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Experimental Study on Engineering Properties of Concrete with Aggregates Partially Replaced by Crushed PET and Cement by Sugar Molasses

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ABSTRACT

Sugar industry earmarked its significance among all agro-based industries. It brings smile to 50,000,000 sugarcane farmers by processing their harvest and provides livelihood and employment to millions of workers. Brazil produces highest sugar in terms of quantum. India stood second in the row with 800 sugar factories and 310 lakh MT production of sugar every year. Not only production of sugar for its consumer, but also there are no quantitative restrictions on by-products like molasses, mud, ethanol, etc. These are primarily categorised in four varying sorts: bagasse/cane top, ethanol, filtered mud and molasses. Molasses are rich in sugar content and comprises 40-60% of sugar. There are no hard and fast rules for safe disposal of these by-products, thus imposing problem to both environment and sugar industry. Molasses are used in the present investigation for strengthening of concrete. The molasses content was retrieved from GMS Sugar mill, Panipat, Haryana. The prime objectives or the foremost goals for which this investigation is carried out are to understand the characteristic features of Molasses and PET, to investigate hardening/setting time and fluidity of cement after incorporation of PET and molasses and to find the compressive and split tensile strength values of modified concrete mix.

Molasses content in present work ranges between 0.1% and 0.4% and PET content was 5% and 10 %. Design mix with 0.2 % molasses (% weight of cement) & 7.5 % PET bottle waste (% weight of fine aggregates i.e. sand) showed most optimum results in case of compressive & tensile strength. On addition of higher quantities, the weight of concrete reduces drastically leading to steep decline in strength characteristics. Thus the optimum dosage recommended by present investigation for molasses and PET are 0.2% and 7.5% respectively

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1. INTRODUCTION

The mixture of chemicals and chemical compounds is called Molasses. Its main constituent being sugar. But it also contains small percentages of chlorides too. That's why its exhibited behavior is really confusing. It acts as accelerating admixture at some percentage and at retarding admixture other percentages.

In India, the use of chemical admixture has not obtained the same degree of acceptance which is observed in most other major countries which produce concrete, even though concreting materials, practice and standards are similar. Inadequate facilities for researchers, inadequate admixture industry and little political motivation are some of the many reasons for this.

Sugar has a retarding action. The effect of sugar depends significantly on the used quantity, and in past conflicting results have been found regarding the exact quantity of sugar required to study the effects. It appears that when used in a precisely controlled manner, it will act as an acceptable retarder i.e. when a small quantity of sugar, say about0.05 percent of the weight of cement is used, it causes a delay in-setting of concrete for about 4 hours. However, the chemical composition of cement greatly affects the exact effects of sugar. For this reason, trial mixes with the actual cement which is to be used in construction should be used to determine the performance of sugar, and indeed same is the safe for any other retarder or retarding agent. A large quantity of sugar if added, say for example a 0.2 to 1 percent by weight of the cement, would virtually prevent setting of the cement. This quantity of sugar added to the concrete can be used a "Kill" to inexpensively delay the setting. For cases such as when a mixer or an agitator breaks down & the setting of concrete needs to be delayed. The early strength of concrete is severally reduced when sugar is used as a controlled set retarder. There is an increase in strength of several percent compared with non-retarded mix beyond 7 days. This is since delayed setting produces a denser gel. Plastic shrinkage increases because of retarders, as the duration of the plastic stage is extended although drying shrinkage is not affected considerately. The action of retarders has not been proven with certainty. Retarders modify the crystal growth or morphology and this leads to a more effective barrier to further hydration of the concrete than is the case without addition of admixture.

