

Experimental Study on Strength and Setting Time of Concrete After Modifying Workability by Using Molasses as Time Retarding and Plasticizing Agent

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ABSTRACT

Molasses is a byproduct recovered from the sugar refining process. Molasses can also recover from the paper industries. Here the waste floating on the surface of boiling sugar juice during the process of production of sugar is taken. Sugar content in such molasses slows down the hydration process in cement. This phenomenon increases the setting time of the concrete mix. Among the quantity of water added to concrete without any admixture, a portion gets evaporated due to heat of hydration during initial setting. When adding molasses in a proportion, as the hydration process reduced, portion of water evaporating also get reduced. This exhibits that, molasses as an admixture in concrete functions as water reducing and time retarding agent. Here a study conducted to measure the time retarding effect of molasses in cement mix, effect of molasses on workability of fresh concrete mix and strength of hardened concrete.

Keywords

Molasses, sugar, time retarding, workability, strength.

1. INTRODUCTION

Plasticizers are the agents used to modify the fresh concrete properties of concrete without affect the strength properties. Constituents of plasticizers are anionic and nonionic surfactants of hydroxyl and carboxyl groups[2]. Carbohydrates in retarders are responsible for time retarding effect. Constituents of pigments of molasses are surfactants of hydroxyl and carboxyl groups[1]. Molasses also consists of 60-80% of inverted sugar[1]. Sugar in such molasses is carbohydrates and functions as a retarder. This exhibits that molasses can be used as a plasticizing agent and time retarder[1]. Here the following studies were conducted.

- Effect of molasses on setting time
- Effect of molasses on workability
- Effect of molasses on strength

The materials used in the studies are initially tested for their basic properties. All the tests are conducted under the norms of Indian Standards (IS).

2. MATERIAL PROPERTIES

Materials involved

- Cement
- Fine aggregate (River sand)
- Coarse aggregate
- Molasses
- Water

2.1 Cement

(Test code: IS: 4031 - 1988)

Grade	: 43 (PPC)
Consistency	: 33 %
Initial setting time	: 18 min.
Final setting time	: 7 hr. 45 min.

2.2 Fine Aggregate

(Test code: IS: 2720)

Specific gravity	: 2.66
Zone	: II
Fineness modulus	: 3.923
Uniformity coefficient	: 2.2
Coefficient of curvature	: 4.099

2.3 Coarse Aggregate

(Test code: IS: 2386 - 1963)

Specific gravity	: 2.41
Water absorption	: 1 %
Bulk density	: 1652 kg/m ³
Impact value	: 12.167 %
Attrition value	: 6.12 %
Abrasion value	: 31.2 %

2.4 Molasses

Specific gravity	: 1.1304
pH	: 6.5
Conductivity	: 9.12 %

3. RESULTS AND DISCUSSION

3.1 Effect of molasses on setting time of concrete

Consistency of plain cement paste is found that 33%. Based on this consistency value, initial and Final setting time were calculated for plain cement as per IS 4031-1988. Initial and final setting time of plain cement is 18 min and 7hr 45min respectively. The same test repeated after 0.2, 0.4, 0.6, 0.8 and 1.0 percentage of molasses added to cement by its weight. At each time the setting time gradually get increased. The following table shows the effect of molasses on setting time of concrete.

Table 1. Effect of molasses on initial and final setting time of concrete

S. No	%of Molasses	Initial setting time (min)	Final setting time (min)
1	0	18	07:45
2	0.2	22	07:45
3	0.4	26	08:15
4	0.6	28	13:00
5	0.8	30	16:45
6	1.0	36	21:30

3.2 Effect of molasses on workability of concrete

Control specimen is prepared with cement content **375 kg/m³** and keeping water cement ratio as **0.48**. Therefore the water content is taken as **180 kg/m³**. Slump value for this mix is found that **5.8 cm**. Molasses is added in **0.2, 0.4, 0.6, 0.8 and 1.0** percentages in weight of cement. As mentioned earlier, workability goes on increasing. This increment can be represented by conducting slump tests and compaction factor test for each fresh concrete mix. The following table shows the effect of molasses on workability of concrete.



