International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 06, June-2019

EFFECT OF SUPER-PLASTICIZER BS FUTURA PCX 107 ON PPC CEMENT FOR M20 GRADE OF CONCRETE

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Abstract— M20 Grade of concrete is the minimum grade of concrete which can be used in structural members as per IS456:2000 and it is the most widely used grade of concrete in the construction field. Plasticizers and Super-plasticizers are also used in the concrete to enhance the different properties of concrete and increase the workability. BS FUTURA PCX 107 a Sodium Naphthalene Formaldehyde, Melamine or Lignosulphate based technology super-plasticizer as per EN 206-1 is readily available in the local region for this purpose and it is also widely used in the construction industry in a nearby area.

This study was conducted to quantify the advantages of the above super-plasticizer on the characteristic strength and the standard deviation of M20 grade concrete strength for the Mix designed proportion with a slump of 25-50mm. The study was performed on 40 of cubes out of which 20 were formed with super-plasticizer and 20 were formed without super-plasticizer. After 28 days, hardened concrete cubes were tested on the Compression testing machine (CTM) and then the cube-strength were analysed. The analysis confirms that the effect of super-plasticizer was as desired.

Keywords— Superplasticizer, Concrete, Characteristic Strength, Mix-Design and Frequency Distribution.

I. INTRODUCTION

Properties of a fresh concrete mix as well as hardened concrete mix are greatly enhanced by the use of super-plasticizers in almost all of the concreting work. A modern-day challenge faced by the engineers is the suitable use of admixture or superplasticizer which can be overcome by the judicious use of these property enhancers in concrete. However, there are also numerous disadvantages and drawbacks in concreting to this unanticipated increment of admixtures. High-performance concrete with a low water-cement ratio can be easily achieved by using Plasticizer/super-plasticizers. Despite the fact that various brands of admixtures are available in the market and they conform to the codal arrangements the impact of these admixtures when blended with concrete needs to be critically analysed.

For this study, the use of superplasticizer BS Futura PCX 107 was proposed along with Ultratech PPC cement. Its effect was desired for quality construction work. Quality of the concrete, which was made up of the locally available 20mm coarse aggregate (Well graded) and Sand (Zone II) as per IS383-1970 along with the above-mentioned cement and superplasticizer, were checked in the performed study.

II. EFFECTS ON FRESH MIXED CONCRETE

The Content of the concrete i.e. cement, aggregates, super-plasticizer (BS FUTURA PCX 107) and water were the materials of choice for this experiment. These were mixed with reasonable quality standards and the following mix design for the given slump of 25-50mm was chosen to perform the test:

TABLE NO: I
MIX PROPORTION WITHOUT SUPERPLASTICISER BY WEIGHT

Cement	Fine Aggregate	Coarse Aggregate	Water	w/c ratio
300 kg	774.8 kg	1225.3 kg	161 kg	0.537
1	2.58	4.08	0.537	0.537

TABLE NO: II
MIX PROPORTION WITH SUPERPLASTICISER BY WEIGHT

Cement	Fine Aggregate	Coarse Aggregate	Water	w/c ratio	Superplasticizer content
300 kg	895.8 kg	1100 kg	161 kg	0.537	0.5%
1	2.98	3.67	0.537	0.537	0.5%

Two sets each of 20 cubes were made for the test from the above mix ratio. The slump was only the 28mm when no superplasticizer was used. while in the second case the slump was observed to be 43mm. This was the first major advantage of superplasticizer on the slumps of concrete mix. Uniformity of mix was easily observed in the set with superplasticizer. Also, it was perceived that the concrete mix with superplasticizer provided a smooth surface on the top

without any segregation, whereas it was hard to achieve such a surface in the concrete mix without superplasticizer when the sets of the mix were poured and compacted in a mould of size150mm*150mm*150mm due to stiff mixing of the ingredients.

