

Experimental Study of Usage of Discarded Engine Oil as an Admixture in Concrete

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Abstract - In accordance with the technological advancements during last few years, various attempts have been made to utilize the by-products of industries to not only dispose-off them wisely but also to reuse them. Previously, many reference books on concrete technology describes that the leakage of oil on cement and concrete surfaces in old grinding units resulted in formation of concrete having more resistance to freezing and thawing. This effect is similar to adding an air-entraining admixture to the concrete for increasing its resistance against freeze-thaw cycles thus enhancing its durability. However this theory is not backed by significant and sufficient experimental data. Therefore, this study was conducted to investigate the effects laid by discarded engine oil on fresh and hardened properties of concrete when used as an admixture. The performance of concrete in its control mix proportion and in various other mixes containing DEO and air-entraining admixture is then studied and results are compared.

Keywords - Admixture, Air Content, Compressive Strength, Concrete Technology, Discarded Engine Oil(DEO), Slump, Waste Material, Workability

1. INTRODUCTION

Wastes or popularly known as the by-products of various industrial, agricultural and other processes are required to be disposed-off properly. For the past few decades, different industrial wastes are being used by civil engineering industry in different areas like cement manufacturing, as components of concrete binder, as aggregates or as ingredients of manufactured aggregates. Lubricants are generally produced from the refinery of crude oil and other hydrocarbons and they have a very

wide range of applications. During service in these applications, a part or sometimes all of the lubricant is consumed in the process. The remaining part then becomes contaminated and considered as a waste which contains substances like metal particles, lead, dirt, carbon etc. This waste is when illegally dispose-off, it can pollute groundwater with some of the harmful contaminants present in it including lead, magnesium, copper, arsenic, cadmium, chlorides. According to various studies, 1litre of waste lubricant can pollute 950,000litres of drinking water. Besides polluting water, if it is illegally disposed-off on land without any prominent treatment and as a result, it produces an adverse impact on environment by blocking the surface to come in contact to the natural environment. A major part of waste lubricant/ DEO is resulted from the vehicles during their periodic maintenance/servicing and thus automobile industry is a huge source which contributes towards the production and generation of waste lubricant/ DEO. Although all over the world, there are already various norms and rules guiding towards the safe and legal disposal of DEO however, the reality shows that only 45% of it is disposed according to the norms. Remaining 55% is illegally discarded which then goes to the land, rivers, seas and pollute the environment.

Aim of the present study is to establish out the way to manage the generation of DEO through automobiles by utilizing it in concrete mixes. This will not only preserve the use of natural and conventional resources but also result in the effective disposal of DEO. In this way we can also maintain economy in our operations. Firstly, by reducing the cost of materials required in concrete mixes and secondly, by eliminating out the cost incurred in treatment and disposal of DEO.

2. RESEARCH SIGNIFICANCE

This paper provides the results of the experimental program to investigate the characteristic properties of concrete in its fresh and hardened state by using DEO as an chemical admixture in it. Results of this research may be useful to determine whether we can use DEO as anchemical admixture by enhancing durability properties of concrete and at the same time as a method to dispose the waste lubricant. This experimental program will help us to understand the main differences, similarities and behaviorof fresh and hardened properties of concretemade with DEO and with that made of traditional chemical admixture.

3. EXPERIMENTAL PROGRAMME

3.1 Materials and Mix-Proportion

A detailed experimental program was prepared to determine the slump and air content of fresh concrete and also to find out the properties of concrete in its hardened state such as compressive strength at the age of 3, 7, 28 days and flexural strength at the age of 28 days.A control mix was prepared without any chemical admixture and 6 other concrete mixes were also prepared containing an amount of 0.20, 0.40 and 0.60 DEO (Discarded Engine Oil) and commercially available air-entraining admixture in the same proportion.

