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Effects of Used Engine Oil as Chemical Admixture in Concrete

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Abstract

Present paper emphasizes on the strength properties of concrete using waste engine oil as admixture. Investigation has been carried out for evaluating the workability and strength properties of concrete using waste engine oil as admixture into the concrete structure. This has a positive environmental effect as the cost of safe disposal of waste industrial material is significantly higher and there are strict environmental regulations. The objective to evaluate the effect of used engine oil on properties of fresh and hardened concrete. However, tests considered for study are slump test and compressive strength test. Four different percentages of admixtures (used engine oil) are chosen in the experimentation at 0.6%, 0.8%, 1.0% and 1.2% by weight of cement. Finally it was concluded that workability was enhanced. Compressive strength of concrete was decreased with increase of waste engine oil into the composition. In order to improve the workability of concrete composition, waste engine oil is a good admixture in composition.

Keywords

Waste Engine Oil, Admixture, Compressive Strength, Slump, Workability

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1. Introduction

Concrete is the major material which most widely used in construction field over the world and it keeps developing and improving day after day to meet up with the global and environmental requirements. The reason for widespread usage of admixtures is that admixtures are able to impart considerable physical and economic benefits with respect to concrete. However, usage of admixture is not remedy for poor quality of concrete due to the use of incorrect mix proportion, poor workmanship in concrete mixing and the problems caused by low quality raw materials selection. Generally admixtures have been used for certain beneficial effects on fresh and hardened concrete. But with these desired effects they can bring some other desirable and undesirable effects on concrete, so these additional effects should also be taken into account for the best performance at fresh and hardened concrete. The concrete Admixture is one ingredient of concrete that is added to the mix before or during mixing to modify concrete properties. Concrete admixtures are used to modify the properties of fresh and hardened concrete in order to achieve the desired objectives or purpose of the concrete mixture. It is also used for economic purpose when admixture allows reduction of concrete ingredients proportions or permits saving in construction practices. Chemical admixtures are used in concrete mixtures to produce particular engineering properties such as rapid hardening, water-proofing or resistance to cold. Chemical Admixtures for Concrete surveys recent developments in admixture technology, explaining the mechanisms by which admixtures produce their effects, the various types of admixtures available, their selection and use. Chemical admixtures give the concrete enough workability at low water cement ratios, leading to concrete with greater strength. The water reducing retarder slows the hydration of the cement and allows workers more time to place the concrete.

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The research of used engine oil in concrete as chemical admixture also start explore by some researcher. The addition of used engine oil to the fresh concrete mix could be similar to adding an air-entraining chemical admixture, thus improving some durability properties of concrete while serving as a technique of disposing the oil waste [1]. The used engine oil can contribute to the improvement of slump as compare to the slump of control concrete, mechanical properties also was reduced and the compressive strength obtained was approximately same as that of the control mix [2]. However, the effects of used engine oil on concrete properties and concrete performance. The effect of used engine oil on properties of fresh and hardened concrete was examined. Results indicated that used engine oil acted as an air-entraining agent by improving the slump and fluidity of the concrete mix, and improving the air content of fresh concrete. Reductions in the strength properties of hardened concrete due to the incorporation of oil were not as significant as when a commercial chemical air-entraining admixture was used. They found that used engine oil did not have significant effect on the structural behavior of reinforced concrete elements, where the ultimate load or load deflection diagrams have not been altered due to adding used engine oil to concrete mix ingredients [3]. The used engine oil can contribute to the improvement the fresh and hardened properties of concrete and also structural performance of concrete. However, it gave the positive effects comparable with the available commercially air entraining agent [4]. Used engine oil also suggested to be used in highway construction but requires well organized oil collection system. The additional research is noteworthy to produce the good quality and performance of concrete [5].

