EFFECT OF ADMIXTURE ON DURABILITY AND STRENGTH OF CONCRETE

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Abstract: There are various materials used in construction but concrete is one of the most important and versatile material which is used in every part of the globe and is made up of cement, aggregates (fine aggregate and coarse aggregate) and water. In this thesis work, we made an attempt to compare the durability and strength properties of plain concrete and those of concrete with various admixtures. It is very important to take into consideration the durability and strength properties of concrete. Durability and strength has an indirect effect on economy, serviceability and maintenance. It has been found from the research that concrete loosed its properties when exposed to certain exposure conditions. This research is all about improving the durability properties of concrete which in turn improves the strength properties of concrete. Deterioration of concrete can occur by various factors like corrosion of steel, exposure of concrete to chloride ions, carbonation, alkali-aggregate reactivity, alkali-silica reactivity, freeze-thaw deterioration, scaling by de-icing chemicals, shrinkage, Sulphur attack, acid attack, etc. Use of admixtures (super-plasticizers) is a very effective way to overcome these effects. In this thesis, suitable admixtures (super-plasticizers) have been used to study their effect on durability and strength properties of concrete.
Keywords: Concrete, Durability, Strength, Admixture, and Super-plasticizers.

I. INTRODUCTION

Concrete is an artificial material obtained by mixing cement, coarse aggregate, fine aggregate and water in required proportion. The mixture when placed in forms and allowed to cure becomes like a stone. It is versatile and durableconstruction material. Concrete is strong, economical and alsoadopts the shape of the form in which it is placed. From the research and experience it has been observed that concrete is prone to deterioration so, it is necessary to take precautionary measures during the process of design and production. Research is being made all over the world to improve the durability properties of concrete and introduction of admixtures is one of the important ways to overcome this issue. An admixture is as a chemical product which is available in liquid and powdered form. In this research it is used liquid form. It should not be added more than 5% by mass of cement. Liquid state is usually used because itdisperses more rapidly than solid state in a uniform manner during mixing of concrete. Admixtures can be added to the concrete at the batching plant during the mixing or directly at the job site during mixing and then concrete is placed in form. In this research we tried to decrease the water cement ratio and because of this the concrete becomes stiff and difficult to mix. In order to increase the workability we had to use the admixtures so, we decided to use three different types of admixtures and check the effect of these admixtures on concrete. These admixtures replace the quantity of water in the same amount it is reduced. The mix is properly designed with standard Indian codes of practice.

II. METHODOLOGY

The overall objective of the present study is to study the effect of adding Admixture in concrete on its performance; however the task is divided in to specific objectives to achieve step by step through experimental procedures.

- A standard mould of size (15 x 15 x15) cm is used for cubes, 15 cm x 15 cm x 70 cm for beams and 150 mm diameter and 300 mm height for cylinders batching is done as per the weight of material for casting the cubes.
- The steel mould is properly assembled, cleaned and then lubricated in order to obtain clean surface and easy removal of specimen.
- The concrete mixture is mixed properly till it reached plastic state and then slump test is carried. After obtaining proper slump value the concrete mixture is poured into the moulds.
- After 24 hours the specimen is taken out from the moulds and the moulds are cleaned properly for future use.
- The specimen is then immersed in water for curing. With proper curing concrete gains strength and also absorb heat of hydration till the time it is taken out for testing.
- In our research the cubes are cured for 7 and 28 days while beams and cylinders are cured for 28days.
- The specimens while taken out from the curing tank are surface dried, cleaned and weighed before taken out for testing.

III. AMIXTURES USED

In this thesis we used three different types of admixtures (super-plasticizers) which are:

Auramix 400:

Advanced Low Viscosity High Performance Superplasticiser, based on Polycarboxylic technology.

Auramix 400 is a high performance superplasticiser intended for applications where high water reduction and long workability retention are required, and it has been developed for use in:

- Self-compacting concrete,
- Pumped concrete,
- Concrete requiring long workability retention,
- High performance concrete.