Ordinary Portland cement, OPC43 Bangur Cement was used that complied with the standards given in IS-8112. Sand was used as fine aggregates and aggregates of size 10mm and 20mm were used as coarse aggregates that were in accordance to the requirement of IS-383. DEO (Discarded Engine Oil) was collected from TVS service center, Phoolbagh, Gwalior and commercially available air-entraining admixture Duraspred AEA, supplied by Dura Build Care, Dwarka, New Delhi were used in this investigation program. By weight mix proportion of 1:1.5:2.623 was used for proportioning of cement, sand and coarse aggregates. Content of water, DEO and admixture were measured in percentage by weight of cement used.Details of all the 7 concrete mixes are listed in Table-1

Table – 1: Details of concrete mix proportion

Mix Type	OPC Kg/m ³	Sand Kg/m ³	Coarse Aggregate Kg/m ³	Water %	DEO %	AEA %
Control	425	638	1115	0.45	-	-
0.20 DEO	425	638	1115	0.45	0.20	-
0.40 DEO	425	638	1115	0.45	0.40	-
0.60 DEO	425	638	1115	0.45	0.60	-
0.20 AER	425	638	1115	0.45	-	0.20
0.40 AER	425	638	1115	0.45	-	0.40
0.60 AER	425	638	1115	0.45	-	0.60

3.2 Mixing, Casting and Curing

All the dry ingredients, cement, sand and coarse aggregates were firstly mixed in the mixer for 1min before adding water to it. Mixing of all the ingredients and concrete was performed in the laboratory of MITS, Gwalior using a 100lit capacity of concrete mixer. Admixtures like DEO and AEA were diluted in water before adding them to the dry mix. When dry mixing was done, the water was added to the dry ingredients and was allowed to get mixed for 2 minutes in order to achieve a homogeneous concrete-mix. After this re-mixing of 2 minutes, concrete was taken out of the mixer and was tested for its fresh properties for determining slump and air-content. Slump value of all the mixes were measured in accordance with the American Society for Testing and Materials (ASTM C-143) and air content was measured in accordance with the American Society for Testing and Materials (ASTM C-231). After testing for fresh concrete properties, concrete cubes were casted in standard steel moulds of dimensions 150mm x 150mm x 150mm. Concrete was poured in the moulds in 2 layers of nearly the same thickness and after laying each layer was then compacted. Compaction of the layers was done by applying vibrations to the moulds by placing them on vibrating table according to the specifications given in Indian Standards (IS-2514). Similarly concrete beams were casted by using steel moulds of dimensions 500mm x 100mm x 100mm and the same layering and compaction methodology was adopted as it was used during casting of concrete cubes. After casting all the specimens in the moulds, they were left for 24hr for drying and then were striped-out and transferred to the water tank for curing till the desired age of 3,7 and 28 days.

3.3 Testing of Specimens

Freshly mixed concrete was tested for the properties of measurement of slump values and air content. These were done in accordance to the standards of American Society for Testing and Materials, ASTM C-143 and ASTM C-231 respectively. In hardened state, concrete cubes were tested for compressive strength at the age of 3, 7 and 28 days in accordance to the specifications given in Indian standards (IS-516) by using a compression testing machine having maximum capacity of 2000 kN and concrete beams were tested for flexural strength at the age of 28 days in accordance to the specifications given in Indian standards (IS-516)

4. RESULTS AND DISCUSSIONS

Properties that were tested during the fresh state and hardened state of concrete and their experimental results obtained during testing are discussed below:

4.1 Fresh concrete properties

4.1.1 Slump value

Slump value is the measurement of workability of concrete. It signifies the fluidity and consistency of concrete. Higher value of slump shows that concrete is of higher workability and lower value of slump shows low workable concrete. Slump values for different concrete mixes are shown in Table-2. The results in given table and figure shows that DEO improved the slump values of the mix as compared to the slump values of control mix. The mix was also tested with the addition of same concentration of AEA and the results for this were also positive, it also improved the slump values of concrete. Range of enhancement of slump value with the addition of DEO is 9.5% to 30% as compared to the slump value of control mix and the range of slump value enhancement in case of addition of AER is 19% to 57%. These test results are shown in Figure-1.

