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Effect of Sugar and Jaggery on Strength Properties of Concrete

Giridhar.V[1],
[1] *Associate Professor, K.S.R.M. College of Engineering, Kadapa, A.P, India*

Gnaneswar . K[2] and Kishore Kumar Reddy. P[3]
[2] *Assistant Executive Engineer, I & CAD Dept., TBP HLC Circle, Anantapuramu, A.P, India.*

[3] *Assistant Professor, K.S.R.M. College of Engineering, Kadapa, A.P, India*

----------ABSTRACT----------

This paper emphasizes the effect of Sugar and Jaggery on strength properties of concrete. The experimentation has been carried out for evaluating the strength properties of concrete using Sugar and Jaggery as admixtures into the concrete composition. Based on the literature, the main function for usage of Sugar and Jaggery is to extend the initial setting time of concrete. Usually these type of admixtures used in the special cases like large piers and long piles. Three different percentages of admixtures (Sugar and Jaggery) are chosen in the experimentation as 0, 0.05 and 0.1% by weight of cement. Finally it was concluded that workability and compressive strength of concrete enhanced when admixtures like Sugar and Jaggery added into the concrete composition.

***Keywords*:** Admixtures, Compressive strength, Jaggery, Sugar and Workability.

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I. INTRODUCTION

Concrete is an inevitable material in the human being's life, because of its superior characteristics like strength and durability, but in certain situations it can't be used in all places because setting time of concrete. Retarders are used in the concrete composition to improve the setting time and also to increase the temperature of the composition with different type of admixtures. It is observed that an old Monuments in Gandikota at Kadapa dist, where bonding between the stones was achieved by mortar with combination of lime, sand and jaggery juice. Concrete made with admixtures like sugar and jaggery can be utilised in particular situations. Usage of these admixtures will decrease the segregation and bleeding. Sugar is a carbohydrate, a substance composed of carbon, oxygen and hydrogen. Jaggery is made from the product of sugar cane. So, both are useful to add as an admixtures in the concrete composition. Cement was replaced by Sugarcane Bagasse Ash (SCBA) in the production of mortar and concrete as 0, 5, 10, 15 and 25%. Based on the experimental results, it was accomplished that, as the replacement ratio increases, workability and significant strength values were increased [1]. White sugar was used from 0 to 1% by weight of cement in the concrete preparation. Compressive strength was marginally improved, but maximum strength was obtained at 0.06% for 28 days [2]. In the process of manufacturing the sandcrete brick of size 450mm x150mm x225mm, 0.1 and 0.2% of sugar was added by weight of cement into the brick manufacturing. The compressive strength was increased by 17 and 9% respectively [3]. Molasses has been procured from three different sugar industries and added two percentages of 0.4 and 0.7% by weight of cement into the concrete as admixture. Setting time was increased when dosage increases. Similar types of trends were observed in the compressive strength of concrete with 0.4% molasses based admixture [4]. Setting of cement extended due to the incorporation of sugar by weight of cement up to certain extent of 0.15%, exceeding this limit of incorporation, it has been acted as accelerator up to 0.3% and the optimum percentage of sugar added into the concrete was 0.15% [5]. 20% of SCBA added into the clinker, which resulted higher compressive strength of mortars among 0 - 40% of SCBA added in the clinker [6]. 28.15 Mpa was recorded and it was an appreciable strength development, when sugar was added as the admixture. This was 16.6% higher than control value [7]. By addition of 0.03% of sugar based admixture into the concrete, it showed better results in strength aspects especially in modulus of rupture [8]. Herbal juice was prepared with herb and palm jiggery, soaked in the water for about 15 days and ambient temperature of 27° to 29°C was maintained. 5% of this juice and lime water was used in the composition and it was concluded that, increments in transverse strength was 1.6, 3% of tensile strength and 2.5% of compressive strength [9]. Retarders were used to improve the workability of concrete and increased the temperature with different combination of admixtures. Finally to maintain the uniform setting time, higher dosage of admixtures were added into the concrete composition. Optimal dosage for getting the compression strength was 0.8% [10].

II. EXPERIMENTAL PROGRAM

Experimentation was carried out to investigate the following

2.1 Workability of fresh concrete with Sugar and Jaggery as admixtures.

2.2 Behavior of concrete under compression with same admixtures.

III. MATERIALS

3.1 Cement:

53 Grade ordinary Portland cement (BHARATI cement PVT limited) conforming to IS: 12269 was used. The Specific gravity of the cement was 3.12, the initial and final setting times were found as 90 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 was found as 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 was 20mm and its specific gravity was 2.68.