TABLE NO: III
LIST OF RESPECTIVE CUBE CRUSHING STRENGTH FOR THE SET OF CONCRETE WITHOUT SUPERPLASTICIZER

Cube No.	Peak Load (kN)	True Area (mm^2)	Reduction* (mm^2)	Net Area (mm^2)	Strength (N/mm^2)	Round Off (N/mm^2)	Frequency
1M20NS	513.4	22500	0	22500	22.82	23	3
2M20NS	449.3	22500	154	22346	20.11	20	1
3M20NS	493.7	22500	0	22500	21.94	22	3
4M20NS	538.3	22500	0	22500	23.92	24	5
5M20NS	612.9	22500	0	22500	27.24	27	2
6M20NS	519.9	22500	0	22500	23.11	23	3
7M20NS	670.3	22500	132	22368	29.97	30	1
8M20NS	480.9	22500	0	22500	21.37	21	2
9M20NS	511.8	22500	0	22500	22.75	23	3
10M20NS	563.2	22500	134	22366	25.18	25	2
11M20NS	543	22500	0	22500	24.13	24	5
12M20NS	533.7	22500	105	22395	23.83	24	5
13M20NS	477.5	22500	0	22500	21.22	21	2
14M20NS	493	22500	0	22500	21.91	22	3
15M20NS	581.5	22500	0	22500	25.84	26	1
16M20NS	501.5	22500	0	22500	22.29	22	3
17M20NS	600.6	22500	0	22500	26.69	27	2
18M20NS	570.8	22500	0	22500	25.37	25	2
19M20NS	530.7	22500	0	22500	23.59	24	5
20M20NS	533.8	22500	0	22500	23.72	24	5

(*The area due to broken corners)

TABLE NO: IV
LIST OF RESPECTIVE CUBE CRUSHING STRENGTH FOR THE SET OF CONCRETE WITH SUPERPLASTICIZER

Cube No.	Peak Load (kN)	True Area (mm^2)	Reduction* (mm^2)	Net Area (mm^2)	Strength (N/mm^2)	Round Off (N/mm^2)	Frequency
101M20WS	538.7	22500	0	22500	23.94	24	9
102M20WS	511.5	22500	0	22500	22.73	23	6
103M20WS	539.0	22500	0	22500	23.96	24	9
104M20WS	530.5	22500	0	22500	23.58	24	9
105M20WS	557.8	22500	0	22500	24.79	25	3
106M20WS	516.1	22500	0	22500	22.94	23	6
107M20WS	531.1	22500	0	22500	23.60	24	9
108M20WS	542.3	22500	0	22500	24.10	24	9
109M20WS	523.1	22500	0	22500	23.25	23	6
110M20WS	510.7	22500	126	22374	22.83	23	6
111M20WS	530.7	22500	0	22500	23.59	24	9
112M20WS	553.5	22500	0	22500	24.60	25	3
113M20WS	497.3	22500	0	22500	22.10	22	1
114M20WS	578.4	22500	0	22500	25.71	26	1
115M20WS	531.8	22500	0	22500	23.64	24	9

116M20WS	511.9	22500	0	22500	22.75	23	6
117M20WS	557.3	22500	0	22500	24.77	25	3
118M20WS	547.4	22500	0	22500	24.33	24	9
119M20WS	547.3	22500	0	22500	24.32	24	9
120M20WS	507.5	22500	0	22500	22.56	23	6

(*The area due to broken corners)

III. EFFECTS ON HARDENED CONCRETE

Crushing test of the cubes was performed after 28 days on a compression testing machine. Two sets of 20 cubes were crushed separately and their crushing strength is tabularized in Table III and IV for a concrete mix without and with superplasticizer respectively. A numerical coding was done for each cube in the set for ease of testing. An additional column, where the strength was mathematically rounded off to zero decimal places, is also included for the construction of frequency distribution curve.

The reductions due to broken corners of the cubes were considered in calculating the net area that successfully resisted the crushing load. In order to get the true compressive strength of concrete, the area of mould was considered as true area and the broken corners were measured and reduced. The results of the Compression test of the concrete cubes are tabularized in table no. III and IV.

Reduction in voids in the cube set with superplasticizer compared to that of without it was seen representing that better compaction is possible in concrete with the use of superplasticizer.

