Research Paper Engineering

A Comparative Study of Varying Dosage of Different Air Entraining Agents for M35 & M40 Concrete Grades

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ABSTRACT

Air is entrained in concrete by various materials, most convenient among them are Air entraining agents supplied by various construction chemical manufacturers. These AEAs are available in liquid state and can be added directly to the concrete while mixing in suitable proportions. AEA enhances workability of concrete but cause a reduction in strength. The purpose of this study is to optimize the amount of AEA and to compare the effect of various AEAs on performance parameters of concrete. For the purpose two AEAs (Fosroc and BASF) were used to design M35 and M40 grades of Air entrained concrete and performance of both is examined. Test results revealed that BASF AEA produces more workable concrete mix while reduction in strength due to air entrainment occurred lesser by use of Fosroc AEA.

KEYWORDS Air entraining agent, Compressive strength, Workability, Optimum dosage.

INTRODUCTION

Air entrained concrete is ordinary concrete containing controlled amount of air in the form of microscopic bubbles in it. These bubbles are spread throughout the body of concrete without significantly altering the setting or rate of hardening of concrete. Generally the diameter of air bubbles varies from 0.05 to 0.025mm and is spaced 0.003mm apart. These bubbles act as flexible ball bearings and modify various properties of fresh and hardened concrete. This concrete is more durable and resistant to damage by frost action and deicing salts and is typically used in concrete roads and bridge decks, airport runways and taxiways and other concrete construction areas potential to frost damage. Air entrainment also enhances workability and cohesion of concrete mixes where poorly graded aggregates are only option and there are chances of segregation, bleeding, or sand runs. There are many manufacturers which supply AEAs having different chemical compositions, but still functions of all of them are same. The AEA act as interface between mixing water and cement/aggregate particle producing tiny bubbles which gets evenly distributed throughout the concrete. This entrained air enhances durability as it provide protection against rapid temperature change in freeze-thaw conditions and with use of de-icing salts. The current paper presents a comparison between a set of results obtained from using two AEAs provided by two different manufacturers.

WORK PLAN

The objective of the work has been:

- To design medium grades of Air entrained concrete.
- To optimize the content of AEA.
- To study the effect of varying dosages of two AEAs on compressive strength of concrete.
- To study the effect of Air Entraining Agents on workability.

The experimental work was conducted in two parts. Firstly cubes of M35 and M40 were cast using varying dosages (0.1%, 0.2%, 0.3%, 0.4%, 0.5% by weight of cement) of Fosroc AEA and then again the procedure was repeated using AEA manufactured by BASF. Curing of samples was carried out after casting and finally they were tested by standard procedures laid down in relevant BIS codes for 7 and 28 day compressive strengths.

MATERIAL DETAILS AND CONCRETE MIX DESIGN

Ordinary portland cement OPC (Specific Gravity=3.15) conforming to IS 8112, sand (Specific Gravity = 2.54),crushed aggregates (Specific Gravity = 2.72), plasticizer (Specific Gravity=1.1) and water are used alongwith AEAs (specific gravity=1.01). The coarse aggregates having shape crushed-angular were used and graded by mixing 60% of 20mm size aggregate and 40% of 12.5mm size aggregates (with reference to IS 383 and IS 2386). Samples were prepared as per provisions recommended in BIS 10262 – 2009. Design mix proportion as obtained have been highlighted in table 1 as hereunder. Cement content for M35 and M40 of concrete as designed have been worked out as 400kg/m^3 and 415kg/m^3 of concrete. Air entraining agents used for this project are:

- FOSROC: Conplast AEA
- BASF: MA16721

TABLE 1:- Mix proportions as per IS 10262-2009

Concrete grade	Cement	FA	CA	W/C Ratio	Plasticizer
M35	1	1.45	3.24	0.42	0.8%
M40	1	1.37	3.11	0.40	1%