3.4 Admixtures:

Sugar was used as admixture in the concrete production. White crystalline solid readily soluble in water and available in market was used in the experimentation work. A solid form of Jaggery available in market and easily soluble in water was used as admixture. Sugar and jaggery was added in concrete composition with three different dosages as 0, 0.05 and 0.1% by weight of cement. Fig: 1 shows the sample of Sugar and Jaggery in solid form.

Fig: 1 Sample of Sugar and Jaggery

IV. MIX PROPORTION

Nominal proportions chosen for the concrete mix of M_{20} grade as per IS 10262-1982 and it 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. OVERVIEW

In this present work, the main object is to resolve the behavior of concrete in compression by adding Sugar and Jaggery as admixtures into the concrete. Sugar and Jaggery were added separately by weight of cement as 0, 0.05 and 0.1% into the concrete. For which cubes were casted to estimate the compressive strength of concrete. Workability of concrete was studied by performing the slump cone test and compaction factor test. For every dosage of admixture, slump cone and compaction factor tests were performed to record the workability of fresh concrete. For each dosage of admixture, six number of cube specimens were casted and tested for evaluating the strength characteristics. Among these three numbers of cube specimens were tested for determining the 7 days compressive strength and further three specimens were used for determining the 28 days compressive strength.

5.1 Overview of 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 the property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished. According to the IS 1199-1959, workability of fresh concrete has been performed. Workability of concrete can also depend on the type structure, thickness of structural element and place of casting. For development of above said characteristics, it is necessary to add admixtures into the concrete. Subsidence of concrete after lifting of slump cone is slump value in mm and ratio between partially compacted concrete and fully compacted is compaction factor. Fig 2 and Fig 3 shows the performance of workability of

fresh concrete. Fig: 2 representing the slump cone and subsidence of concrete after lifting. Fig: 3 representing the compaction factor apparatus and weighing of partially compacted cylinder.

Fig: 2 Slump cone and collapse of concrete after lifting.

Fig:3 Compaction factor apparatus and weighing of partially weighed concrete

5.2 Over view of Compressive strength:

Six cube specimens of each percentage (0, 0.05 and 0.1%) were casted according to the nominal mix proportion and the size of cube specimen was 150 mm x 150 mm x 150 mm. According to the IS: 10086-1982, cube moulds were used in the experimentation. Specimens were casted in cube mould and filled with concrete in three layers. Hand compaction was applied with tamping rod. Finished the top surface smoothly and de-molded after 24 hrs. Specimens were marked with marker and allowed to dry for some time and immersed in the curing pond. Demoulding of cube specimen was difficult after 24 hrs for specimens casted with admixture of 0.05% and 0.1% because of extension of setting time. Specimens casted with 0.05% admixture were demoulded after 48 hrs and for 0.1% after 72 hrs. The specimens were kept into the curing pond for curing @ temp 27±2° for a period of 28days. After completion of curing period, specimens were removed from curing pond, kept for drying and tested in CTM with 2000 kN Capacity. Fig: 4 show the casted cube specimens. During the experimentation of casting, it was clearly observed lower ranking of bleeding and segregation.

Fig: 4 Casted cube specimens.

VI. TEST PROCEDURE

6.1 Test procedure of Workability:

Workability of 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 5.1and record the values, tabulated properly. During the testing of slump value, it was clearly observed that collapse of slump, when admixtures added at dosage of 0.05 and 0.1%.

6.2 Test procedure of Compressive strength:

Remove the cube specimens from the curing pond after appropriate period of 7 days and 28 days and allow drying in shade for about some time. 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: 5Testing of cube specimen.

VII. RESULTS AND DISCUSSIONS

7.1 Workability of concrete with Sugar and Jaggery:

Concrete has been prepared with addition of two different admixtures (Sugar and Jaggery) with three different percentages as 0 %, 0.05% and 0.1%. All test results were compared with conventional concrete and results were tabulated in table 1. Based on the experimental results, as the percentage of admixtures increased, consequently both slump and compaction factor also increased. Addition of Sugar and Jaggery to the concrete greatly influenced the setting property and clear collapse of slump witnessed during the experimentation. Setting of cube specimens after 24 hrs was difficult. During the demoulding after 24 hrs, cube specimens were exhibited cracks. So, demoulding of specimens carried out after 48 hrs for 0.05% of admixture and 72 hrs for 0.1%.The basic reason for extending the setting of time is adsorption of sugar and jaggery acted as thin layer over the cement particles and it slows down the hydration process. Formation of calcium ions will increase the solubility and discouraging the formation of calcium hydroxide. By this reason setting property of concrete has been improved.

Table1: Workability of concrete with Sugar and Jaggery as admixture.

S. No	Admixture	% of Admixture	Slump value in mm	Compaction Factor
1	Sugar	0	100	0.93
2	Sugar	0.05	160	0.94
3	Sugar	0.1	200	0.95
4	Jaggery	0	100	0.93
5	Jaggery	0.05	150	0.935
6	Jaggery	0.1	180	0.94

Concrete specimens with sugar as admixture exhibited better workability than jaggery. Fig 6 and 7 give the graphical representation of slump and compaction factors.

