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Strength Characteristics of Air Entrained Concrete

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---ABSTRACT---
Present paper emphasizes on the strength characteristics of air entrained concrete using admixtures. The main function of air entrained agent is to increase the workability of fresh concrete, and durability of hardened concrete. For this purpose, three different air entrained agents are used in the concrete preparation those are Olive Oil, Oleic Acid, and Hydrogen Peroxide. The dosage of admixtures is chosen in the concrete production as 0%, 0.5%, 1% and 1.5% by weight of cement. By adding admixtures into the concrete, Workability of fresh concrete has been increased and strength of the concrete decreased.

KEYWORDS: *Air entrainment agents, Air entrained concrete, strength of concrete, Olive Oil, Oleic Acid, and Hydrogen Peroxide.*

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I. INTRODUCTION:

Concrete is a composite construction material and composed primarily with aggregates, cement, and water. There are many formulations that have varied properties. In present days, concrete is being used for wide variety of purposes to make it suitable in different conditions. In these conditions ordinary concrete may fail to exhibit the required performance of quality and durability. In such cases admixtures are used to modify the properties of ordinary concrete, so as to make it more suitable for any situation. Perhaps one of the important advancement made in concrete technology was the discovery of air entrained concrete. Since 1930, it has been an ever increasing use of air entrained concrete all over the world. Air entrained agent is one type of admixture, which will improves the all characters of concrete. Air entrained concrete is made by mixing a small quantity of air entraining agent or by using air entraining cement. These air entraining agents incorporate millions of no-coalescing air bubbles, which will act as flexible ball bearings and will modify the properties of concrete regarding workability, segregation, bleeding and finishing quality of concrete. It also modifies the properties of hardened concrete regarding its resistance to frost action and permeability. Use of air entrainment improves workability of pervious concrete, thus reducing the overall porosity and increasing unit weight of the pervious concrete. The air entrained concrete was durable after 300 cycles of freeze – Thaw than the conventional concrete [1]. Air entraining admixtures yielded high workability, with adequate strength and abrasion resistance, low permeability, and superior chemical resistance is possible. These properties can be useful in sewer structures and concrete applications where surfaces are subjected to mild abrasion and aggressive chemicals [2].The inducement of air entrainment by using super absorbent Polymer (SAP) shows better results in workability, reduction in shrinkage and moisture loss [3]. Fatty acids like sunflower oil and olive oil which were influencing the strength as decreased when these were added into the cement clinker [4]. The addition of dry super absorbent polymers (SAP) for air entrainment in concrete is beneficial for frost protection of concrete [5]. In circumstances where concrete structures are liable to freezing and thawing, concrete durability can be further enhanced through uniform entrainment of air bubbles of optimal dimensions and total volume [6]. By addition of vegetable oils like olive oil and soya beans oil into the cement mortar, decease of compressive strength and flexural strength

observed [7]. Recycled coarse aggregate produced from non air entrained concrete shows poor resistance to freezing and thawing than the concrete produced with air entrainment [8]. The feasibility increases with the proportioning usage of air-entrained SCC to high stability and resistance to blockage. Optimized mixtures exhibited adequate engineering properties and durability [9]. In investigating the correlation between water/cement ratio and air entraining in to the concrete, it is proved that low water/cement ratios were no substitutes for adequate air entraining concerning PCC freeze/thaw durability [10]. In correlating the fundamental interaction between fly ash and air entraining admixtures, it was known that the interaction was time dependant and occurs only to a degree up to the amount of carbon present [11]. The Rice Husk Ash as a supplementing material in producing High performance Concrete shows that RHA is highly pozzolanic and shows high compressive strengths at various ages up to 730 days compared with that of the control concrete and has excellent performance under freezing and thawing conditions [12].Three different admixtures chosen for present experimentation work, these are Oleic acid, Hydrogen peroxide and Olive oil.