Risks related with used engine oil are resulted from various additives used in its manufacture and from heavy metal contaminants picked up from the internal combustion engine. Used engine oil poured into household drains or directly onto the ground, may leads into waterways and groundwater's. Illegitimately disposed of oil can pollute the groundwater with contaminants such as lead, copper, arsenic, chlorides, magnesium, chromium, zinc, cadmium and polychlorinated biphenyls. It is estimated that less than 45% of the used-engine oil is being collected worldwide while the remaining 55% is thrown by the end user in the environment. The discharge of used oil can develop a serious problem or a valuable resource depending upon how it is managed. Simply reflect on the fact that one oil change contains four quarts of foils, which when improperly disposed of sufficient to ruin one million gallons of fresh water, which in turn adversely impacting human life, fish and plant life [6, 7]. So, in this context, the proper management of used oil is essential to eliminate or minimize potential environmental impacts. Many countries in the world have imposed rules and regulations regarding the safe and legal disposal of used engine oil. However, the actual fact is that approximately 60% of the used engine oil is illegally disposed of, that eventually drops into the rivers and seas [8, 9]. It has been reported in the literature that the leakage of oil into the cement in older grinding units resulted in concrete with greater resistance to freezing and thawing. This means that adding used engine oil into fresh concrete mix could be similar to adding an air-entraining chemical admixture [10, 8]. The used engine oil acted as a chemical plasticizer by improving the fluidity and the slump of the concrete mix. The used engine oil decreases the initial setting time and increases the consistency of concrete composition [11]. The compressive strength decreased by 75% and 77% for water wet and oil wet respectively compared to the control at 28 days of age [12]. Concrete with used engine oil and new engine oil have lower compressive strength than the control specimens [13]. The effect of waste engine oil in concrete was enhanced workability. Compressive strength of concrete was decreased with increase of waste engine oil into the composition [14]. Compressive strength of concrete was reduced by the addition of 2% kerosene into the composition in all exposure conditions [15]. The performance of concrete containing used cooking oil concluded that used cooking oil can contribute to the improvement of slump, mechanical properties and microstructure with the optimum dosage of 1.5 of cement content [16]. Analysis of Fresh and Hardened Properties of M35 Concrete Mix using Burned Engine Oil as an Admixture considered the used engine oil acted as a plasticizer [17]. 18 to 90% of strength was reduced with addition of crude oil 2.5% to 25% into the concrete composition [18]. However, the study of used engine oil effects in concrete were stated the inclusion of 0.5% used engine oil gave the highest compressive strength and comparable with SP [19]. Other study concluded that an optimum used engine oil dosage of 0.3% of cement mass was found, beyond which detrimental effects on initial slump, setting time, and compressive strength can be encountered [20]. The aggressiveness of oil was very clear for low and high strength concrete specimens and the reduction of compressive strengths was 17 and 11.8% [21]. A lot of wastes are being utilized to replace the commercially available materials. While the previous researchers have discussed the powerful superplasticizer function, however the alternative admixture to replace it is something new to be explored. Waste engine oil is being disposed as profitless waste materials, and not sufficiently used in any construction industry. The application of concrete has been increasing throughout the world with the various method used to improve the performance such as workability and strength of concrete. As the price of chemical admixtures and material costs escalate and pressures of maintaining the Sustainability of our environment, owners must continually find methods to decrease material costs and

maximize their benefits. One such method is to increase and/or begin using readily available recycled materials like waste engine oil. The researchers are continually searching for methods to decrease material costs and maximize their benefits with no compromise in performance. One such method is to develop innovative technology to incorporate waste and recycled materials, such as waste engine oil as chemical admixture. However, the increase usage of concrete, new type of admixtures that are cost effective may have many economic and technical impacts on the Libyan construction industry as well as worldwide concrete usage. This research was carried out extensively along with the increasing concern about environmental issues from waste engine oil disposal. The main aim of this research is to identify the effects of used engine oil with respect to workability, important consideration in the design and construction of new structures and also when assessing the condition of existing structures.

1.1. Objective of the Study

The main objective of this investigation is to study the effect of used engine oil on the workability and compressive strength of concrete and to compare the performance with that of conventional concrete.

1.2. Research Significance

This paper deals with the experimental study to investigate the fresh and hardened properties of concrete using utilized engine oil as a chemical admixture in it. Results of this research will be helpful in determining whether we can use utilized engine oil as a chemical admixture in concrete or not. This study emerged out as a new technique where used lubricant is utilized in concrete.

2. Research Methodology

2.1. Materials

The Ordinary Portland Cement (OPC) Type-I was used in this research, that complied with the requirements of BS 12 (1996). OPC Type-I was preferred because the observation on concrete properties can be done in normal hydration process. OPC was supplied by Zlitan industry, located in Zlitan city, Libya. Aggregate was obtained locally from the crashed stone as coarse aggregate with a maximum size of (20 mm) and sea sand was used as a fine aggregate. For preparation of mix and curing of concrete samples, potable water supplied from a tube well located in the campus was used. However, waste engine oil was collected from service-stations around Bani Walid City, used engine oil is shown in Figure 1. It was collected randomly at the service-stations that have no proper disposal. The chemical composition of used engine oil is shown in Table 1.