Table - 2: Slump values of different concrete mixes

Mix Type	1 st reading (mm)	2 nd reading (mm)	3 rd reading (mm)	Average value (mm)
Control	73	76	70	73
0.20 DEO	78	81	81	80
0.40 DEO	87	86	88	87
0.60 DEO	92	97	96	95
0.20 AEA	87	88	86	87
0.40 AEA	103	100	97	100
0.60 AEA	117	113	115	115

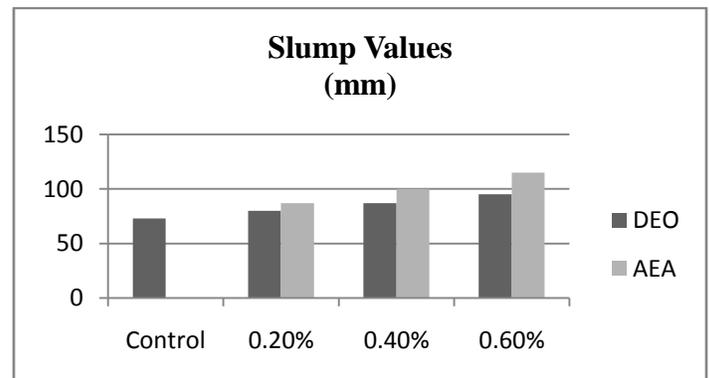


Chart - 1: Variation in slump of different concrete mixes

4.1.2 Air-content

Air-content is the measurement of amount of entrained air in concrete. This entrained air provides resistance to concrete to maintain its durability by overcoming the effects caused by freezing and thawing. Although, the strength of concrete gets lowered by the addition of air in concrete but still it is desired to introduce air in concrete for providing resistance to freeze-thaw cycles and to increase the durability of the structure. It is considered that for every 1% of increase in entrained air, the compressive strength of concrete gets lowered by 5%. If

the air content holds within the range of 6 to 7%, it provides the desired durability and limits the amount of loss of compressive strength of concrete. Air content of different mixes is shown in Table-3. The results show that DEO improved the air content of the mix as compared to the entrained air in control mix. The mix was also tested with the addition of same concentration of AEA and the results for this were also positive, it also improved the air content of concrete. Range of improvement in values of entrained air with the addition of DEO is 28% to 92% as compared to air in control mix and the range of improvement in values of entrained air with the addition of AEA is 52% to 140%. These test results are also shown in Figure-2.

Table – 3: Air content of concrete mixes

Mix Type	Air content %
Control	2.5
0.20 DEO	3.5
0.40 DEO	4.4
0.60 DEO	5.5
0.20 AER	3.8
0.40 AER	5.2
0.60 AER	6.5

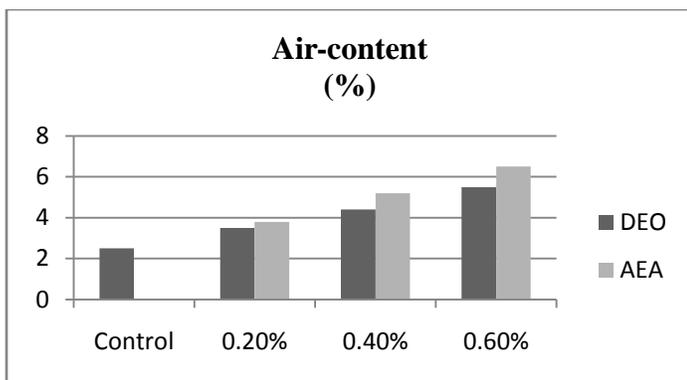


Chart – 2: Variation in air-content of concrete mixes

mix at three different age of 3, 7 and 28 days. The mix tested is of grade M-30. Firstly, the readings were noted for compressive strength of control mix and then for the different values of concentration of DEO and AEA. The readings for compressive load of different mixes are given in Table-4. The results show that the range of deterioration of compressive strength of concrete at the age of 28-days using DEO was in control i.e. from 3.5% to 11% while this range was quite high when commercially available AEA was used, it varied from 6.5% to 20%. Hence, it can be concluded that reduction in compressive strength using commercially available AEA is just double to that of reduction in strength by using DEO in concrete mix. Variation in compressive strength at all the ages of 3, 7 and 28-days is depicted in Figure-3 and comparison of 28-days characteristic strength of concrete mix is shown in Figure-4.

