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Experimental Study On M-Sand With Addition Of Sugar As Admixture In Concrete

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Abstract: ***The Concrete is a composite construction material plays a vital role in the construction of the nation's infrastructure. One of the important ingredients of conventional concrete is natural sand or river sand. The issue of environmental degradation and expensive nature of the river sand make us to switch on to the alternative sources. Lots of researches has been done to replace the sand, in this project we study the effect of Sugar and replace the river sand by M-Sand with 50% and 100%. Its micro-filling effect reduces pores in concretes and provides better moisture resistivity and thus durability. M40 grade of concrete was used and the specimens were tested at 7, 14 and 28 days. Effective use for waste material and thus cost effective and performs as well as naturally occurring sand. Different percentages of admixtures as Sugar are selected in the evaluation as 0.25 % and 0.5% by weight of cement. The experimental work mainly concluded after evaluation workability and concentrates with compressive strength and split tensile strength and acid attack test on concrete enhanced when admixtures like Sugar added into the concrete Mix.***

Keywords:M-Sand, Addition, Sugar, Admixture, Concrete

1. 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. Concrete is most widely used man made construction material in the world and obtain by mixing cement, sand, aggregates and water, and sometime admixtures is required in suitable proportions. The strength, durability and other characteristics of concrete depends up on the properties of its ingredients, on the proportion of mix, the method of compaction and other control during placing, compaction and curing. Concrete block has its superior properties like binding, strength and durability, but it cannot be used in all places due to different weather conditions in different countries. Variation in weather condition and sessions causes changes in the initial setting time of concrete. Retarder and Accelerator are used to increase and decrease the initial setting time of concrete specially in winter sessions and summer sessions respectively.

When water is added to cement, it sets and hardens gradually under normal climatic conditions. But in some countries, including Pakistan, higher summer temperatures, low relative humidity and hot wind blowing cause rapid evaporation of water from the fresh concrete surface. Consequently concrete sets earlier and no proper time is left available for concreting operations. For example, it has been reported that, when the temperature of cement mortar with a water/cement (w/c) ratio of 0.6 is increased from 27.80C to45.50C both the initial and final setting times are nearly halved.

Concrete has its superior properties like binding, strength and durability, but it cannot be used in all places due to different weather conditions in different countries. Variation in weather condition and sessions causes changes in the initial setting time of concrete. Retarder and Accelerator are used to increase and decrease the initial setting time of concrete especially in winter sessions and summer sessions respectively. With the help of different type of admixture used such as Retarder- sugar and gypsum etc. and Accelerator- calcium chloride (cacl2) etc. By going through studying to various review papers and research papers sugar is good admixture to increasing the initial setting time. Sugar is a carbohydrate, a composition of carbon, oxygen and hydrogen. It can be useful when concreting used in hot weather conditions, when the normal setting time of concrete is shortened by the higher surrounding temperature such as Gujarat, Rajasthan states etc. Very small dosage of the order of 0.05 to 0.1 per cent of the mass of the concrete is enough. 0.05 per cent of sugar can delay initial setting time by about 3 hours. Usually three different percentage of sugar admixtures were taken as by weight of cement. Hence in order to maintain the standard condition, admixtures are used. Retarders are

admixture that extend the hydration induction period, thereby lengthening the setting times(Lea).Sugar, carbohydrate derivatives , soluble zinc salts ,soluble borates exhibits retarding action.Lea,1988-Sugar falls under the category of 'coating ' admixture ;in the presence of water a cement particle sends out a swarm of calcium ions into the surrounding water and any substance capable of immobilizing or delaying this surge will also slowdown the interchanges between the water and the particle, thus retarding the hydration process.

