To Study Accelerating and Retarding Behaviors of Molasses in Cement Mortar and Concrete

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***Abstract* – Sugar industries are the vital part of Indian industries and consumption of sugar in India is at its peak. There are several waste products which obtained as by products. Molasses is one among the four types of sugar waste and it contains 40-60 percent of total sugar content depending upon types of molasses. While other sugar-wastes are bagasse, pressed mud and discharging water containing mud. Among these wastes first two contains 3 percent of sugar and three contains negligible percent of sugar. In the present work molasses was collected from sugar mill Sonepat Haryana.**

The effects of different dosage level from 0 to 2.00 percent of the molasses by weight of cement were studied for standard consistency, setting time, water – reduction behavior and air – entrainment in fresh concrete. The studies were also carried out for 7-day and 28-day compressive strength of the mortar, 7-day and 28-day. This test results indicates that molasses acts as accelerator upto 0.50 percent dose and then becomes retarder. Also it is slightly a water reducer and air entraining agent. The compressive strength of mortar, concrete, flexural strength and tensile strength of concrete get increased on using 0 - 0.50 percent dose of molasses but the most favorable dose is 0.20 percent of molasses by weight of cement.

***Keywords*: Molasses, compressive, strength, accelerator, retarder**

1. INTRODUCTION

Waste management becomes the huge sector for research and developing new technique, method and alternative to utilize or minimize the waste by product. Side by side one or another means of safe disposal of such a material which can cause environmental pollution is discovered. After realizing that the waste and by-product of sugar industry may found a suitable admixture with cement and other binding materials. It can prove itself in the field of construction material investigation particularly for the leading sugar producing nations of third world like India, Ghana etc.

Molasses is the effluent obtained from the centrifugals on pouring or spinning a massecuite and is distinguished as A, B and C etc. The discharge before washing begins, is termed heavy molasses and when diluted with wash water it is called Light Molasses. The molasses eventually removed from the process is called waste, exhausted or final molasses.

Molasses is a mixture of chemicals and chemical compounds. But its main constituent is sugar i.e. carbohydrates. But it contains little percentages of chlorides also. That's why its behavior is very confusing. At some percentage it acts as accelerating admixture and at other percentage it acts as retarding admixture.

Sugar has a retarding action. The effect of sugar depends greatly on the quantity used, and conflicting results have been reported in past. It seems that, used in a care- fully controlled manner, a small quantity of sugar (about0.05 percent of the weight of cement) will act as an acceptable retarder, the delay in-setting of concrete is about 4 hours. However, the exact effects of sugar depend greatly on the chemical composition of cement. For this reason the performance of sugar, and indeed of any retarder, should be determined by trial mixes with the actual cement which is to be used in construction.

A large quantity of sugar, say 0.2 to 1 percent of the weight of cement, will virtually prevent the setting of cement such quantities of sugar can therefore be used as an inexpensive Kill, for instance when a mixer or an agitator has broken down and cannot be discharged.

When sugar is used as a controlled set retarder, the early strength of concrete is severally reduced. But beyond about 7 days there is an increase in strength of several percent compared with non-retarded mix. This is probably due to the fact that delayed setting produces a denser gel.

It is considered that water reducing admixture operated by chemically reacting through their acidic and hydroxyl functional groups with predominately the early hydration products of the C3A (Tri Calcium Aluminate 3Cao.Al2O3) phase and to some extent with the C3S(Tri Calcium Silicate 3CAO.SIO2) initial- hyadration products to form a monomolecular layer of admixture at the water- cement interface. This monomolecular layer will be associated with a sheath of water molecules to form a total barrier, some tens of angstroms thick which will prevent close approach of cement hydration particles and reduce the effect of the Van Der Waal forces of attraction normally operating at close proximity. Thus the inter-particle friction in the system is reduced so that the energy required to induce flow into the system is also reduced. An alternative and possibly in some cases concurrent mechanism is that the absorbed molecules retain their ionic nature resulting in initial repulsion of the particles by electrostatic means.

The presence of the admixture at the surface, depending on the forces between the admixture and the surface will impose an additional barrier to the diffusion of hydration products, increasing the length of dormancy period.

1.1 Sampling of Waste Molasses from Sugar Industry

The samples taken should be referred to each pan-strike. A sample may be taken from the storage tank by hand at every 4 hours and composited for analysis. A small sub-sample i.e. 100 gm. of every daily sample is weighed out and transferred into a second collecting bottle. These sub-samples are mixed and served for the total analysis, which is made once a week or a fortnight. Although the main objective of the sugar industry is to produce a final molasses, whose purity and total sugar content is as low as possible, yet the final molasses comes out as waste from the sugar industry having no uniform brix and total sugar content.