2. Literature review

K. Ramadevi1 et al (2012) In this study, fine aggregates were partially replaced with PET bottles. The experiments showcased that the concrete with PET fibers reduced the weight of concrete which would help us make concrete &mortars with littler weight in comparison with controlled specimens. It was observed that with 2% replacement of the fine aggregate with PET, the compressive strength increased but later it gradually decreased when the quantity was increased to 4% and 6% replacements. Hence replacement of fine aggregate with 2% replacement will be reasonable. The same case was observed with the split tensile strength of the concrete it also increased up to 2% replacement of the fine aggregate with PET bottle fibers and later gradually decreased when 4% and 6% replacements were done. So, it was concluded that for the replacement of the fine aggregate PET bottles, 2% replacement would be the most reasonable & favorable replacement with a higher split tensile strength compared to compositions. The effect on replacement on flexural strength was also studied & the conclusions were derived that 2% replacement of the fine aggregate is more favorable that 4% & 6% as at 2% the flexural strength increased but decreased at 4% & remained same at 6%. Hence, the conclusion brought together from the study was that 2% partial replacement of the concrete can be adopted with reasonable increase in tensile & flexural strength of the concrete.

Akogu Elijah Abalaka; et al (2011) In this study, the author studied the effects of sugar on the properties of the concrete. For the study, various percentage of sugar was added to concrete mixes. It was concluded that concrete retarders should only be used for concreting where competent personnel and adequate quality control of the production processes are available as sugar showed both behaviors that is accelerating & retarding of concrete. If miss handled the retarders could behave in opposite manner. The quantity of the retarder plays an important role so the quantity of it and other related quantities should be measured adequately. Sugar content of 0.06% by weight of cement improved compressive strength of concrete by 3.62% at 28 days testing and also delayed initial setting time by 1.556 hours (94 minutes). Besides this no adverse effect on concrete and cement paste were observed at this concentration of sugar. He concluded on the note that this delay in setting of concrete by adding this optimum dosage of sugar content could be proved useful in preventing cold joints and in reducing early setting of cement in hot weather concreting conditions.

L. R. Bandodkar et al (2011) In this study, the author studied the behavior of concrete by partial replacement of fine aggerates with polythene & PET bottles. It was found out that considerable results were found out upon partial replacement of fine aggregates with 10% mix of PET & polythene. Apart from recycling benefit it also proved to be an economical substitute to the san. When 10% of plastic was added, reduction in strength of 10.5% to 13.5% was observed for injection molded, pulverized blow and PET bottle plastic. Whereas in the case of polythene bags the reduction in strength was only 3.5% which indicated that there was issue with proper bonding and mixing of pulverized blow and injection molded plastic and similar could be the reason for PET bottles. In Pulverized polythene bags, their fibrous nature helped in the bonding. It was concluded that replacement was not found suitable for concretes ten to be used for RCC purpose but may be used in concreate mixes for much lean purpose or in case of plain concreates. It was also observed that the reduction in the compressive strength could be controlled with use of admixtures & could help in use of plastic waste with higher quantities. Further the other effects of plastic such as heat, insulating properties, elimination of shrinkage cracks, etc. were unexplored.

Zainab Z. Ismail, et al (2007) In this study, the author studies the effect on concreate by partial replacement of aggregates with waste plastic materials. It was found that compressive strength values of all waste plastic concrete mixtures decreased with reference to standard concrete mix, but there was also seen as increase in the plasticity. It was observed that it could be because of lesser binding between waste plastic & cement. In addition, as waste plastic is hydrophobic material it may also prevent hydration of the cement. It was observed that the flexural strength also decreased upon excessive replacement of the aggerates, a decline of up to 30.5% was shown when 20% of the aggregates were replaced. Dry density of waste plastic concrete mixtures showed decline at each curing age.On 28 days curing age, testes derived the lowest dry density of 2223.7 kg/m3, which exceeds the recommended range of the dry density of structural lightweight concrete. The fresh concrete density also observed a decline of 5%to 8.7% for different constituencies. It was observed that slump value of the concrete also decreases with increase in the percentage replacement which lead to high workable concreate.

3. Material Used

Cement

Ordinary Portland Cement OPC 43 Grade with trade name Ultratech was precured locally for project. The cement was tested as per requirements of IS: 4031-1969 and results were found to be satisfactory.

Sr No.	Characteristics	Result	IS: 269-1976 (9) Requirements
1	Color	Dark Grey	----
2	Consistency	28%	----
3	Specific Gravity	3.15	3.14 - 3.15
4	Initial Setting time	115 Min.	30 min. (Minimum)
5	Final Setting Time	220 Min.	60 Min (Minimum)
6	Fineness (residue on IS: Sieve no. 9)	6.1 %	10 % (Maximum)

Aggregates

Sand as fine aggregate & 20mm and 10mm as coarse aggregates were precured locally & used. Sieve Analysis were conducted on aggregates as per IS code 383-1970 & results were found to be satisfactory for usage.