2.METHODOLOGY

Figure 1. Shows the methodology adopted in this study

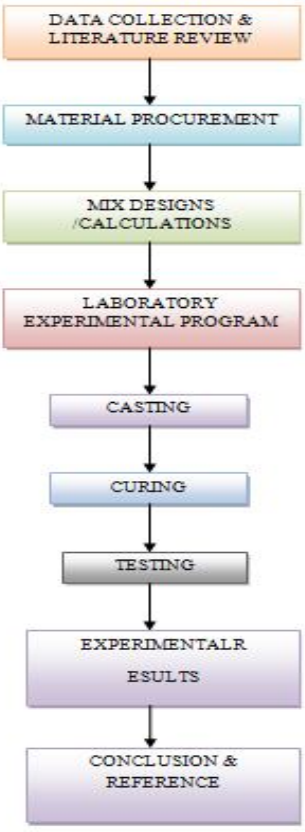

Figure 1 Methodology

3.MATERIAL COLLECTION

3.1 Cement

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).Non-hydraulic cement will not set in wet conditions or underwater; rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

3.2 Coarse Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

3.3 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve.

3.4 Sugar

Sugar was used in the concrete production. A white crystalline solid easily soluble in water and easily available in market and used in the experimental works. Sugar, using sugar-based ingredients that are used as additives to the concrete.

Figure 2 Sugar as Admixture

It shows that the effect of adding sugar-based materials in the form of sucrose, sugar, and sugar cane in concrete mixture is very significant, that is accelerate or slow the time of hardening of concrete, and increase the compressive strength of concrete. It should be noted that bagasse contains 30-50% cellulose and 20-24% lignin. Cane plant is known as the main ingredient of sugar production in my country (Indonesia). In general, cooking cane rods contain 67-75% water, 8-16%, and 8-16% sucrose, 0.5-20% reducing sugar, 0.5-1% organic material, 0.2-0.6% inorganic compounds, 0.5-1% compounds nitrogenic, 0.3-0.8% ash, and 10-16% fibre. Cane also contains 30-50% cellulose and 20-24% lignin. The presence of lignin in the bagasse and its juice is indicated to contribute the attachment, when the sugarcane solution is mixed into the concrete mixture. The sugar-based added ingredients in the concrete mixture enhances the C-S-H bond so that it will increase the value of the compressive strength of the concrete over time until the optimal value of the compressive strength is achieved. At certain doses, sugars can accelerate or slow down the time of binding of cement

and hardening of concrete and improve the performance of compressive strength of mortar and concrete. Sugar-based concrete increased strength at a dose of 0.03% and 0.3% of the weight of cement.

3.5 M-Sand

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing. Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. Figure.3 shows M-sand and sand.

Figure 3 M-sand and sand

3.5.1 Advantages of Manufactured Sand (M-Sand)

- It is well graded in the required proportion.
- It does not contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- M-Sand is obtained from specific hard rock (granite) using the state-of-the-art International technology, thus the required property of sand is obtained.

3.6 Water

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking.

4. MATERIAL PROPERTIES

4.1 Cement

Cement, a popular binding material, is a very important civil engineering material. This article concerns the physical and chemical properties of cement, as well as the methods to test cement properties.

4.1.1Properties of Good Cement

It is always desirable to use the best cement in constructions. Therefore, the properties of a cement must be investigated. Although desirable cement properties may vary depending on the type of construction, generally a good cement possesses following properties (which depend upon its composition, thoroughness of burning and fineness of grinding).

- Provides strength to masonry.
- Stiffens or hardens early.
- Possesses good plasticity.
- An excellent building material.
- Easily workable.
- Good moisture-resistant.

4.2 Properties of Coarse Aggregate

Concrete is a mixture of cementious material, aggregate, and water. Aggregate is commonly considered inert filler, which accounts for 60 to 80 percent of the volume and 70 to 85 percent of the weight of concrete. Although aggregate is considered inert filler, it is a necessary component that defines the concrete's thermal and elastic properties and dimensional stability. Aggregate is classified as two different types, coarse and fine. Coarse aggregate is usually greater than 4.75 mm (retained on a No. 4 sieve), while fine aggregate is less than 4.75 mm (passing the No. 4 sieve). The compressive aggregate strength is an important factor in the selection of aggregate. When determining the strength of normal concrete, most concrete aggregates are several times stronger than the other components in concrete and therefore not a factor in the strength of normal strength concrete. Lightweight aggregate concrete may be more influenced by the compressive strength of the aggregates. Other physical and mineralogical properties of aggregate must be known before mixing concrete to obtain a desirable mixture. These properties include shape and texture, size gradation, moisture content, specific gravity, reactivity, soundness and bulk unit weight.