1.2 Molasses as admixture

Molasses is a waste product of sugar industry, which contains too much sugar content (40 to 60 %) as compared to other waste product of that industry. Molasses form the sugar mill has been taken as an admixture for the cement mortar and cement concrete in present study. There are three types of molasses depending upon the degree of bricks and total sugar content. Normally from a sugar factory lowest grade of molasses (i.e. C grade molasses) comes as an effluent, which is available in market for commercial purpose. This C grade molasses contain about 40- 45% total sugar content. It contains about 20% water and rests other chemicals. So its effect on concrete is very complicated. Its specific gravity at normal temperature is 1.34.

2. LITERATURE REVIEW

The mechanism of action of retarders has not been established with certainty. We know that they modify the crystal growth or morphology and this result in a more effective barrier to further hydration than is the case without admixture. The admixtures are finally removed from solution by being incorporated into the hydrated material but this does not necessarily mean the formation of different complex hydrates.

2.1 Molasses as Air-Entraining Admixtures

Molasses also acts as air-entraining admixture. The air-entraining admixtures are organic materials normally in soluble form (as molasses), which when added to the gauging water of a concrete mix, entrain a controlled quantity of air in the form of uniformly dispensed microscopic bubbles.

These admixtures are used to improve the durability of concrete exposed to a combination of injurious salts and cycles of freezing and thawing and to improve the resistance of concrete to surface scaling due to ice removal. In the fresh state, these admixtures improve the workability of concrete also.

Concrete which are produced using fine aggregates deficient at the fine end of the grading, e.g. sea dredged aggregates, exhibit a tendency to bleed and segregate. The presence of a small amount of entrained air (2 to 4 percent by volume) leads to an improvement in cohesion, or mix stability. Alternatively, with mixes which are adequate in this respect, a reduction in sand content can be made when air is entrained without loss of cohesion. The amount that can be removed is approximately equal on a volume basis and leads to a reduction in water/cement ratio to minimize the effect of entrained air on compressive strength.

Durability and cohesion are normally associated with minor quantities (less than 8 percent by volume) of entrained air. But using different chemical types of materials, much larger quantities (upto 30 percent by volume) can be entrained to lower the density, enhance the thermal insulation properties or to produce light weight concrete in conjunction with light weight aggregates.

2.2 Molasses as Water-Reducing Admixture

Molasses is also a water-reducing admixture. Since molasses acts as retarder and accelerator both. By the addition of the admixture, a reduction in water -cement ratio results and thus a concrete having the same workability as that of the control concrete can be obtained, with unconfined compressive strength at all ages exceeding that of the control concrete.

It is more difficult to obtain higher strength and workability by further increasing the cement content. It is in this area that the hydroxy-Carboxylic acid water-reducing admixtures are particularly beneficial, enabling considerable increase in strength to be obtained without the additional cost and undesirable side effects of large cement increments. These types of admixtures behave in a similar manner to the normal materials and are often of similar chemical composition at higher dosages level. But they extend the period of time when the concrete is in the workable state. This means, that the time available for transport, handling and placing is increased. The retarders are actually retarding water-reducing admixtures.

3. EXPERIMENTAL SETUP AND RESULT DISCUSSION

The aim of present investigation was to study the effect of Sugar-Waste (Molasses) on the various properties of cement, cement-mortar and cement-concrete. The Molasses were taken from Sugar mill Sonepat(Haryana), whose main Constituents are listed in Table 3.1 By varying the dosage level of molasses the tests were performed on cement and different mixes of the cement-mortar and the cement-concrete.

The standard consistency, initial setting time and final setting time was compared with and without the use of Molasses. The effect of Molasses on these properties of cement was compared with the effect of sugar on these properties of cement. The water-reducing effect in different mixes of cement-sand mortar (1:3, 1:4 and 1:5) has been worked out for different dosages of Molasses. The workability of the mortar was kept same i.e. flow value = 110± 5 percent. Using 50 mm size cube specimens the 7-day and 28-day compressive strength were determined.

3.1 Testing for Standard Consistency and Setting time of Cement

The investigations were done with the help of Vicat apparatus conforming to IS:5513-1969. All the tests followed the IS:4031-1968, Indian Standard Methods of Physical Tests for Hydraulic Cement. Same procedure was adopted for the dosage levels of 0.10, 0.25and 0.50 (Percent by weight of cement) of Molasses and Sugars. The observations are presented in Table 1 and fig 1.