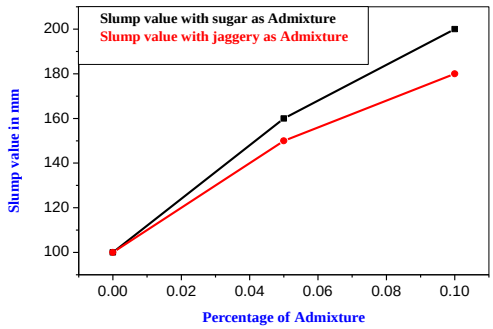

Fig 6: Slump value of concrete with added Admixtures.

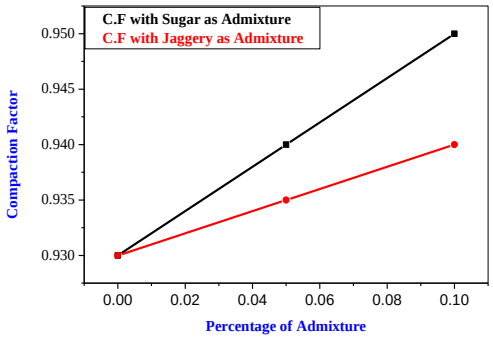

Fig 7: Compaction Factor of concrete with added Admixtures.

7.2 Compressive strength of concrete with sugar and jaggery as admixtures:

Based on the test results, as percentage of admixture increases from 0 to 0.1% the compressive strength of concrete also increased. Maximum strength of concrete was related on workability of concrete and it can be achieved by high degree of workability. The compressive strength of concrete measured for both admixtures after 7 and 28 days. From table 2 and 3, it is clear that, as the percentage of admixture increased, the compressive strength in both cases increased. The only reason for improvement of strength was bonding. Sugar and Jaggery had good bonding property and it was proved that in olden day's jaggery was used as bonding material in construction. After 28 days, the percentage of variation between the conventional concrete and concrete with 0.1% of sugar added as admixture was 12.0%. For the jaggery, the variation was 15.11% after 28 days. Among these two admixtures raw jaggery was best suited admixture into the concrete composition and strength values are represented in fig 8 and 9.

Table 2: Compressive strength of concrete with Sugar added as Admixture.

S.No	Percentage of admixture	Density of concrete in Kg/m^3	7 days compressive strength in Mpa	28 days compressive strength in Mpa
1	0	2456.7	26.67	35.34
2	0.05	2488.0	28.24	38.44
3	0.1	2498.2	30.72	40.68

Table 3: Compressive strength of concrete with Jaggery added as Admixture.

S.No	Percentage of admixture	Density of concrete in Kg/m^3	7 days compressive strength in Mpa	28 days compressive strength in Mpa
1	0	2456.7	26.67	35.34
2	0.05	2475.3	29.34	37.42
3	0.1	2492.6	31.10	39.59

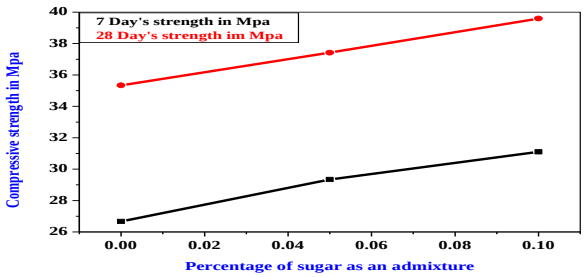

Fig 8: Compressive strength of concrete with Sugar as admixture.

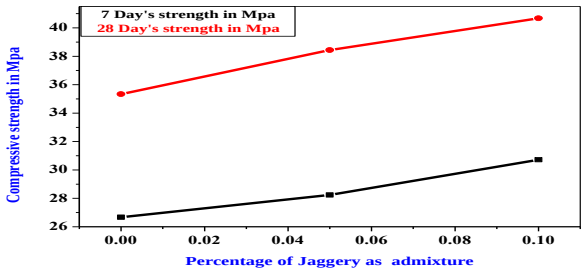

Fig 9: Compressive strength of concrete with Jaggery as Admixture

VIII. CONCLUSIONS

- Collapse of Slump was observed in both the admixtures at a dosage of 0.1%.
- Workability increased when the dosage of admixture was increased.
- Compressive strength of concrete enhanced when dosage of admixture was increased.
- Concrete with Jaggery as admixture, has given better strength values than the Sugar.
- Segregation and bleeding was very less due to the usage of these admixtures.
- Setting time of the concrete increased as the dosage of admixture was increased.
- Strength of the concrete improved with little extra cost and utility in specified situations.

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