Fig: 1 Oleic acid Fig: 2 Hydrogen peroxide Fig: 3 Olive oil

II. EXPERIMENTAL PROGRAMMED:

Experimentation was performed for conclusion of the following
2.1 Workability of air entrained concrete
2.2 Behavior of air entrained concrete under compression

III. MATERIALS:

3.1 Cement: 53 Grade ordinary Portland cement of DALMIA make conforming to IS: 12269 were used. The Specific gravity of the cement was 3.05. The initial and final setting times were found as 80 minutes and 280 minutes respectively.

3.2 Fine aggregate: Locally available river (Pennar basin in Kadapa region) sand passing through 4.75 mm IS Sieve was used. The specific gravity of the sand is found to be 2.62 and confirming to zone II of table 4 of IS 383-1970**.**

3.3 Coarse - Aggregate: Crushed granite aggregate available from local sources has been used. The size of coarse aggregate is 20mm. The specific gravity of the aggregate is 2.68.

3.4 Oleic acid: Oleic acid was used in 0.5%, 1.0% and 1.5 % by
Weight of cement.

3.5 Hydrogen Peroxide: Hydrogen peroxide was used in 0.5%, 1.0% and 1.5 % by weight of cement.

3.6 Olive Oil: Olive oil was used in 0.5%, 1.0% and 1.5 % by weight of cement.

3.7 Water: Potable water available from local sources was used for mixing and curing of specimens.

IV. MIX PROPORTION:

Nominal proportions chosen for the concrete mix of M_{20} grade as per IS 10262-1982 and its proportion was 0.50: 1: 1.50:3.00 (W: C: FA: CA) by weight. For better workability, graded aggregates were used as 60 % of 20 mm and 40 % of 12.5mm and fine aggregate of zone II was used in the concrete preparation.

V. CASTING PROCEDURE:

Overview: In this present work, to determine the behavior of concrete in compression by adding Oleic acid, Hydrogen peroxide and Olive oil as admixtures into the concrete. Oleic acid, Hydrogen peroxide and Olive oil were added separately by weight of cement as 0.5%, 1.0% and 1.5% into the concrete. For which cubes and cylinders were casted and tested to estimate the compressive strength and split tensile strength of air entrained concrete. Workability of air entrained concrete was studied by performing the slump cone test and compaction factor test. For each admixture, same types of specimens were casted and tested for evaluating the strength characteristics.

5.1 Workability: The workability of fresh concrete is a composite property. It is difficult to define precisely all the aspects of the workability in a single definition. IS: 6461 (Part-VII) – 1973 defines workability as that property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished. In this work, workability has been measured with slump cone and compaction factor equipments. In slump cone, the cone was filled with the fresh concrete up to the brim of the cone and then the cone was lifted upwards, the subsidence of the concrete was taken as slump value. The compaction factor test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. The degree of compaction is called the compacting factor and it is measured by the ratio of the partially compacted to the fully compacted. The sample of concrete to be tested was placed in the upper hopper up to the brim. The trap-door was opened so that the concrete falls into the lower hopper. Then the trap-door of the lower hopper was opened and the concrete is allowed to fall into the cylinder. The excess concrete remaining above the top level of the cylinder was then cut off with the help of plane blades supplied with the apparatus. The outside of the cylinder was wiped clean. The concrete is filled up exactly up to the top level of the cylinder. It is weighed to the nearest 10 grams. This weight is known as "Weight of partially compacted concrete". The cylinder was emptied and then refilled with the concrete from the same sample in layers approximately 5 cm deep. The layers are heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighed to the nearest 10 gm. This weight was known as "Weight of fully compacted concrete". Then the compaction factor is calculated by the ratio of weight of partially compacted concrete to the weight of fully compacted concrete.

Fig 4: Measurement of Workability by Slump Cone and Compaction Factor apparatus

5.2 Compressive strength: Six specimens of each percentage (0%, 0.5%, 1.0% and 1.5%) were casted according to the nominal mix proportion and the size of the specimen was 150 x 150 x 150 mm. Specimens were casted in cube mould and filled with concrete in three layers. Hand compaction was applied with tamping rod and again compacted in table vibrator after completion of filling the mould with concrete. Finish the top surface smoothly and de-molded after 24 hrs. Keep the specimens into the curing pond for curing @ temp 27±2° for a period of 28days. After completion of curing period, specimens were removed from pond, kept for drying and tested in CTM with 2000 kN Capacity.