Table -1: Effect of Molasses on Standard Consistency and Setting Time

Sr.No.	Dose of Molasses(percent by wt. of cement)	Standard consistency	Setting times (Minutes)	
			Initial	Final
1	0.0	27.00	110	220
2	0.050	27.00	102	210
3	0.075	27.00	63	175
4	0.100	27.00	46	110
5	0.150	27.00	41	98
6	0.200	26.75	38	90
7	0.250	26.75	60	135
8	0.500	26.75	88	190
9	0.750	26.75	111	230
10	1.000	26.50	130	285
11	2.000	26.00	171	360

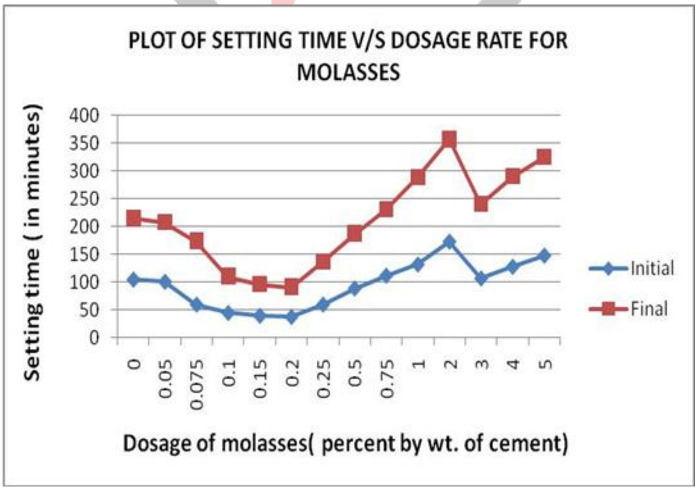

Fig. 1 Plot of Setting Time v/s Dosage Rate for Molasses

Molasses contain 20-25 percent sugar (i.e. sucrose). At any dose of molasses and 20-25 % of that dose has given the similar trend of graph of 'setting time v/s dose' of molasses and that of sugar. Initial setting time and final setting time first decrease upto 0.2 percent dose of molasses and then increase upto the dose of 2.0 percent. Thus at some particular percentage it acts as an accelerating agent and at other span of dose it acts as retarding agent. This behaviour may be due to presence of a large number of chemicals and chemical compounds. Due to carbohydrates it is acting as retarding agent and due to chlorides and hydroxides it is acting as accelerating agent. Upto 0.50 percent dose it acts as accelerating agent and later as retarding agent.

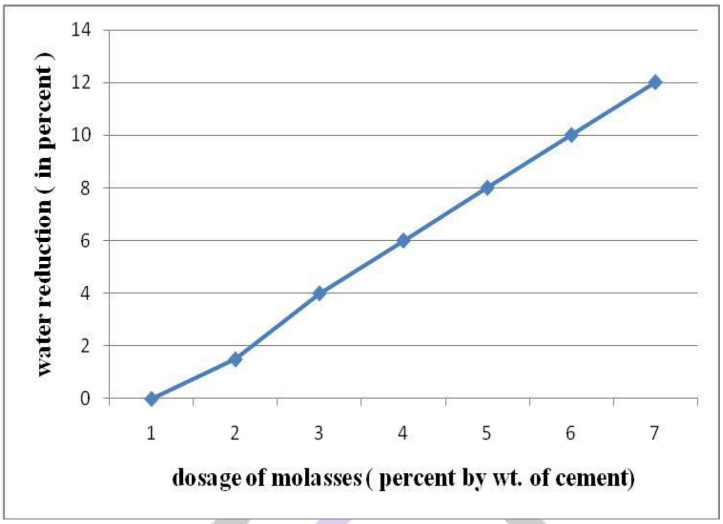

Fig. 2 Water Reduction Behaviour of Molasses in Mortar

Maintaining the room temperature as per laboratory conditions, the mix was prepared. The proportions of cement and sand was taken 1:3, 1:4 and 1:5 by weight for different mixes of mortar. The amount of water was adjusted to get the flow of 110 + 5 percent. The flow value was deter-mined.

Moulding, storage, curing and testing of specimens were done respectively. Similar tests were repeated for the dosages of 0.10, 0.25 and 0.50 (Percent by weight of cement) of Molasses.

The following main points can be noticed regarding water reduction behavior of molasses:-

1. Molasses is slightly a water-reducing admixture. By adding 5 percent molasses by weight of cement, water being reduced by 12 percent for the same workability of mortar.

2. The graph between water-reduction and dose of molasses is linear. Thus water-reduction is directly proportional to the dose of molasses.

The air content of freshly mixed concrete is increasing with an increase in the dosage of molasses. The air content of freshly nixed concrete and dosage are almost directly proportional to each other.