CASTING AND TESTING OF SPECIMENS

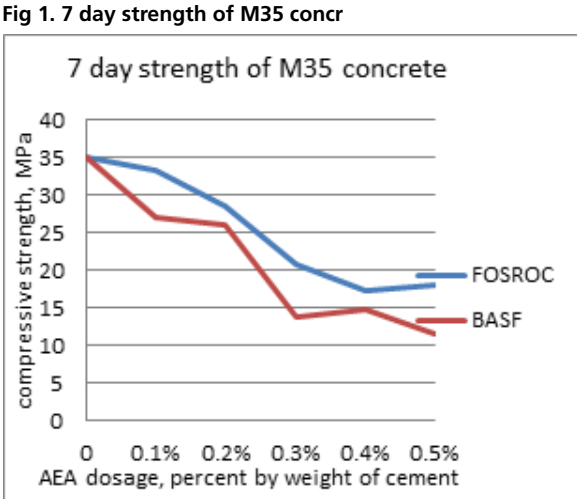
Pan mixer is used for mixing of materials and the AEA is added in concrete while mixing so that all the ingredients of concrete get evenly mixed. Slump test is carried out for workability, which gave zero slump value of control mix, so compacting factor test is conducted. Compacting factor apparatus as per BIS 5515-1983 was set and oiled to avoid sticking of concrete on the walls of the apparatus and the test was carried out as per the procedure laid out in IS 1199-1959. Cubes were cast in standard metallic moulds of size 15cm×15cm×15cm as per code and then finally vibrated using table vibrator. After 24 hours of casting, the specimens are demoulded and placed in curing tank with a water temperature of

25±2° C. Finally the cubes were tested at two different ages of curing i.e. 7 and 28 days to analyze the gain in strength over period of time. The uniaxial compressive test was carried out on samples as per IS: 516. Loading was done at a rate of 14 MPa/min. and three cubes were tested at each dosage of AEA supplied from both the manufacturers. Control specimens are also prepared without use of AEA in order to use it as reference for strength comparison and other characteristics. Results so obtained were analyzed to find out the optimum dosage of AEA obtained for each product in order to study their performance in aforesaid concrete grades.

Table 2. Compressive strength of Air Entrained Concrete

AEA dosage	FOSROC(M35)		BASF(M35)		FOSROC(M40)		BASF(M40)	
	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day
0	35.11	39.56	35.11	39.56	37.33	41.33	37.33	41.33
0.1%	33.33	39.11	27.11	33.78	35.11	41.78	25.78	35.56
0.2%	28.44	38.60	26.00	28.89	33.20	40.89	24.00	28.67
0.3%	20.89	29.56	13.78	23.11	31.56	39.11	19.11	26.67
0.4%	17.33	26.67	14.67	21.33	27.56	32.00	13.78	26.22
0.5%	18.11	27.02	11.56	18.22	21.33	28.89	14.00	26.67