IV. FREQUENCY DISTRIBUTION CURVES OF CONCRETE

The frequency distribution curve from the compressive strength values is plotted in table III and IV to compare the variation of the magnitude of the compressive strength of the concrete. The frequency of the round-off value of the compressive strength of the cubes calculated in the last column was used for this

Excel was used to plot the curve with the data present in Table V given below. It was observed that the frequency of compressive strength of 24 MPa was highest in case of concrete mix with superplasticizer. While it is also observed that in the case of concrete mix without superplasticizer, the characteristic strength of the concrete cubes as per IS456 may be found as 21 MPa instead of design characteristic strength of 20 MPa, (the characteristic strength is that strength below which not more than 5 percent of the test result is expected to fall). But the Cubes with superplasticizer as per the definition of characteristic strength can be termed as 23 MPa instead of the design characteristic strength of 20 MPa.

TABLE NO: V
FREQUENCY DISTRIBUTION OF THE VALUE OF COMPRESSIVE STRENGTH OF THE TWO SET OF CUBES

Strength in MPa	**Set of Mix with No Superplasticizer**	**Set of Mix with Superplasticizer**
	No of Cubes	**No of Cubes**
20	1	0
21	2	0
22	3	1
23	3	6
24	5	9
25	2	3
26	1	1
27	2	0
30	1	0

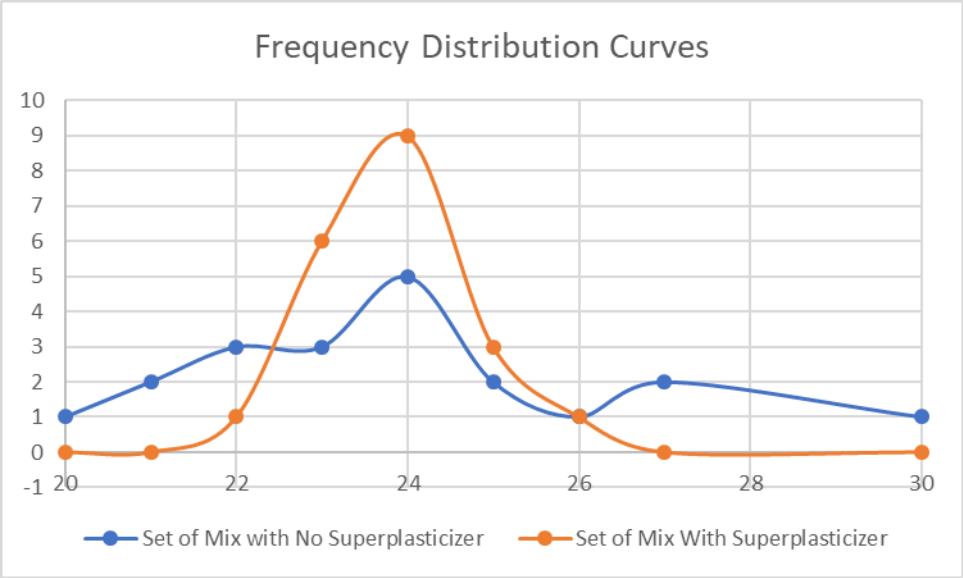

Fig. 1 The Frequency Distribution Curve of the results of the compressive strength of the concrete cube of two sets

V. CONCLUSIONS

1. In conclusion, the grade of M20 concrete made up of Ultratech PPC cement as used in this study along with the superplasticizer BS Futura PCX 107 as per EN 206-1 is advantageous at same slump of range 25-50mm as compared to the concrete made up of Ultratech PPC cement without superplasticizer.
2. Benefits in fresh mix of concrete:
3. 1. Greater Workability can be attained in fresh concrete
4. 2. Better mixing of ingredients of fresh concrete is possible
5. 3. Significant reduction in Segregation.
6. Benefits in hardened concrete:
7. 1. Sounder finishing can be possible in the concrete
8. 2. Fewer voids on the surface in contact with mould/shuttering
9. 3. Uniformity of the strength of the fresh concrete is possible when concreting is done in a mass
10. 4. Also, a slight enhancement of the strength was observed.

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