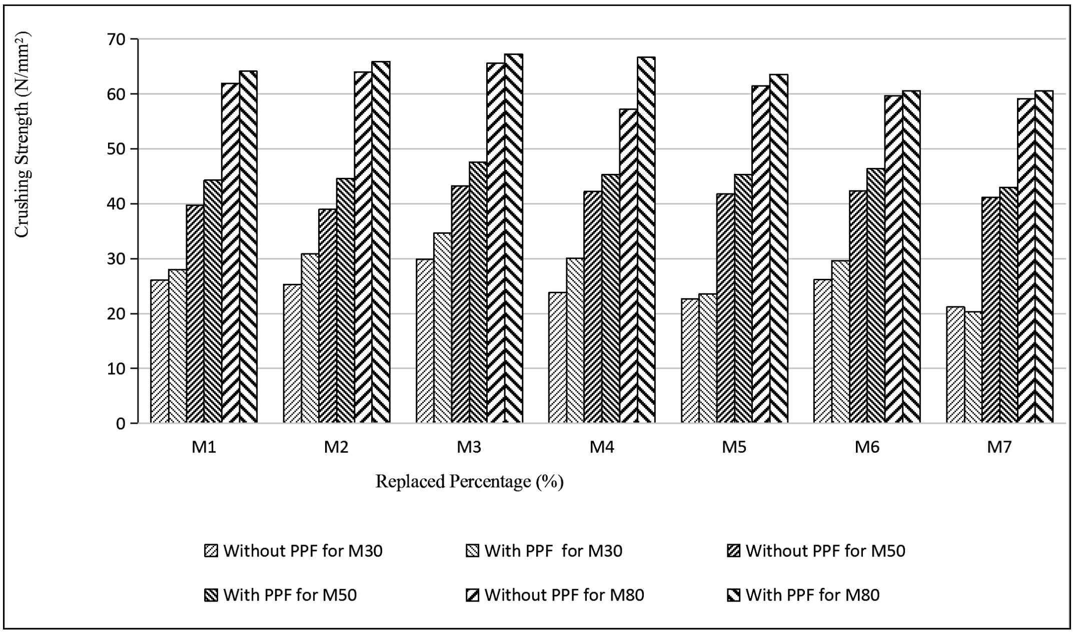

Figure 4. Graph showing Crushing strength of FS & CCW for 7 days curing

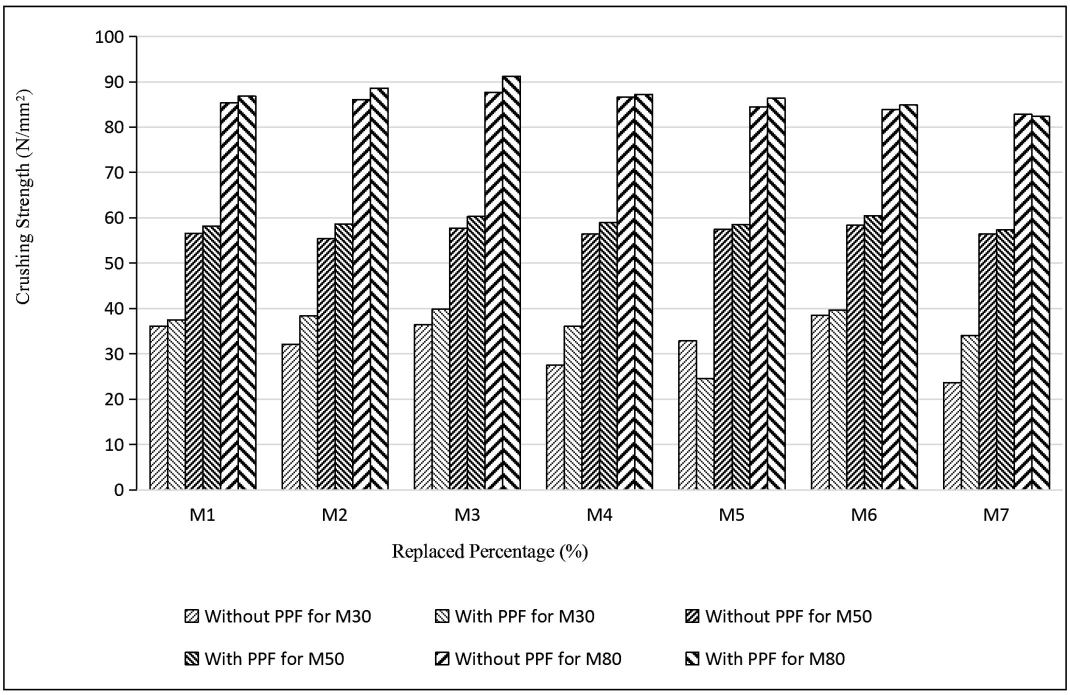

Figure 5. Graph showing Crushing strength of FS & CCW for 14 days curing

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results are shows separately in Figure 4, Figure 5 and Figure 6.