Properties:

Table: 1: Properties of Auramix-400

Appearance	Light yellow coloured liquid
pH	Minimum 6.0
Volumetric mass @ 200 C	1.09 kg/litre
Chloride content	Nil to IS:456
Alkali content	Typically less than 1.5 g Na2O equivalent / litre of admixture.

Auramix 200:
High performance Superplasticiser, based on Special Polymer technology.
Auramix 200 is a high performance superplasticiser intended for applications where high water reduction and long workability retention are required.
Properties:

Table: 2: Properties of Auramix-200

Appearance	Yellowish to Brownish liquid.
pH	Minimum 6.0
Specific Gravity @ 27 °C	1.03 – 1.07
Chloride content	Nil (As per BS:5075 Part I)
Alkali content	Typically less than 1g Na2O equivalent / litre of admixture.

BASF:
(Sodium Lignosulphonate Based Admixture)
Specifications
Ceramic additive sodium lignosulfonate CSA 8061-51-6
Basic information
Cas:8061 – 52-7
Formula: $C_{20}H_{24}CaO_{10}S_2$
Raw materials: 100% imported wood pulp

Properties:

Table: 3: Properties of BASF

Test Items	Specification
pH	10 - 12
Lignosulphonate	50 – 60 %
Dry Matter	≥ 93.0 %
Water Insolubles	≤ 1.5 %
Ca + Mg content	≤ 0.5 %

IV. MATERIAL SPECIFICATION

Coarse Aggregate Specification:

- Type:- Boulder Crushed
- Sp. Gravity:- 2.7
- Water Absorption:- 1.1%
- Free Surface Moisture:- 1.09%

Table: 4: Sieve analysis of Coarse Aggregate: 5kg sample

IS Sieve	Mass Retained (kg)	Mass Passing (kg)	% Passing	Limit as per IS Code
40mm	0.0	5.0	100%	100%
20mm	0.0	5.0	100%	95 – 100%
10mm	3.2	1.8	36%	30 – 70%
4.75mm	1.5	0.3	6%	0 – 10%
2.36mm	0.3	0.0	0%	---

Fine Aggregate Specification:
Sp. Gravity:- 2.65
Water Absorption:- 1%
Surface Moisture:- 1%
Zone:- 1

Table: 5: Grading of Fine Aggregates: 1kg Sample

IS Sieve	Mass Passing (g)	% Passing
10mm	1000	100%
4.75mm	920	92%
2.36mm	820	82%
1.18mm	530	53%
600μ	290	29%
300μ	130	13%
150μ	30	3%

Cement Specification:

- Cement used is OPC 43 grade (TCI Max)
- Specific Gravity : 3.15

Fineness Test of Cement:

- Wt. of sample:- 500g
- Mass retained on 90µ IS Sieve:- 20g
- % of cement retained on 90µ sieve:- $\frac{20}{500} \times 100$ = 4% < 10%

V. RESULT AND DISCUSSION

Test Data For Materials:
Cement used: OPC 43 grade
Sp. Gravity of cement: 3.15
Sp. Gravity of Coarse Aggregate: 2.7
Sp. Gravity of Fine Aggregate: 2.65
Sp. Gravity of admixture: 1.09
Water absorption of coarse aggregate: 1.1%
Water absorption of fine aggregate: 1%
Surface moisture of coarse aggregate: 1.09%
Surface moisture of fine aggregate: 1%
Maximum nominal size of aggregate: 20mm
Fine aggregate: Zone 1

Target Strength of Mix Proportioning:

$$f'_{ck} = f_{ck} + 1.65s$$
$$= 30 + 1.65\,(5)$$
$$= 38.25 \text{ N/mm}^2$$

Trail Mix:
The first Trial Mix was taken at w/c ratio of 0.45. The mean 28 day compressive strength came out to be 23.15 N/mm² < 38.25 N/mm²
After this two more trials were taken at w/c ratio 0.4 and 0.38 and finally the target strength was achieved at w/c ratio of 0.38.