Figure 1. Workability tests on various percentages of molasses

Table 2. Effect of molasses on workability

S. No	%of molasses	Slump loss (cm)	Compaction factor
1	0	5.4	0.790
2	0.2	6.3	0.901
3	0.4	8.6	0.916
4	0.6	15.2	0.905
5	0.8	16.4	0.91
6	1.0	19.6	0.932

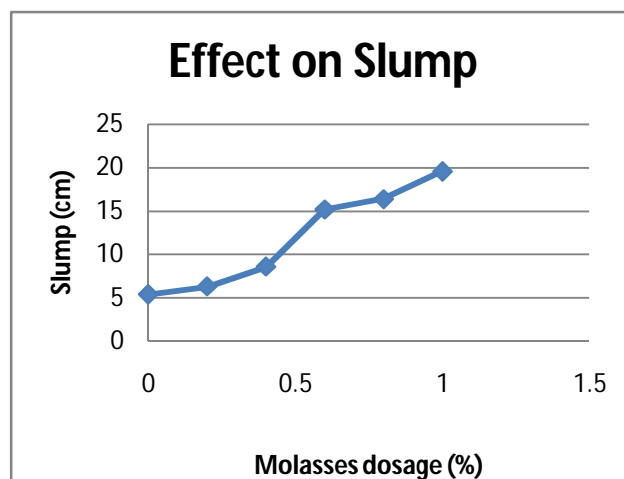


Figure 2. Effect of molasses on slump value

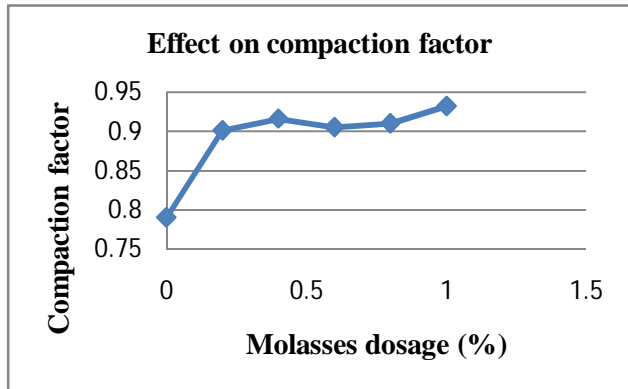


Figure 3. Effect of molasses on compaction factor

Figure 1 shows that addition of molasses at 0.4 to 1.0 percentage of weight of cement gives a considerable increase in workability.

3.3 Effect of molasses on strength properties of concrete

Concrete specimens like cubes, cylinders and prisms are casted by adding 0.2, 0.4, 0.6, 0.8 and 1.0 percentage. After the curing periods of 7,14and18 days strength properties were tested for each specimen. And their strengths are compared with the control sample. The following table shows the effect of molasses on strength properties of concrete.

Table 3a Effects of molasses on compressive Strength of concrete

S.no	% of Molasses	Compressive strength		
		7d	14d	28d
1	0	17.40	21.9	23.93
2	0.2	16.16	18.49	24.53
3	0.4	16.91	19.78	23.38
4	0.6	18.36	20.00	20.60
5	0.8	17.73	18.98	22.98
6	1.0	18.67	19.56	23.11