5.3 Split tensile strength: Six cylindrical specimens of each percentage were casted according to the mix and the size of the specimen was 150 x 300 ^{mm}. It was measured by testing the cylinder under diametric compression. Based on the load at which the cylinder split to compute the split tensile strength. Specimens were casted and vibrated as mentioned in the previous section and allowed to cured in curing pond .Temp was maintained in curing pond as 27±2° C for a period of 28 days. Testing of a specimen carried out in 2000 kN Capacity CTM.

VI. TEST PROCEDURE:

6.1 Workability:

Workability of air entrained concrete has been measured by performing slump cone and compaction factor tests. Mix the ingredients of concrete properly on a water tight plat form and measure the slump cone value and compaction factor as stated in the above section 5.1

6.2 Compressive strength: Remove the cube specimens from the curing pond after appropriate period of 7 days and 28 days and allow for dry for about 2 hrs. Take the weight of the each sample and place the specimen opposite direction of casting in 2000 kN CTM. Check whether the surface of specimen contact to the upper arm of the CTM or not. Apply load uniformly and record the ultimate load. Testing of specimen has been shown in Fig 5.

Fig 5: Testing of air entrained concrete Cube specimen

6.3 Split tensile strength :

Remove the cylindrical specimens from the water pond and allow to dry for about 2 hrs. Place the cylindrical specimen in diametrical position because it is difficult to apply uniaxial tension to acylindrical specimen. Apply load uniformly and record the splitting load. Following fig 6 shows the testing of specimen.

Fig6: Testing of Cylindrical specimens in CTM

VII. RESULTS AND DISCUSSIONS:

7.1 Workability of air entrained concrete:

Air entrained concrete has been prepared with addition of three different admixtures with three different percentages as 0.5%, 1.0% and 1.5%. All test results were compared with conventional concrete. Based on the verification of the test results and observing the graphs, as the replacement of admixture improves workability of air entrained concrete are also improved. Three admixtures have been showing similar type trends in workability of concrete. Adding these air entrained agents extending the setting time and better workability observed during the laying. Apart from that better homogeneity in the concrete, less segregation and bleeding was observed. The concrete mixed with Hydrogen peroxide and Olive oil and oleic acid shows relatively higher values of slump than that of conventional concrete. Similar trend has been observed even in the compaction factor also. Graphical representation of slump and compaction factor has shown in fig 7 and 8.

Table 1: Workability results of slump cone and compaction factor

SL. No	Type of Admixture used	% of admixture added	Slump value (in cm)	Compaction Factor
1	Conventional concrete	0	11	0.86
2	Oleic acid	0.5	13	0.88
3	Oleic acid	1.0	14.5	0.90
4	Oleic acid	1.5	15	0.915
5	Hydrogen peroxide	0.5	13	0.90
6	Hydrogen peroxide	1.0	14	0.91
7	Hydrogen peroxide	1.5	15	0.92
8	Olive oil	0.5	13	0.89
9	Olive oil	1.0	13.5	0.91
10	Olive Oil	1.5	14	0.915