Mix proportions for 0.05m³ concrete at w/c ratio of 0.38 :

- Cement = 450 × 0.05 = 22.5 kg
- Water = 171 × 0.05 = 8.55 kg
- Fine aggregate = 818.29 × 0.05 = 41 kg
- Coarse aggregates = 1019 × 0.05 = 51 kg

Mix Ratio: 1 : 1.82 : 2.27

Mix proportions for 0.05m³ concrete with Admixture Auramix 400:

- Cement = 339.5 × 0.05 = 17 kg
- Water = 129 × 0.05 = 6.46 kg
- Fine aggregate = 910.23 × 0.05 = 45.5 kg
- Coarse aggregates = 1133.5 × 0.05 = 56.5 kg
- Admixture = 3.06 × 0.05 = 153 kg

Mix Ratio: 1 : 2.67 : 3.32

Quantities Of Material For 1m³ Of Concrete Mix:
M-30 Without Admixture:

Table:6: Quantities Of Material For 1m³ M-30 Without Admixture

MIX	M-30 Without Admixture
Cement (Kg/m³)	450
Water (Kg/m³)	171
Coarse Aggregate (Kg/m³)	1019
Fine Aggregate (Kg/m³)	818.29
Admixture (Kg/m³)	Nil
Water Reduction (%)	Nil
W/C Ratio	0.38
Mix Ratio	1:1.82:2.27

M-30 With Admixture (AURAMIX 400):

Table:7: Quantities Of Material For 1m³ M-30 With Admixture (AURAMIX 400)

MIX	M-30 With Admixture (AURAMIX 400)
Cement (Kg/m³)	339.5
Water (Kg/m³)	129
Coarse Aggregate(Kg/m³)	1133.5
Fine Aggregate (Kg/m³)	910.23
Admixture (Kg/m³)	3.06
Water Reduction (%)	25
W/C Ratio	0.38
Mix Ratio	1:2.67:3.32

M-30 With Admixture (AURAMIX 200):

Table: 8: Quantities Of Material For 1m³ M-30 With Admixture (AURAMIX 200)

MIX	M-30 With Admixture (AURAMIX 200)
Cement (Kg/m³)	360
Water (Kg/m³)	136.8
Coarse Aggregate (Kg/m³)	1108.4
Fine Aggregate (Kg/m³)	890
Admixture (Kg/m³)	3.6

Water Reduction (%)	20
W/C Ratio	0.38
Mix Ratio	1:2.47:3.07

M-30 With Admixture (BASF):

Table: 9: Quantities Of Material For 1m³ M-30 With Admixture (BASF)

MIX	M-30 With Admixture (BASF)
Cement (Kg/m³)	360
Water (Kg/m³)	136.8
Coarse Aggregate (Kg/m³)	1108.4
Fine Aggregate (Kg/m³)	890
Admixture (Kg/m³)	3.6
Water Reduction (%)	20
W/C Ratio	0.38
Mix Ratio	1:2.47:3.07

VI. TEST RESULTS:

Table: 10: Test Results

TEST	CONCRETE MIX			
	PLAIN CONCRETE	AURAMIX-400	AURAMIX-200	BASF
Compaction Factor	0.84	0.87	0.89	0.89
7-Day Compressive Strength (N/mm²)	30.02	32.02	32.41	34.40
28-Day Compressive Strength (N/mm²)	44.16	49.02	50.07	52.13
28-Day Split Tensile Strength (N/mm²)	4.15	3.25	3.49	3.78
28-Day Flexural Strength (N/mm²)	4.19	5.73	5.23	6.40
Water Absorption (%)	3.37	1.51	1.28	1.25

GRAPHICAL REPRESENTATION:

Figure:1: Compressive Strength Of M-30 (Without Superplasticizer)