In above Figure 4, it can be observed that the Crushing strength (CS) of various mixes from M1 to M7 for 7days of curing. In which the Crushing strength (CS) as compared to the both with & without PPF. It shows that with fibers shows maximum Crushing strength (CS) as compared to the without fibers.

In above Figure 5, it can be observed that the Crushing strength (CS) of various mixes from M1 to M7 for 14 days of curing. In which the Crushing strength (CS) as compared to the both with & without PPF. It shows that with fibers shows maximum Crushing strength (CS) as compared to the without fibers.

6.2.2 Table 11. Density of Concrete

In above Figure 6, it can be observed that the Crushing strength (CS) of various mixes from M1 to M7 for 28days of curing. In which the Crushing strength (CS) as compared to the both with & without PPF. It shows that with fibers shows maximum Crushing strength (CS) as compared to the without fibers.

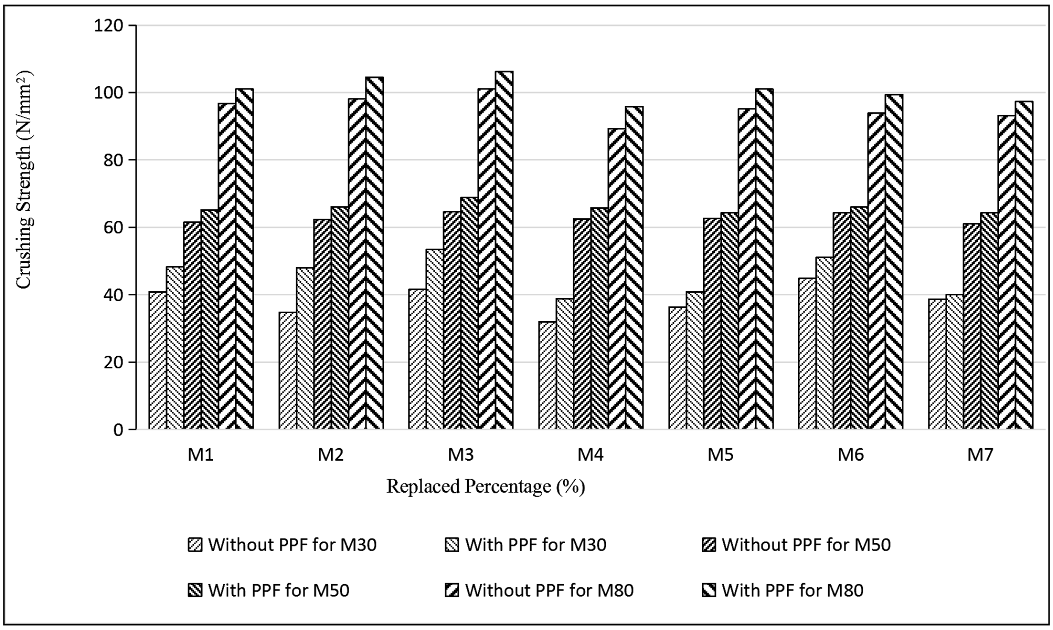

Figure 6. Graph showing Crushing strength of FS & CCW for 28 days curing

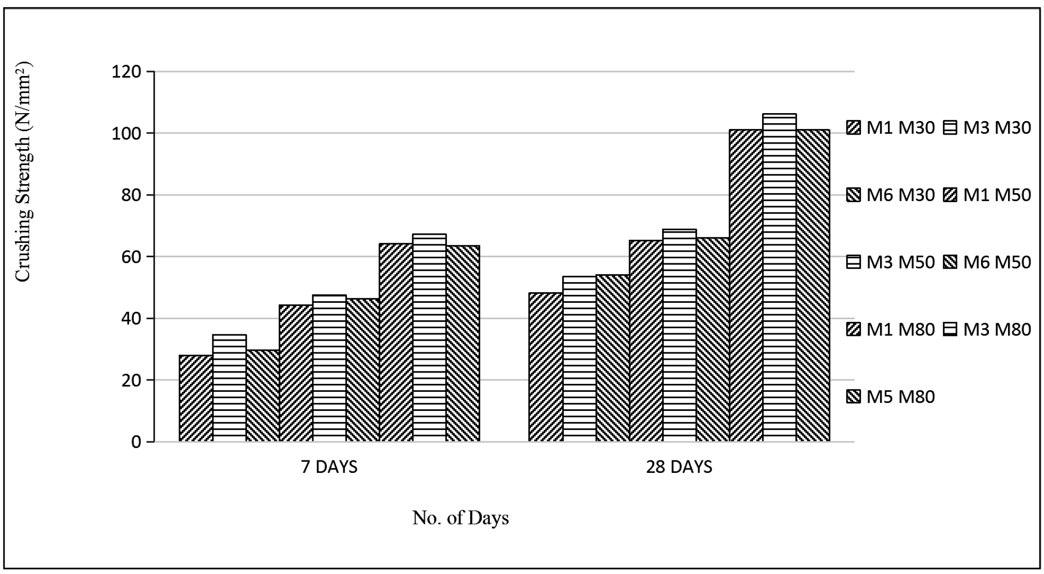

Figure 7. Graph showing Crushing strength of FS & CCW for 7 and 28 days curing

Table 11. Density of concrete

Grade	FS					CCW				
	Mix	0% PP		0.3% PP		Mix	0% PP		0.3% PP	
		Surface Dry	Oven Dry	Surface Dry	Oven Dry		Surface Dry	Oven Dry	Surface Dry	Oven Dry
M30	M1	8250	8060	8190	7090	M1	8250	8060	8190	7090
	M2	8260	8150	8200	8030	M5	8230	7980	8200	8070
	M3	8250	8130	8195	7990	M6	8200	7990	8170	7950
	M4	8300	8050	8210	8000	M7	8220	8110	8210	8000
M50	M1	8550	8360	8430	8220	M1	8550	8360	8430	8220
	M2	8620	8270	8590	8370	M5	8530	8310	8410	8200
	M3	8600	8310	8570	8350	M6	8540	8300	8440	8210
	M4	8680	8380	8650	8440	M7	8555	8340	8430	8190
M80	M1	8740	8490	8690	8470	M1	8740	8490	8690	8470
	M2	8800	8650	8770	8550	M5	8710	8500	8670	8250
	M3	8750	8530	8730	8610	M6	8730	8690	8650	8240
	M4	8780	8550	8750	8620	M7	8720	8500	8680	8260

Table 12. Hardened Concrete test results of FS &CCW for 7 and 28 Days of curing

SL	Tests	Days	M30 Grade with 0.3%PP			M50 Grade with 0.3%PP			M80 Grade with 0.3%PP		
			M1	M3	M6	M1	M3	M6	M1	M3	M5
1	Compressive strength test	7	27.99	34.66	29.62	44.29	47.55	46.37	64.14	67.25	63.55
		28	48.29	53.47	54.10	65.18	68.88	66.07	101.03	106.22	101.03