Molasses

The Molasses were collected from ISGEC (Indian Sugar and General Eng. Corporation) Panipat. Molasses is a sugar industry waste, containing high quantity of sugar i.e. of approximate 40-60 %. As it is a by-product the quantity of sugar varies distinctly. Generally, molasses is divided under three categories that is A, B & C. The molasses obtained from general sugar factories is mostly of type C that is contains nearly 40-45% sugar & 20% water, the rest composition is of other chemicals

Sr No.	Characteristics	Result
1	Color	Wine Brown (Reddish Brown)
2	State	Liquid
3	Brix	80 degree (Theoretical)
4	Specific Gravity	1.4 (Theoretical)
	Sugar Content	
1	Reducing Sugar (Glucose)	18% - 22% (Average) (Theoretical)
2	Sugar Content (Sucrose)	25% - 30% (Average) (Theoretical)
3	Total Sugar Content	40% - 50% (Average) (Theoretical)

PET

Waste Plastic bottles were collected locally & shredded for project use.

Sr No.	Characteristics	Result
1	Color	White / Transparent
2	State	Solid
3	Specific Gravity	1.31

4. Methodology

The experiments were conducted in laboratory of Jan Nayak Chaudary Devi Lal Memorial Collage of Engineering, Sirsa. Experimentation were conducted as rigorous as possible with keen observation & precautions. From the stage of casting, curing & till the Testing of materials deep care was taken for time & duration. The aim of present investigation was to study the effect of Molasses & PET on the various properties of cement-concrete. Molasses was added by partial replacement with weight of cement & shredded Pet bottles were used to partially replace sand that is fine aggregates. Total 42 No of each cylindrical & cubical mold were casted. The mix design for M30 grade concrete was calculated using IS 456:2000 & IS 10262: 2009.

5. Results and Discussion

Compressive Strength Test

Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Cube No.	Weight(kg)	7-day Strength (N/mm^2)
N0	0	0	N0-1	8.32	17.02
			N0-2	8.17	16.99
			N0-3	8.23	17.52
N1	0.1	0	N1-1	8.36	17.22
			N1-2	8.27	17.05
			N1-3	8.12	17.53
N2	0	5	N2-1	8.15	17.23
			N2-2	8.28	17.25
			N2-3	8.21	17.58
N3	0.1	5	N3-1	8.25	17.29
			N3-2	8.18	17.59
			N3-3	8.20	17.57
N4	0.2	7.5	N4-1	8.12	17.24
			N4-2	8.00	17.56
			N4-3	8.11	17.90
N5	0.3	10	N5-1	8.01	17.23
			N5-2	7.99	17.18
			N5-3	8.05	17.22
N6	0.4	12.5	N6-1	7.80	17.32
			N6-2	7.95	16.59
			N6-3	8.00	17.28

Table Effect of Molasses & PET on7-Day Compressive strength

6.

Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Cube No.	Weight(kg)	28-day Strength (N/mm^2)
N0	0	0	N0-4	8.23	30.56
			N0-5	8.19	31.67
			N0-6	8.24	30.11
N1	0.1	0	N1-4	8.30	30.61
			N1-5	8.26	31.62
			N1-6	8.12	30.13
N2	0	5	N2-4	8.17	30.63
			N2-5	8.27	31.78
			N2-6	8.22	31
N3	0.1	5	N3-4	8.26	30.63
			N35	8.19	32.2
			N3-6	8.22	31
N4	0.2	7.5	N4-4	8.12	31.44
			N4-5	8.00	32.78
			N4-6	8.11	32.33
N5	0.3	10	N5-4	8.01	30.11
			N5-5	7.99	30.22
			N5-6	8.05	25.33
N6	0.4	12.5	N6-4	7.80	28
			N6-5	7.95	29.9
			N6-6	8.00	25.10