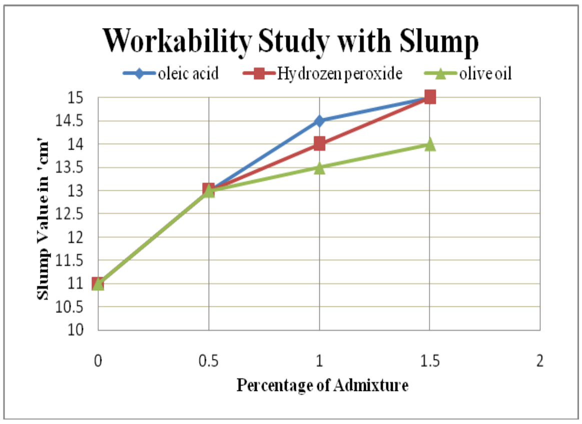

Fig 7: % of admixture used vs. slump value

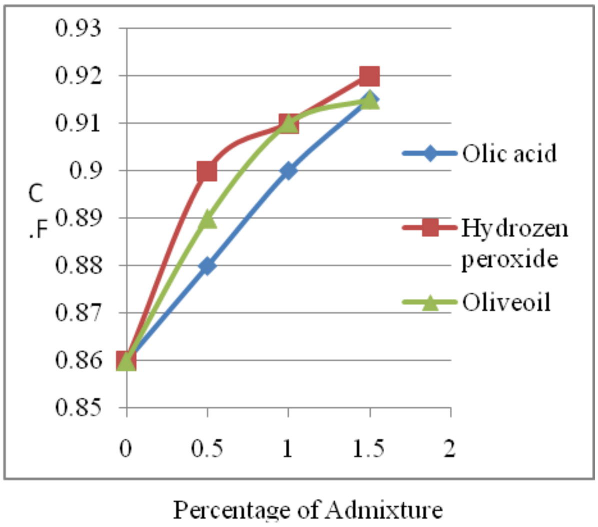

Fig 8: % of admixture used vs compaction factor

7.2 Compressive Strength Test Results:

Compressive strength of air entrained concrete was decreased as the percentage of replacement of admixture improved. Test results shown in the table no2. The percentage decrease of compressive strength for all air entrained concrete was 27%, 14% and 22% after replacing 1.5% of admixture in to the concrete. Similar type of trends was observed even in the previous research work. Reason for decrease of strength was entrapped air. Based on the percentage of entrapped air, the percentage of decrease of strength observed. From the following figs 9 and 10, it was concluded that hydrogen peroxide was the better admixture into a concrete composition than other remaining.

Table 2: Compressive Strength of air entrained concrete.

Sl. No	Type of Admixture used	% of Admixture Added	Compressive Strength in N/mm^2	
			After 7 days of curing	After 28 days of curing
1	Conventional Concrete	0%	30.07	35.26
2	Oleic Acid	0.5%	21.33	28.74
3	Oleic Acid	1.0%	21.46	27.50
4	Oleic Acid	1.5%	18.75	25.65
5	Hydrogen Peroxide	0.5%	28.25	33.38
6	Hydrogen Peroxide	1.0%	26.82	32.56
7	Hydrogen Peroxide	1.5%	23.26	30.50
8	Olive Oil	0.5%	23.41	30.67
9	Olive Oil	1.0%	23.40	29.56
10	Olive Oil	1.5%	19.70	27.56

7.3 Split Tensile Strength Test Results:

The behavior of air entrained concrete under compression is determined by split tensile strength also. Split tensile strength values were decreasing when the percentage of admixture increases. The percentage variation with respect to conventional concrete was 30%, 12% and 18% even after 1.5% of replacement by admixture. Hydrogen peroxide shows promising results, so, among the above admixtures it is the best suited choice for addition of admixture into concrete to improve the characteristics. Fig 11 and 12 were representing 7 days and 28 days strength.