2	Flexural Strength test	7	3.14	3.82	3.02	3.38	4.75	3.88	8.5	8.0	7.5
		28	3.73	4.24	3.77	4.02	6.41	5.77	13.0	12.5	12.0

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6.2.3 Density of Concrete

The Water absorption test results for FS & CCW of various percentage replacements for 28 days are detailed in Table 11.

Tests on Hardened Concrete results for optimum replaced materials.

The test on Hardened concrete test results for Optimum replaced materials FS & CCW are detailed in Table 12 and the graphical representation of each test results are shows separately in Figure 7, Figure 8, Figure 9 and Figure 10.

In above Figure 7, it can be observed that the Crushing strength (CS) of various grades of concrete such as M30, M50 and M80 for 7 and 28days of curing respectively. By comparing this optimum mixes of M3, M5 and M6 to the conventional mix M1 mix. The Crushing strength (CS) of M3 & M6 has shown increases strength than the M1 mix for M30 grade, the Crushing strength (CS) of M3 & M6 has shown increases strength than the M1 mix for M50 grade and the Crushing strength (CS) of M3 shown increases strength and M5 shown decreases strength than the M1 mix for M80 grade for both 7 and 28 days of curing.

In above Figure 8, it can be observed that the Flexural strength test (FST) of various grades of concrete such as M30, M50 and M80 for 7 and 28days of curing respectively. By comparing this optimum mixes of M3, M5 and M6 to the conventional mix M1 mix. The Flexural strength test (FST) of M3 shown increases strength and M6 shown decreases strength than the M1 mix for M30 grade, the Flexural strength test (FST) of M3 & M6 has shown increases strength than the M1 mix for M50 grade and the Flexural strength test (FST) of M3 & M5 shown decreases strength than the M1 mix for M80 grade for both 7 and 28 days of curing.

7. Observations

Following observation are made based on the experimentation conducted for determining the mechanical properties of concrete with replacement of foundry sand and crushed concrete waste in concrete with and without adding the poly-propylene fibers are bellow:

It is observed that, materials which procured are functioned well and all the materials are satisfied the basic tests and strength requirements.