Figure 1. Used engine oil.

Table 1. Chemical Composition of Waste Engine Oil.

Chemical composition	Used engine oil (%)
Fe_2O_3	0.43
CaO	15.9
SO_3	37.0
P_2O_5	8.95
ZnO	17.7
$C1^-$	15.9

2.2. Design Mix

In order to achieve reliable results, practicing of strict measures of quality control is the most important criterion for the experimental investigation as part of any research program. Therefore, the spurious results and false trend can be avoided by applying the prevailing code of standards and specifications for the selection of concrete making materials and mix proportions. The mix proportions of concrete for casting of specimens are presented in Table 2. Five mixes were cast with water binder ratios) w/b) of 0.55. Water and used engine oil as chemical admixture were measured in percentage by weight of cement.

Table 2. Mix Proportions of concrete used.

Mix No	OPC	Sand	Coarse Aggregate	Water	W/C ratio
	Kg/m^3	Kg/m^3	Kg/m^3	Kg/m^3	%
Control	350	738	1107	192.5	0.55
0.6 used oil	350	738	1107	192.5	0.55
0.8 used oil	350	738	1107	192.5	0.55
1.0 used oil	350	738	1107	192.5	0.55
1.2 used oil	350	738	1107	192.5	0.55

Freshly mixed concrete was tested for the measurement of slump values and air content. These tests were done in accordance to the British Standards Institution, BS 1881 Part 102. In hardened state, after were demoulded, the specimens were cured in tap water at laboratory temperature up to the age of 28 days. The compressive strength test was determined according to B.S. 1881 Part 116. This test was conducted on 150 mm cubes using an electrical testing machine with a capacity of 3000 KN at loading rate of 10 MPa per minute.

3. 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:

3.1. Fresh Concrete Properties

Slump and Flow Value

Slump value signifies the fluidity of concrete. It is the measurement of workability of concrete. Higher value of slump shows concrete of higher workability and lower value of slump shows low workable concrete. Slump values for different concrete mixes are shown in Table 3.

Table 3. Slump and Flow Values of Concrete Mixes.

Mix Type	Slump values mm	Flow values mm
Control	50	325
0.6 used oil	75	355
0.8 used oil	140	390
1.0 used oil	190	425
1.2 used oil	200	435

The results show that usage of used engine oil improved the slump values of mix as compared to the slump of control mix. Range of enhancement slump value increased from 50 mm to 75 mm when dosage of used engine oil was increase by 0.6%. A steady increase in the slump value was observed when the used engine oil dosage was increased to 0.8%, 1.0% and 1.2%, which was measured as 140 mm, 190 mm and 200 mm respectively. There was a sudden jump in the slump value to 200 mm when the used engine oil dosage was increased to 1.2%. However at 1% used engine oil dosage, the rate of increment was lower and it reached to 190 mm. However, flow value with the addition of used engine oil is 355 mm to 435 mm as compared to the slump value of control mix. These test results of fresh concrete are shown in Figure 2 and 3.

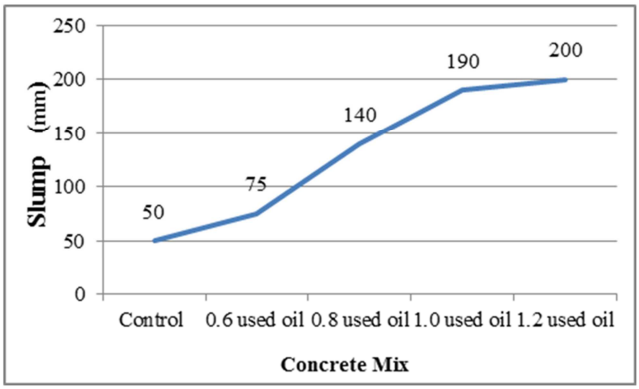

Figure 2. Variation in slump of different concrete mixes.