4.3 Fine Aggregate

4.3.1 Basic Properties of Aggregates Used In Concrete Composition

Aggregates consisting of materials that can react with alkalies in cement and cause excessive expansion, cracking and deterioration of concrete mix should never be used. Therefore it is required to test aggregates to know whether

there is presence of any such constituents in aggregate or not.

4.3.2 Size and shape

The size and shape of the aggregate particles greatly influence the quantity of cement required in concrete mix and hence ultimately economy of concrete. For the preparation of economical concrete mix on should use largest coarse aggregates feasible for the structure. IS-456 suggests following recommendation to decide the maximum size of coarse aggregate to be used in P.C.C & R.C.C mix.

4.3.3 Porosity and absorption

The minute holes formed in rocks during solidification of the molten magma, due to air bubbles, are known as pores. Rocks containing pores are called porous rocks. Water absorption may be defined as the difference between the weight of very dry aggregates and the weight of the saturated aggregates with surface dry conditions. Depending upon the amount of moisture content in aggregates, it can exist in any of the 4 conditions.

- Very dry aggregate (having no moisture)
- Dry aggregate (contain some moisture in its pores)
- Saturated surface dry aggregate (pores completely filled with moisture but no moisture on surface)
- Moist or wet aggregates (pores are filled with moisture and also having moisture on surface)

4.4 Properties of Sugar as Admixture

4.4.1 Physical and Chemical Properties

Pure sucrose is most often prepared as a fine, colourless, odourless crystalline powder with a pleasing, sweet taste. Large crystals are sometimes precipitated from water solutions of sucrose onto a string (or other nucleation surface) to form rock candy, a confection. Like other carbohydrates, sucrose has hydrogen to oxygen ratio of 2:1. It consists of two monosaccharides, Î±-glucose and fructose, joined by a glycosidic bond between carbon atom 1 of the glucose unit and carbon atom 2 of the fructose unit. What is notable about sucrose is that unlike most polysaccharides, the glycosidic bond is formed between the reducing ends of both glucose and fructose, and not between the reducing end of one and the non-reducing end of the other.

5. MIX DESIGN

Design Stipulations

Grade Designation	M-40
Type of cement	O.P.C-53grade
Fine Aggregate	Zone-I
Sp. Gravity Cement	3.15
Sp. Gravity Fine Aggregate	2.85
Sp. Gravity Coarse Aggregate	2.66

5.1 Mix proportion

Mix Proportion shown in Table.1

Table 1.Mixproportion

Cement (kg)/m^3	FA (kg)/m^3	CA (kg)/m^3	Water (liter)/m^3
547.37	656.42	1038.2	191.58

6. TEST PROCEDURE

6.1 Slump Test

Concrete slump test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. Generally concrete slump value is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc. also affect the concrete slump value.

6.2 Workability

- Workability of concrete has been measured by performing slump cone tests. Mix the material of concrete properly on a water tight plat form and measure the slump cone value as stated in the above section 5.1 and record the values, tabulated properly.
- During the testing of slump value, it was clearly observed that collapse of slump.
- Addition of Sugar to the concrete greatly influenced the setting property and clear collapse of slump witnessed during the experimentation. Setting of cubes specimen after 24 hrs is difficult.
- During the de-moulding after 24 hrs. Cube specimens are found cracks.

6.3 Compressive Strength Test

Cube specimens of each percentage (0, 0.05, 0.1, 0.15, 0.2 and 0.25%) are 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 are used for experimental work. Specimens are casted in cube mould and filled with concrete in three layers. Hand compaction is done with tamping rod and de-moulded after 24 hrs. Specimens are marked with marker and allowed to dry for some time and immersed in the curing tank. De-moulding of cube specimen is 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% and 0.1% admixture were de-moulded after 48 hrs and for 0.15, 0.2 and 0.25% after 72 hrs. The specimens are kept into the curing tank for curing @ temp 27±2° for a period of 28days. After completion of curing

period, specimens are removed from curing tank, kept for drying and tested in UTM. Fig: 3 show the casted cube specimens. During the experimentation of casting, it is clearly observed lower ranking of bleeding and segregation.