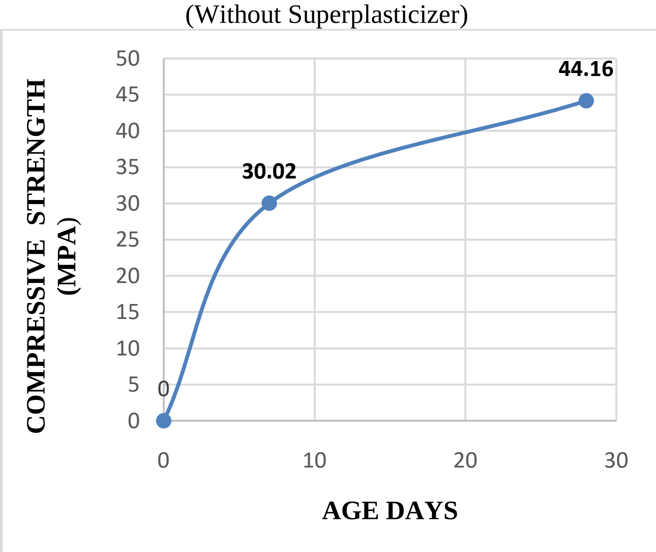


Figure: 2: Compressive Strength Of M-30 (With Admixture Auramix-400)

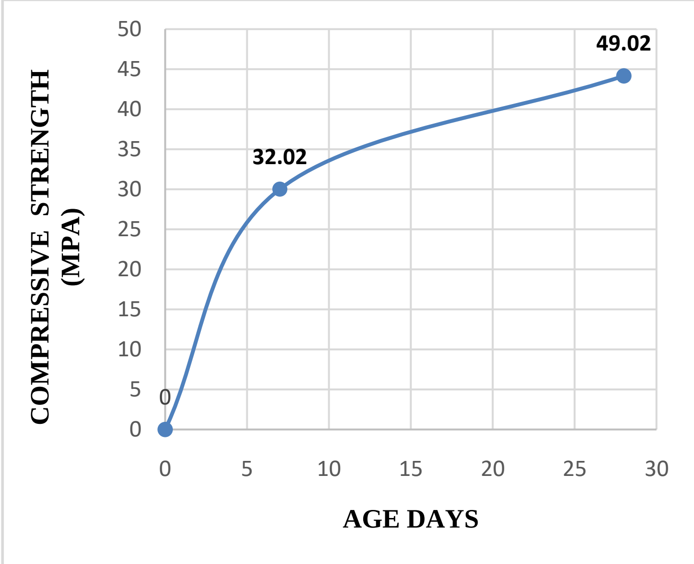


Figure: 3: Compressive Strength Of M-30 (With Admixture Auramix-200)

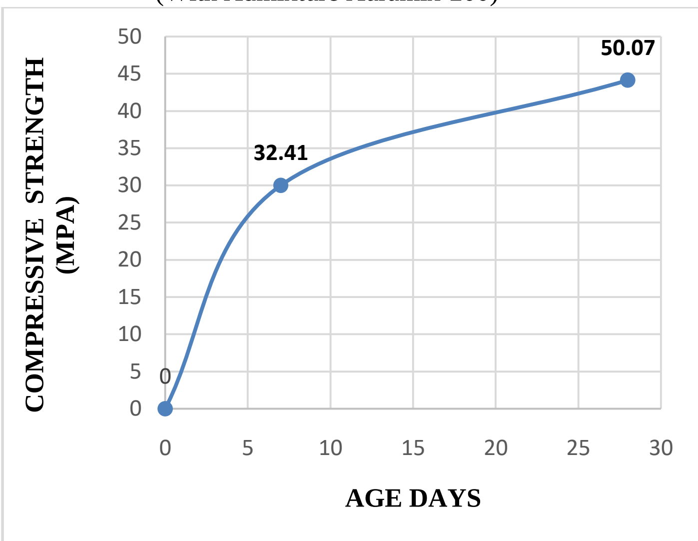


Figure: 4: Compressive Strength Of M-30 (With Admixture BASF)