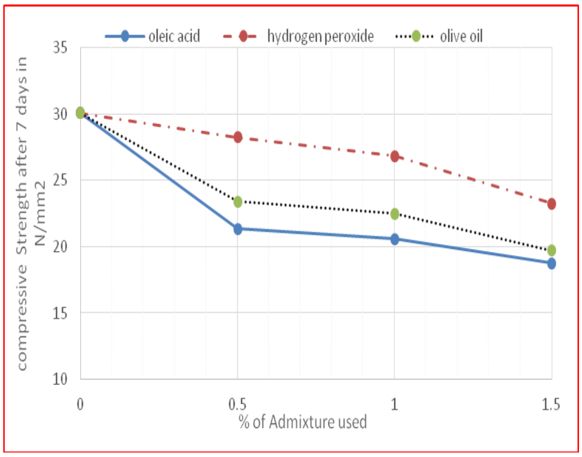

Fig 9: 7 Days of Compressive Strength vs. % of Admixtures

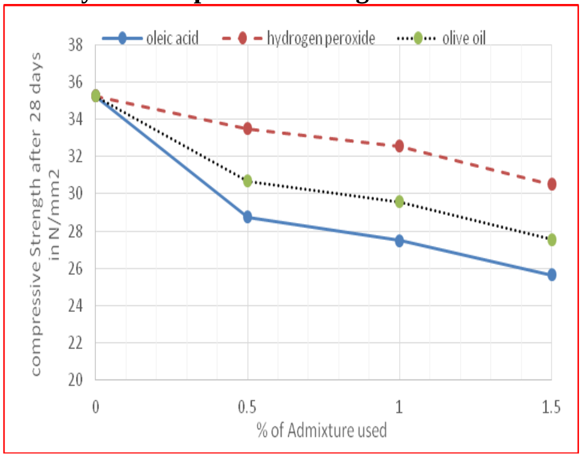

Fig 10: 28 day's compressive strength vs. % of admixtures added

Table 3: Split Tensile Strength test results for conventional concrete and different percentages of admixtures

Sl. No	Type of Admixture used	% of Admixture Added	Split Tensile Strength in N/mm^2	
			After 7 days of curing	After 28 days of curing
1	Conventional Concrete	0%	2.32	3.10
2	Oleic Acid	0.5%	2.1	2.54
3	Oleic Acid	1.0%	1.90	2.32
4	Oleic Acid	1.5%	1.76	2.1 5
5	Hydrogen Peroxide	0.5%	2.25	2.95
6	Hydrogen Peroxide	1.0%	2.06	2.82
7	Hydrogen Peroxide	1.5%	1.88	2.75
8	Olive Oil	0.5%	2.03	2.70
9	Olive Oil	1.0%	1.92	2.64
10	Olive Oil	1.5%	1.78	2.56

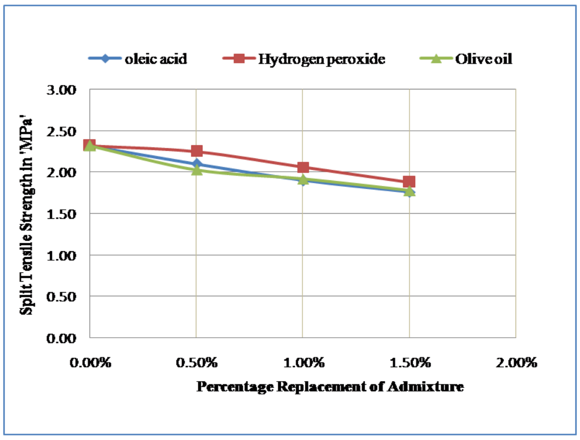

Fig 11: 7 days split tensile strength vs. % of admixtures used

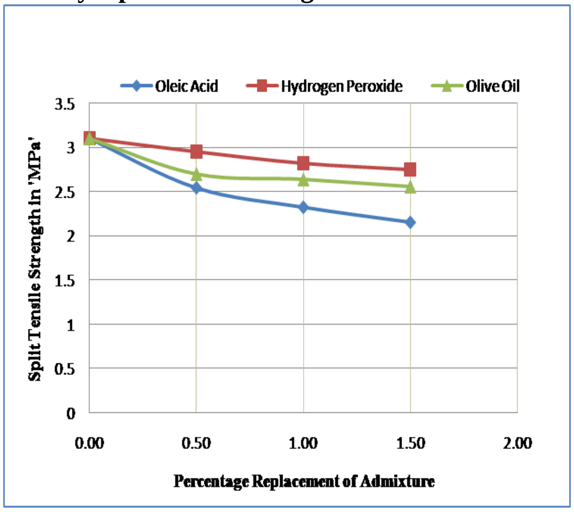

Fig 12: 28 days split tensile strength vs. % of admixtures used

VIII. CONCLUSIONS:

8.1 Reliable values observed in the experimentation by comparing with conventional concrete.
8.2 Slump values were increased when percentage of admixture improved.
8.3 Compaction factor values were also improved when admixture increased.
8.4 Compressive strength of air entrained concrete decreased when admixture percentage increased.
8.5 Split tensile strength also decreased when percentage of admixture increased

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