6.4Acid Attack Test

The concrete cube specimens of various concrete mixtures of size 150 mm were cast and after 28 days of water curing, the specimens were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. The acid attack test on concrete cube was conducted by immersing the cubes in the acid water for90 days after 28 days of curing. Hydrochloric acid (HCL) with pH of about 2 at 5% weight of water was added to water in which the concrete cubes were stored. The pH was maintained throughout the period of 90 days. After 90 days of immersion, the concrete cubes were taken out of acid water. Then, the specimens were tested for compressive strength. The resistance of concrete to acid attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersing concrete cubes in acid water.

6.5 Alkaline Attack Test

To determine the resistance of various concrete mixtures to alkaline attack, the residual compressive strength of concrete mixtures of cubes immersed in alkaline water having 5% of sodium hydroxide (NaOH) by weight of water was found. The concrete cubes which were cured in water for 28 days were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. Then the cubes were immersed in alkaline water continuously for 90days. The alkalinity of water was maintained same throughout the test period. After 90 days of immersion, the concrete cubes were taken out of alkaline water. Then, the specimens were tested for compressive strength. The resistance of concrete to alkaline attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersion of concrete cubes in alkaline water.

7.TESTING RESULT

7.1 Ratios for Special Concrete (Extra Ingredients)

Ratio –I

Sugar Adding 0.25 % of Water
Sand Replacing 50 % of M-Sand

Ratio - II

Sand Replacing 100 % of M-Sand
Sugar Adding 0.5 % of Water

7.2 Compressive Strength of Cube

Compressive strength test Results shown in Table.2 and Figure.4 shows Compression Test Graph Result.

Table 2 Compressive strength test Result

MIX DESIGN	% OF REPLACEMENT	COMPRESSIVE STRENGTH(N/mm^2)		
		7DAYS	14 DAYS	28DAYS
M_{40}	0	25.12	33.93	43.36
	(0.25 +50)	27.16	35.66	45.33
	(0. 5 +100)	23.12	30.67	40.16

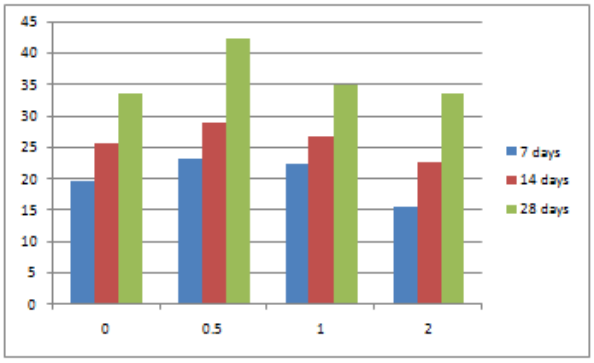

Figure4 Compression Test Graph Result

7.3 Split Tensile Test for Cylinder

Table 3 shows Split Tensile Test Result and Figure 5 shows Split Tensile Graph Result

Table 3 Split Tensile Test Result

MIX DESIGN	% OF REPLACEMENT	SPLIT TENSILE TEST (N/mm^2)		
		7 DAYS	14 DAYS	28 DAYS
M_{40}	0	1.98	2.3	3.17
	(0.25 +50)	2.16	2.5	3.31
	(0. 5 +100)	1.86	2.2	3.06