Table – 4: Compressive load of concrete mixes

Mix Type	3-days	7-days	28-days
Control	360kN	640kN	840kN
0.20 DEO	345kN	620kN	810kN
0.40 DEO	335kN	600kN	785kN
0.60 DEO	325kN	570kN	750kN
0.20 AEA	335kN	600kN	785kN
0.40 AEA	310kN	560kN	725kN
0.60 AEA	290kN	510kN	675kN

4.2 Hardened concrete properties

4.2.1 Compressive strength

Compressive strength is the measurement of the capacity of a material to withstand loads which tends to reduce its size. Thus, compressive strength was measured for each

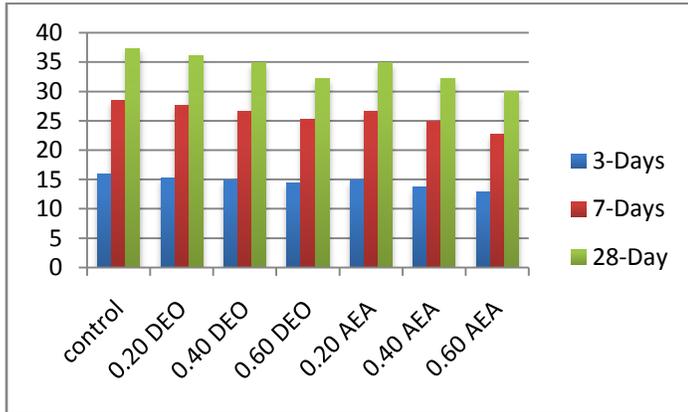


Chart - 3: Variation in compressive strength at ages of 3.7 & 28-days

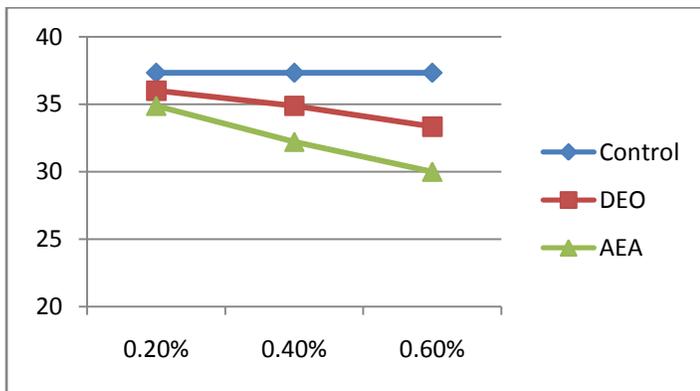


Chart -4: Variation in 28-days compressive strength (N/mm²)

4.2.2 Flexural strength

Flexural strength is the measurement of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist its failure against bending. Concrete is considered to be possessed negligible flexural strength and hence for making it safe against bending it is reinforced by providing steel bars in it. In this research study, flexural strength was measured by casting concrete beams of size 500mm x 100mm x 100mm for all the seven mixes and then tested for flexural strength at the age of 28-days. The readings are depicted in Table-5. Results shows that range of decrement of flexural strength using commercially available AEA was high as compare to that of concrete mixes using DEO as percentage loss in case of AEA was

15-45% while it was 8-30% in case of DEO. This relation is also depicted in Figure-5.

Table - 5: Flexural strength for different concrete mixes

Mix Type	Flexural Strength N/mm²
Control	3.8
0.20 DEO	3.5
0.40 DEO	3.0
0.60 DEO	2.6
0.20 AEA	3.2
0.40 AEA	2.7
0.60 AEA	2.1