Fig 1. 7 day strength of M35 concr



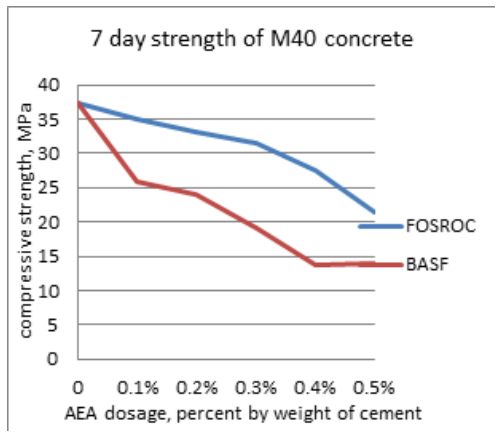


Fig 2. 7 day strength of M40 concrete

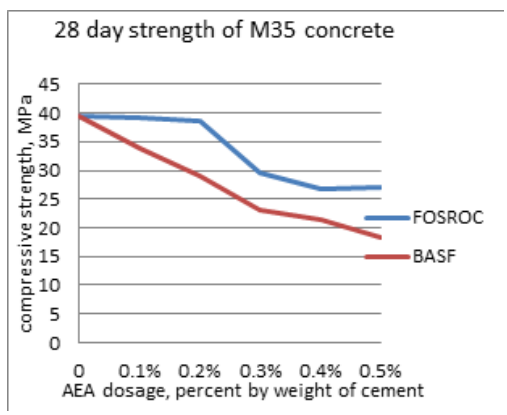


Fig 3. 28 day strength of M35 concrete

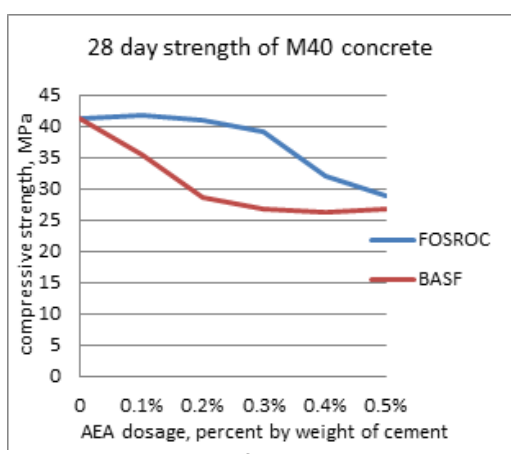


Fig 4. 28 day strength of M40 concrete

Table 4. Workability of Air Entrained Concrete by Compacting Factor Test

AEA dosage	M35		M40	
	Fosroc	BASF	Fosroc	BASF
0	0.70	0.70	0.72	0.72
0.1%	0.71	0.73	0.74	0.75
0.2%	0.73	0.77	0.75	0.78
0.3%	0.77	0.83	0.78	0.85
0.4%	0.81	0.87	0.82	0.89
0.5%	0.83	0.91	0.85	0.95

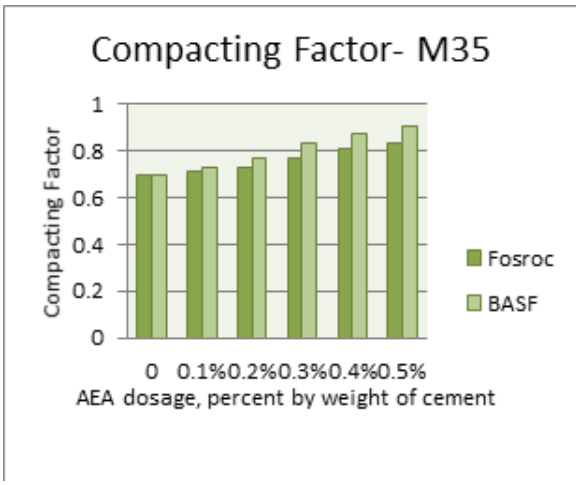


Fig 5. Workability of M35 Concrete

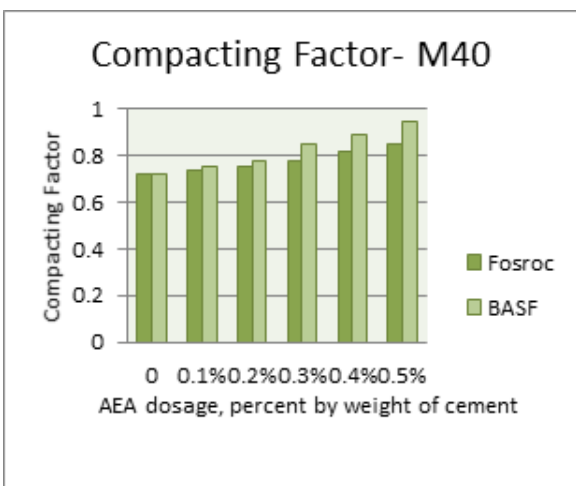


Fig 6. Workability of M40 Concrete

5. RESULTS AND DISCUSSION

During casting, it was observed that the workability goes on increasing with increased dosage of AEA. The control mixes were harsh with their values of compacting factor being less than 0.75. On comparing both the products for determining their performance in concrete for workability parameter it was observed that product of BASF yielded high workability and allied characteristics over and above Fosroc product. However, on comparing compressive strength of AEA concrete for both the products, it was observed that AEA from Fosroc produced stronger concrete than BASF. The detailed comparative analysis and graphical representation is highlighted here under.

6. CONCLUSION

The experimental results emphasize on the effect of Air Entraining Agents on both green and hardened concrete of grades M35 and M40.

- The fresh concrete shows an increase in workability with increasing dosage of AEA. This change is linear i.e. more the amount of AEA, enhanced will be the workability.
- In hardened concrete, compressive strength goes on declining as amount of air entraining admixture is increased.
- AEA from BASF results in more workability than that of Fosroc while the latter results in higher compressive strength of concrete.
- As increasing amount of AEA reduces strength, the target strength of concrete mix is achieved at very lower concentrations of AEA. So optimum content comes out to be 0.10% for M35 and 0.11% for M40 concrete.

Introduction of AEA to concrete reduces its strength but enhances workability, so this strength reduction can be controlled by reducing w/c ratio of the concrete mix. The study here reveals that BASF AEA is better for workability enhancement while Fosroc AEA produces concrete with higher strength. Both can be used as per the requirements of desired strength and workability.

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