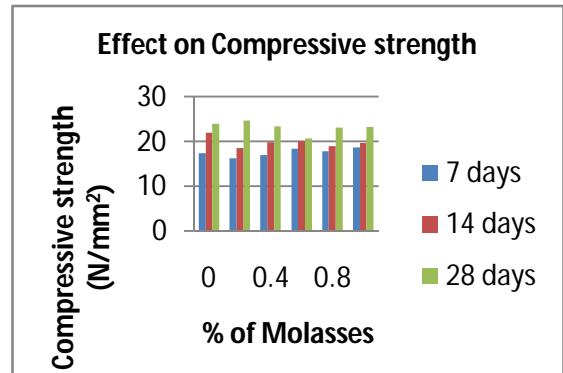


Figure.4. Effect of molasses on compressive strength of concrete

Table 3b. Effect of molasses on split tensile strength of concrete

S.no	% of Molasses	Split tensile Strength (N/mm ²)		
		7d	14d	28d
1	0	2.01	2.97	3.03
2	0.2	1.92	2.53	3.02
3	0.4	1.84	1.83	2.55
4	0.6	1.38	2.05	2.05
5	0.8	2.10	2.39	2.40
6	1.0	1.63	2.19	2.38

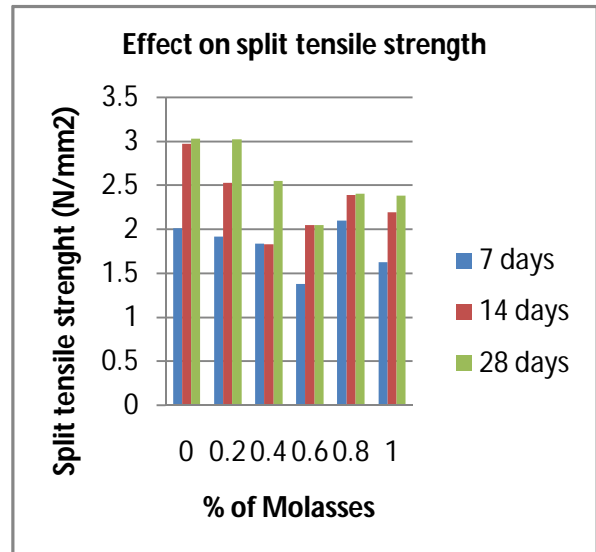


Figure 5. Effect of molasses on split tensile strength

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Table 3c. Effect of molasses on flexural strength of concrete

S.no	% of Molasses	Flexural Strength (N/mm ²)		
		7d	14d	28d
1	0	3.0	3.38	3.38
2	0.2	3.0	3.0	4.125
3	0.4	2.25	3.38	3.75
4	0.6	2.63	3.0	3.0
5	0.8	3.0	3.38	3.38
6	1.0	2.63	3.38	3.38

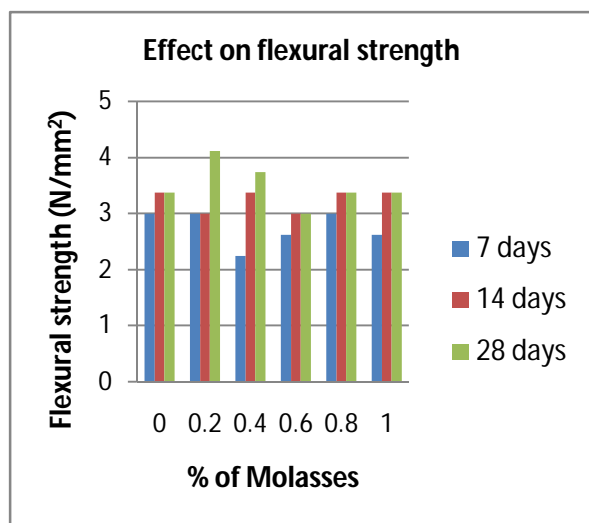


Figure 6. Effect of molasses on flexural strength of concrete

The above tables and charts shows that increase in workability does not cause any aggressive effect on strength parameters when compare to the control sample.

4. CONCLUSION

The various experiments conducted in concrete using molasses reflecting that, it can be used as a time retarding plasticizer. It increased both initial and final setting time of a concrete to a greater extent. It also enhanced the workability of fresh concrete. It can confirm from the values of slump and compaction factor test. And at the same time, the target strength of 20N/mm² is achieved for all the samples of concrete. Therefore, using molasses as a plasticizer will be very handy instead of using very costly chemical plasticizers.

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