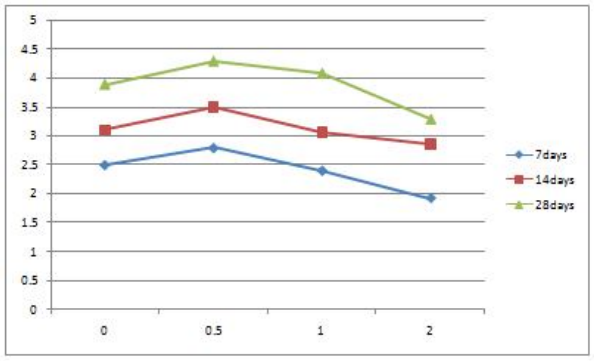

Figure5 Split Tensile Graph Result

7.4 Workability of Concrete

Table 4 shows Workability of concrete results. Figure 6 Graph shows the workability results Figure 7 shows Slump test results

Table 4 Workability of concrete results

% OF REPLACEMENT	SLUMP VALUE	COMPACTION FACTOR
0	200	0.98
(0.25 +50)	170	0.96
(0. 5 +100)	150	0.86

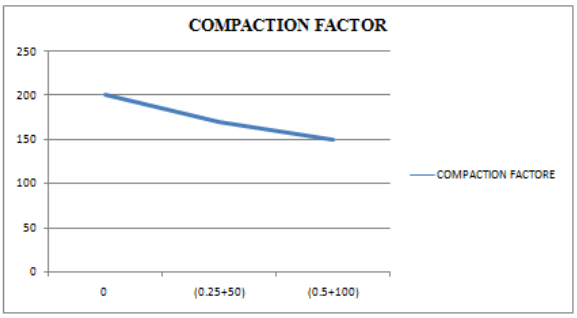

Figure 6 Graph shows the workability results

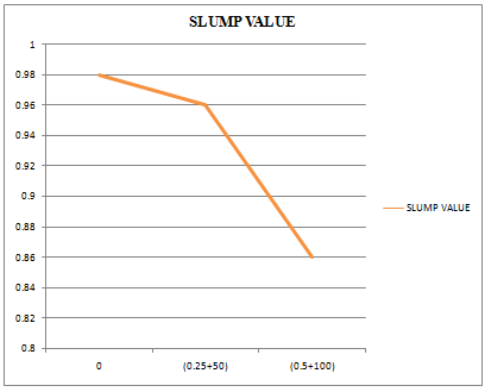

Figure7 Slump test results

7.5 Acid Attack Test

Table 5 shows Acid attack test results. Figure 8 shows Graphs shows acid attack test results

Table 5 Acid attack test results

TYPE OF CONCRETE	ACID ATTACK		
	BEFORE ACID CURING	AFTER ACID CURING	REDUCTION OF WEIGHT %
0	7.86	6.81	13.3
(0.25 +50)	7.81	6.85	12.2
(0. 5 +100)	7.78	6.89	11.43

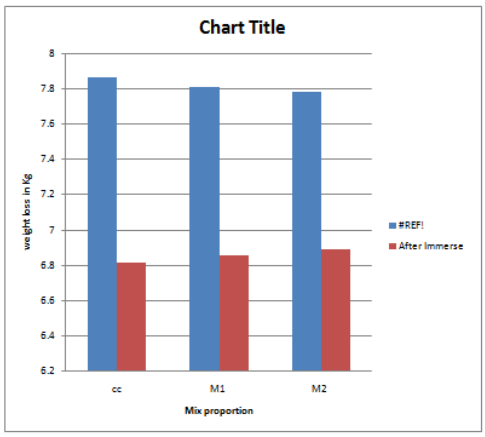

Figure 13 Graphs shows acid attack test results

8.CONCLUSION

The test carried out at 3 days, 7 days, 14 days and 28 days, the comparison is made between the varying proportions 0.25%,0.5% addition and 50 %,100% replacement of M-sand for Fine aggregate sugars in concrete mix for Setting time ,Workability & Compressive strength.

- Workability increased when the Ratio I compared to conventional concrete.
- The setting time of concrete increase sugar with increase the percentage of sugar.
- Both split tensile &compressive strength increases as the percentage of 0.25% sugar with 50% replacement of M-sand increases45.33N/mm^2 attained at 28 days compared to conventional concrete 43.36N/mm^2.
- Strength of the concrete improved with little extra cost and utility in specified situations.
- Segregation and bleeding was very less due to the usage of these admixtures.

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