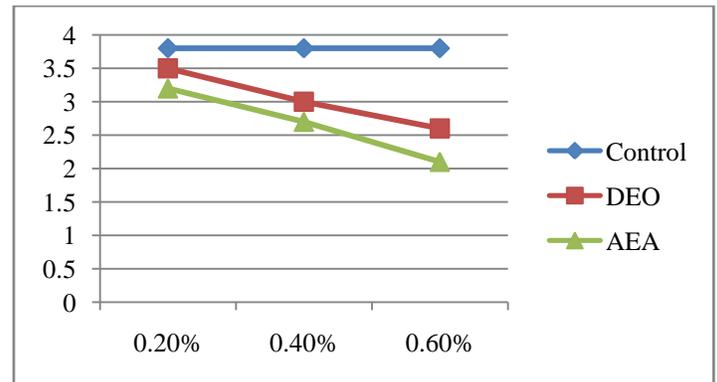


Chart - 5: Variation in flexural strength (N/mm²)

5. CONCLUSION

Based on the results and discussions the following conclusions are made:

1. Role of DEO found to be act as a plasticizer in concrete which improves the workability of concrete by increasing the slump of concrete mix. This

- enhancement goes on increasing as the concentration of DEO is increased gradually.
2. Increment in the air content of fresh concrete mix was noticed with the introduction of DEO in the concrete mix, the results were positive and increases with its concentration. DEO increased the air content within the range of 28-92% whereas the use of commercial air-entraining admixture, almost doubled the content of entrained air.
 3. The results on compressive strength using DEO shows that it maintained the strength of the mix with the negligible loss of about 10% in compressive strength while the same concentration of usage of commercial air-entraining admixture resulted in approximately 20% loss of strength at all ages. Thus, DEO based concrete mix yielded a higher range of compressive strength as compare to using commercial air-entraining admixture
 4. Use of DEO in the concrete mix resulted in the loss of about 8-30% in the value of flexural strength while the use of commercial air-entraining admixture resulted in approximately 15-45% of loss in flexural strength of the concrete mix.
 5. Dosage of DEO in concrete mix acted as both the plasticizer and as an air-entraining agent.

ACKNOWLEDGEMENT

The authors would like to express their appreciation to the Department of Civil Engineering, Madhav Institute Of Technology & Science, Gwalior for the facilities and support for this research work.

REFERENCES

- [1] Abdelaziz Elsayed Gamal, "Utilization of used-engine oil in concrete as a chemical admixture"
- [2] American society for testing and materials, "Standard test method for air content of freshly mixed concrete by the pressure method", C-231-03
- [3] Chin, S.C, Shafiq N. and Nuruddin M.F, "Effects of used engine oil in reinforced concrete beams: the structural behavior" World Academy of Science, Engineering and Technology, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, Vol.6, No.3, 2012
- [4] Du, L. and Folliard, K. J, "Mechanisms of air entrainment concrete", Cement and Concrete Research, Vol. 35, pp. 11463-1471, 2005
- [5] Hamad S. Bilal, Rteil A. Ahmad, "Effect of used engine oil on structural behavior of reinforced concrete elements" Construction and Building Materials, Vol. 17, 2003, pp. 203-211
- [6] Hesham Diab, "Effect of mineral oil on reinforced concrete structures part-1 deterioration of compressive strength" Journal of Engineering Sciences, Vol. 39, pp.1321-1333, November 2011
- [7] Ibrahim, T. H. and Al-Zubaidy, A. H, "Assessment of using unleaded fuel in harsh environment of the United Arab Emirates", Journal of Environmental Management, Vol.85, pp. 171-178, 2007
- [8] Indian Standards: 8112-2013, "Ordinary portland cement, 43 grade-specification"
- [9] Indian Standards: 383-1970, "Specification for coarse and fine aggregates from natural sources for concrete"
- [10] Indian Standards: 456-2000, "Plain and reinforced concrete-code of practice"
- [11] Indian Standards: 10262-2009, "Concrete mix proportioning - guidelines"
- [12] Indian Standards: 516-2004, "Methods of tests for strength of concrete"
- [13] Samarin, A, "Wastes in concrete: converting liabilities into assets", Proceedings of the International Seminar on Exploring Wastes in Concrete, 1999
- [14] Shafiq Nasir, Mohd. Nuruddin Fadhil and Ibrahim Kamaruddin, "Effectiveness of used engine oil on improvement of properties of fresh and hardened concrete" Proceedings of the 6th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2006), Kuala Lumpur, Malaysia, 5-6 Sept. 2006