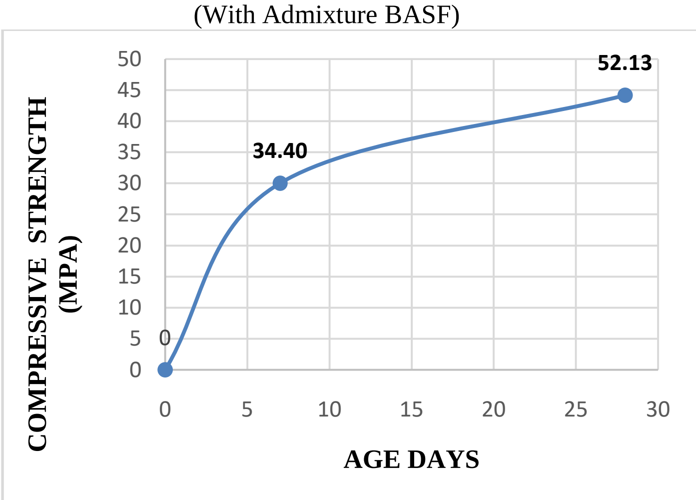
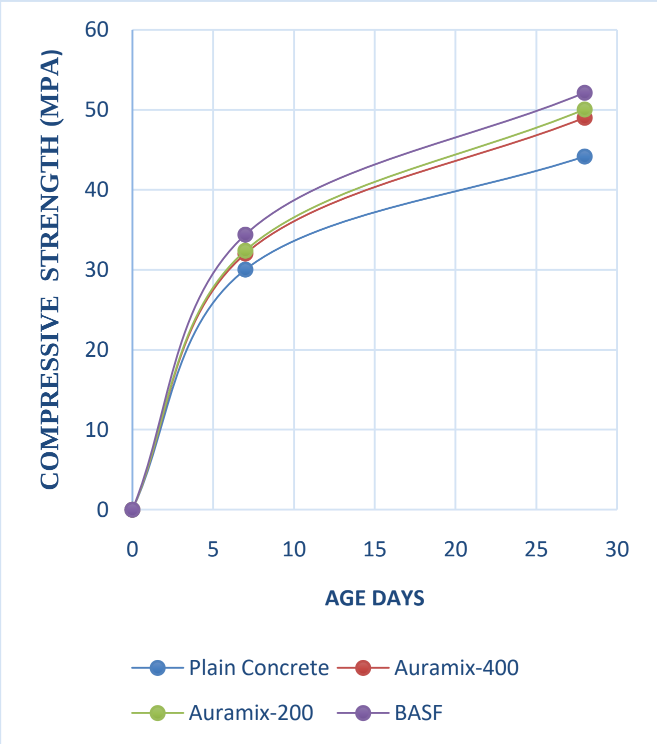


Figure: 5: Compressive Strength Comparison



VII. CONCLUSIONS

The conclusion drawn from the comparative study of durability of concrete without admixture and with admixture are as:

- Both 7 – day and 28 - day compressive strength of concrete with different admixtures was found to be higher than that of plain concrete. This was, probably, due to the fact that lower water content was used in concrete with admixture.
- Flexural strength of concrete with different admixtures was more than that of the plain concrete.
- Split Tensile strength of concrete with different admixtures was lower than that of the plain concrete. However, tensile strength parameter is seldom considered in RCC designs.
- Water absorption of concrete with different admixtures was lower than that of plain concrete. Thus the durability of concrete with admixture is expected to be better than that of plain concrete.
- Concrete with admixtures consumed about 90 – 100 kg lesser cement for achieving the target strength than that required by plain concrete. This saving in cost of concrete was utilized in adding the admixtures. Thus use of admixture is economically viable.
- Compaction factor of concrete with different admixtures was found to be higher than that of the plain concrete. Thus use of admixture imparts better workability to concretes.

FUTURE SCOPE OF THE PROJECT

Studying the effect of admixtures on durability and strength of concrete is still a field of research. In future, the work can be done on higher grades of concrete like M-35, M-40. Tests like permeability and chlorine penetration can be done to have better idea of effect of admixtures on the durability and strength properties of concrete. Effect of adverse climatic conditions especially freezing and thawing need to be studied, also the effect of properties aggregates need to be studied. Still lot of work can be done on this area. This field needs fast track development so that we can create better, durable and strengthened concrete.

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