HPC with replacements are measured from slump and compaction factor and observation made that, the degree of workability goes on decreased as the percentage of replacements goes on increasing. This is due to the fineness of the foundry sand, its surface area and uniform in size and in coarse aggregate, due to the presence of pores in the crushed concrete waste, the absorption of water increases. With the addition of poly-propylene fibre into the concrete, still decrease in the value of the slump there by decrease in the workability of the concrete.

Crushing strength of Crushed concrete waste goes on decreased with increase in the percentage from 0-40% (for every 10% intervals) but the same concrete with

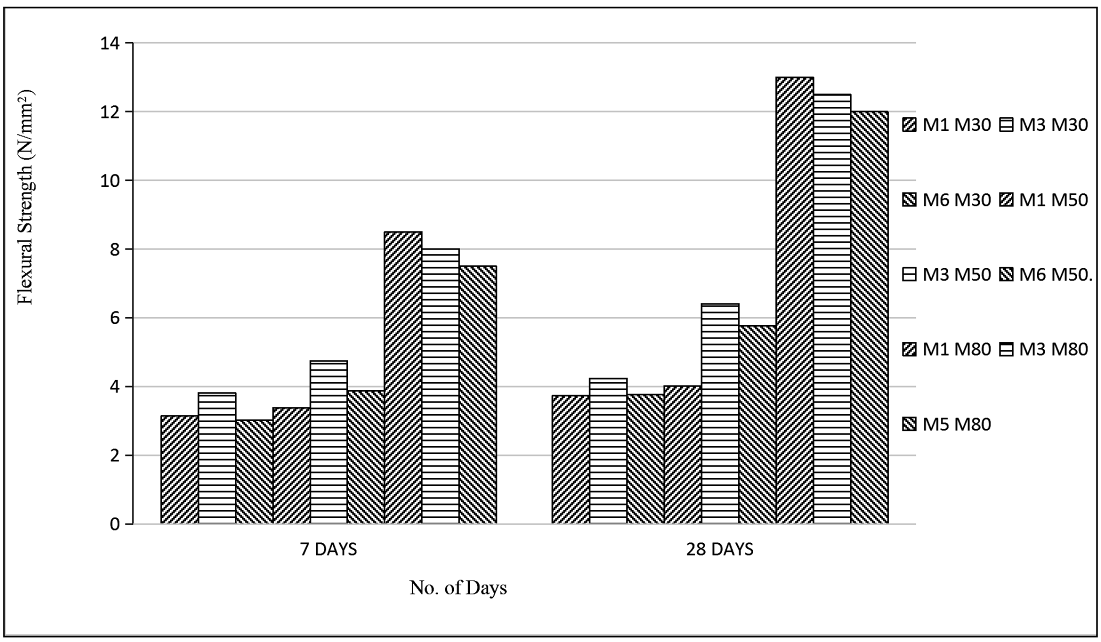

Figure 8. Graph showing Flexural strength of FS & CCW for 7 and 28 days curing

polypropylene fibre gives 5-10% increase in the crushing strength there by getting the optimum value of concrete with Crushed concrete waste as 10% with the addition of dosage of fibre as 0.3% and for 28 days of curing.

It is observed that the crushing strength of foundry sand goes on increased up to 15% replacement with and without adding the fibre into the concrete. But there is a 5-10% increase in the value of crushing strength of the concrete with the use of fibres. This is due to the internal bondage between the fibre and the concrete, initially concrete fails by compression there by transformation of load from concrete to fibre and since, the proper presence of gradation, aspect ratio of the fibre, tensile taking capacity of fibre, there is an increase in the crushing of concrete.

Flexural strength results obtained for HPC with the addition of fibres improved but with the addition of replacement aggregates to the concrete, there is a decrease in the Flexural strength. Observation says that, the bondage between the fibre and concrete may not be conditioned for bending test.

8. Conclusions

Workability property of the FRHPC with replacement decreases the slump value and same condition reflects to the fibered concrete also. But for the case compaction factor maintained less than 1 (Compaction factor <1). Shear slump obtained for all types of HPC in this present investigation.

Optimum value of crushing strength of Standard Concrete (SC), High Strength Concrete (HSC) and High Performance Concrete (HPC) compared with and without adding the Poly-Propylene fibres (PPF) for 7, 14 and 28 days of curing. Results obtained for Concrete are increase in its crushing strength for an optimum replacement of foundry sand from 15% up to 30% and Crushed Concrete Waste 10% to 20% for above mentioned three types of concrete.

Optimum replacements obtained from the crushing strength after 28 days of curing were selected and for those concrete mixes, the Flexural strength test of the concrete was conducted.

There is a substantial increase in the Flexural strength of the HPC by providing the poly-propylene fibres of dosage about 0.3% by volume of cementitious material for both conventional and replaced concrete.

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