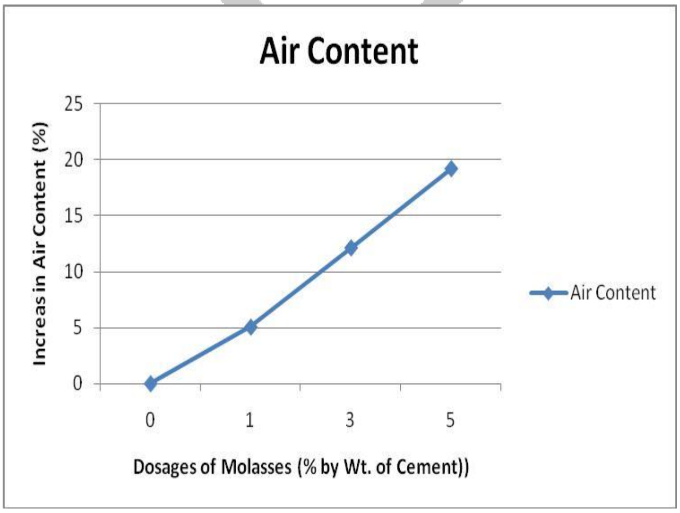

Fig. 3 Air Entrainment in fresh concrete due to addition of molasses

Compressive Strength is determined by CTM by testing the cube of size 50X50 mm at gradual loading. The tests are conducted at 14 days and 28 days of casting the blocks. The result obtained are shown below:-

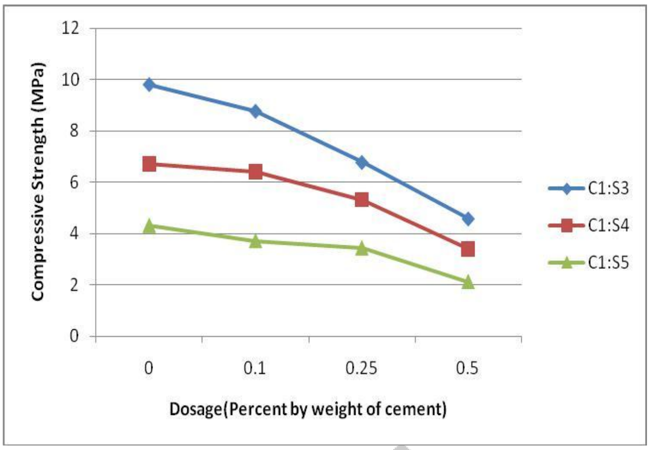

Fig. 4 Effect of Molasses on 7-days Compressive Strength of mortar

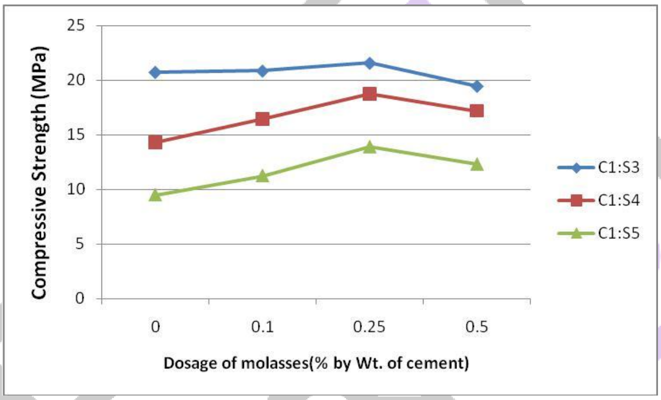

Fig. 5 Effect of Molasses on 28-days Compressive Strength of mortar

It is also seen that during the experiment that at higher dose of molasses the cement mortar is not setting within 24 hours. In cold season (i.e. at lower temperature) the cement-sand mortar with a dose of 0.75 percent by weight of cement and at higher dose, is not setting within 24 hour.

In general it is seen that the,28-day compressive strength of mortar gets increased upto a dose of 0.25 percent by weight of cement and then decreases with lower rate so much so that at 0.50 percent dose the compressive strength is more than the reference strength.

4. CONCLUSIONS

The following conclusion can be revealed as:-

a) Molasses acts as accelerating agent at lower dosage level an as retarding agent at higher dosage level. Thus initial setting time and final setting time of cement-paste with molasses has too much variation. Out upto 0.5 percent dose it acts as accelerating agent. From 0.75 percent to5.0 percent dose it acts as retarding agent. The trend shows that at higher percentage it will act as retarding agent.

b) The molasses is a water reducing agent. It is capable of reducing water by 12 percent by adding 5 percent molasses by weight of cement.

c) The rate of water reduction is different for the different mixes, when they were studied with the use of the molasses. It is maximum for poor mix and minimum for richer mix.

d) Molasses act as air entraining agent. By addition of 5 percent molasses, the air content of freshly mixed concrete has increased by 20 percent. The relationship between increase in air content (in percent) and dosage of molasses is almost linear in the range of 0 to 5 percent of dosage level.

e) For mortar the 7-day compressive strength decreases with an increase in the dosage level. Rut 28-day compressive strength of mortar is favorable in the range of 0 to 0.5 percent of dosage level. But the most favorable dose is 0.25 percent.

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