Table Effect of Molasses & PET on28-Day Compressive strength

Serial No.	Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Avg. 7-day Strength	Avg. 28-day Strength
1	N0	0	0	17.17	30.38
2	N1	0.1	0	17.26	30.78
3	N2	0	5	17.35	31.13
4	N3	0.1	5	17.48	31.27
5	N4	0.2	7.5	17.56	32.18
6	N5	0.3	10	17.21	28.55
7	N6	0.4	12.5	17.06	27.66

- Average compressive strength of the concrete was maximum with addition of 7.5% of PET bottle waste as fine aggregates in correlation with 0.2% of molasses in place of cement.
- Upon attaining a certain point the compressive strength starts to drop drastically.
- N6 mix that is the mix with 20% of PET as aggregate& 0.5% molasses had least compressive strength. It showed unacceptable compressive strength. Mix was considered to be insufficient for compressive strength design purpose.
- Compressive strength increrese slowly and up to N4 and maximum value is also n4 than decrease.
- Combined together, the design mix shows improved results in term of compressive strength.
- Combination of molasses & PET in optimum quantity showed increased compressive strength in comparison with controlled design mix.

Splitting Tensile Test

Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Cylinder No.	Weight(kg)	7-day Strength (N/mm^2)
N0	0	0	N0-1	13.07	2.31
			N0-2	12.83	2.32
			N0-3	12.93	2.30
N1	0.1	0	N1-1	13.13	2.32
			N1-2	12.99	2.34
			N1-3	12.75	2.32
N2	0	5	N2-1	12.80	2.35
			N2-2	13.01	2.36
			N2-3	12.90	2.36
N3	0.1	5	N3-1	12.96	2.39
			N3-2	12.85	2.38
			N3-3	12.88	2.39
N4	0.2	7.5	N4-1	12.75	2.48
			N4-2	12.57	2.42
			N4-3	12.74	2.40
N5	0.3	10	N5-1	12.58	2.28
			N5-2	12.55	2.26
			N5-3	12.64	2.25
N6	0.4	12.5	N6-1	12.25	2.20
			N6-2	12.49	2.18
			N6-3	12.57	2.12

Table Effect of Molasses & PET on7-Day Tensile strength

Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Cube No.	Weight(kg)	28-day Strength (N/mm^2)
N0	0	0	N0-1	13.07	3.70
			N0-2	12.83	3.72
			N0-3	12.93	3.72

N1	0.1	0	N1-1	13.13	3.72
			N1-2	12.99	3.74
			N1-3	12.75	3.76
N2	0	5	N2-1	12.80	3.72
			N2-2	13.01	3.78
			N2-3	12.90	3.76
N3	0.1	5	N3-1	12.96	3.80
			N3-2	12.85	3.78
			N3-3	12.88	3.79
N4	0.2	7.5	N4-1	12.75	3.82
			N4-2	12.57	3.84
			N4-3	12.74	3.86
N5	0.3	10	N5-1	12.58	3.71
			N5-2	12.55	3.69
			N5-3	12.64	3.68
N6	0.4	12.5	N6-1	12.25	3.66
			N6-2	12.49	3.65
			N6-3	12.57	3.60

Table Effect of Molasses & PET on28-Day Tensile strength

Serial No.	Specimen	Molasses (%weight of Cement)	PET (%weight of sand)	Avg. 7-day Strength	Avg. 28-day Strength
1	N0	0	0	2.31	3.71
2	N1	0.1	0	2.32	3.74
3	N2	0	5	2.36	3.75
4	N3	0.1	5	2.39	3.79
5	N4	0.2	7.5	2.43	3.84
6	N5	0.3	10	2.26	3.69
7	N6	0.4	12.5	2.16	3.63

- Highest split tensile strength was found out in N4 design mix.
- Split tensile strength was lowest in N6 & highest in N4 mix.
- In design mix N5 &N6 the strength dropped due to low density.
- Design N4 was consider the most optimum mix among all mixes for tensile strength.

Up to the design mix N4 the tensile strength increased with increase in quantity of molasses & PET bottles, but upon the saturation the strength decreased rapidly due to voids & lesser density

7. Conclusion

1. Molasses acts as accelerator when used in lower quantity that is rapidly dries the cement paste, thus decreasing the initial & final setting time of the cement paste.
2. With percentages, up to 0.15 it acted as accelerator, upon further increasing the quantity of molasses it started to act as retarder.
3. As the standard consistency of mixes decreased with increase in quantity of molasses, it could be derived that molasses also acts as water reducing agent.
4. While determining the initial & final setting time of cement paste with molasses, it was also observed that at 1% replacement of cement with molasses, it should nonlinear results i.e. non-sequential. At 1% molasses, it acted as accelerator in comparison to 5% & 2% molasses. This could be due to inconsistency of properties of molasses, due to molasses being a byproduct. Thus, it is concluded that deep care needs to be taken while addition of molasses & separate test needs to conducted for each quality & batch of molasses.
5. Design mix with 0.2 % molasses (% weight of cement) & 7.5 % PET bottle waste (% weight of fine aggregates i.e. sand) showed most optimum results in case of compressive & tensile strength. On addition of higher quantities, the weight of concrete reduces drastically leading to steep decline in strength characteristics.
6. Thus, it was concluded that molasses & PET bottle waste should be use in quantities not more than 02. % weight of cement & 7.5% weight of sand respectively.

References

[1] Akogu Elijah Abalaka; et al (Jan. 2011) “Effects of Sugar on Physical Properties of Ordinary Portland Cement Paste and Concrete” AU J.T. Volume 14, Issue 3.

[2] Aftab Aalm; et al. (July 2016) “Experimental Study on Strength Characteristics of Cement Concrete by Adding Sugar Waste” International Journal of Enhanced Research in Science, Technology & Engineering. Vol. 5 Issue 7.

[3] Shantanu Bhide, Jayesh Darshane, Darshana Shinde, Sudhanshu Dhokale, Prathamesh Deshmukh, Yashraj Desai, Pradeep Kodag; et al (2017) “Effect of Sugarcane Molasses on Compressive Strength and Workability of Fly Ash Mixed Concrete” IJSRSET. Volume 3, Issue 3.

[4] M. Phanindra, S. Ram Surya, J. Naresh; et al (July 2014), “Percentage Replacement of Bitumen with sugarcane Waste Molasses” International Journal of Civil Engineering and Technology. Volume 5, Issue 7.

[5] Mr. Shubham Auti1, Mr. Shubham Patel, Mr. Sumit Mahajan, Mr. Pushkar Patil, Mr. Rahul Chaudhari; at el (April 2017) “To Study the Variation in Compressive and Split Tensile Strength of Concrete by Using Various Binders” International Journal for Research in Applied Science & Engineering Technology. Volume 5, Issue 4.

[6] R. Sathish Kumar; et al (July – August 2013) “Comparison of strength of Properties of Bitumen mixed with Waste Materials as Modifier” International Journal of Civil Engineering and Technology. Volume 4, Issue 4

[7] Darshan N & Rajani V Akki; et al (October 2014) “Experimental Study on the Hardened Properties of Concrete by Using Soft Drink Bottle Caps as Partial Replacement for Coarse Aggregates” International Journal of Emerging Trends in Science and Technology. Vol. 1 Issue 8.

[8] Ms. K. Ramadevi1; et al (June 2012) Experimental Investigation on the Properties of Concrete with Plastic PET (Bottle) Fibers as Fine Aggregates” International Journal of Emerging Technology and Advanced Engineering. Volume 2, Issue 6.

[9] Pramod S. Patil, Ganesh V. Tapkire; et al (June 2014) “Innovative Techniques of Waste Plastic used in Concrete Mixture’ International Journal of Research in Engineering and Technology. Volume 3, Special Issue 9.

[10] Mastan Vali N; et al (January 2017) “PET Bottle Waste as a Supplement to Concrete Fine Aggregate” International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 1.

[11] L. R. Bandodkar, A. A. Gaonkar, N. D. Gaonkar & Y. P. Gauns, et al (October 2011) “Pulverised PET Bottles as Partial Replacement for Sand” International Journal of Earth Sciences and Engineering. Volume 4, Special Issue 6.

[12] Zainab Z. Ismail, et al (August 2007) “Use of waste plastic in concrete mixture as aggregate replacement” Science Direct.