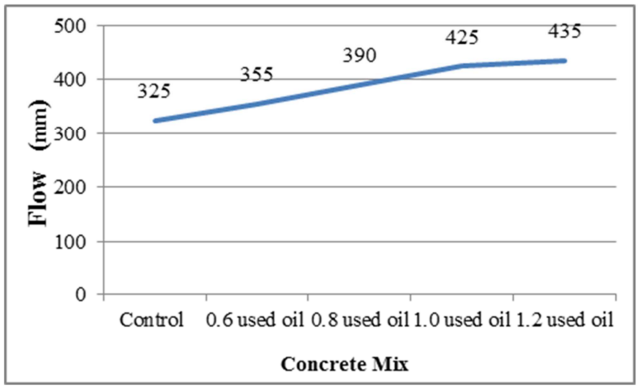

Figure 3. Variation in flow of different concrete mixes.

3.2. Hardened Concrete Properties

Compressive Strength

Compressive strength is the measurement of the capacity of a material to carry loads that tends to reduce its size. In this study, compressive strength for concrete mix of grade M-30 was measured at the age of 28 days. The readings for compressive load of different mixes are given in Table 4.

Table 4. Result of Compressive Strength of Concrete at 28 Days.

Mix Type	Compressive Strength N/mm^2
Control	30
0.6 used oil	23
0.8 used oil	29
1.0 used oil	28
1.2 used oil	19

The results show that range of deterioration of compressive strength of concrete at the age of 28-days. From 0.8% to 1.0% while this range was high enough when UEO was used compared with control mix. Hence, it can be concluded that reduction in compressive strength negligible loss. Characteristic strength of concrete mix is shown in Figure 4.

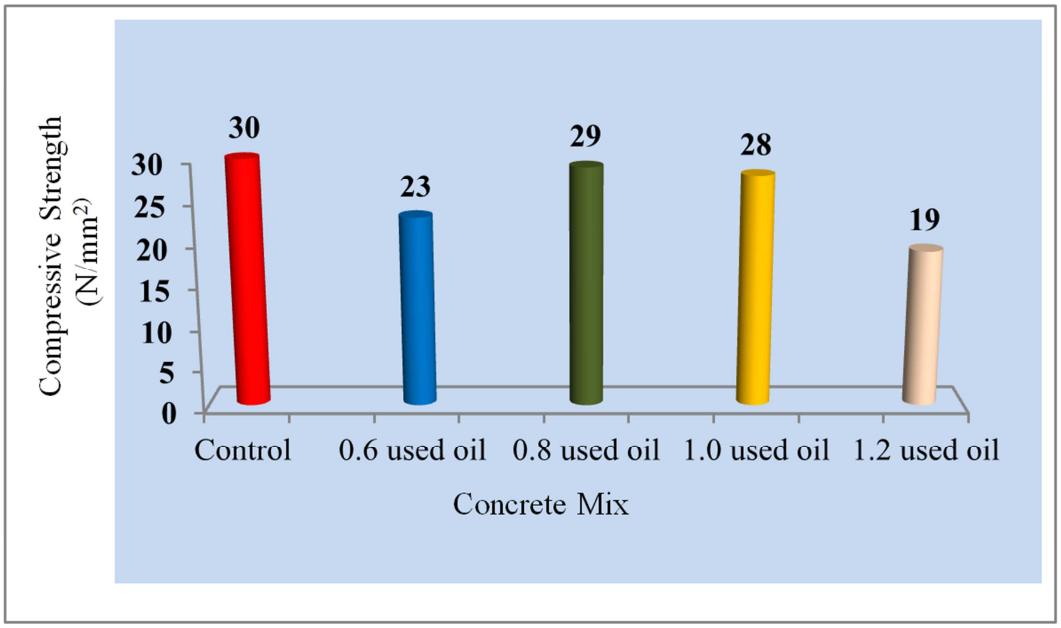

Figure 4. Compressive Strength for Concrete with Used Engine Oil with Age 28 Days.

4. Conclusions and Recommendation

An investigation has been performed to study the effects of used engine oil on properties of concrete with characteristic strength of 30 N/mm^2. The properties investigated were workability (slump and flow table) and compressive strength. The conclusion, which follow are drawn based on experimental results and observations presented earlier in the paper. These conclusions are of necessity specific to this study. Nevertheless, the findings of this investigation should provide a significant contribution towards the knowledge on the effect of used engine oil on properties of concrete. The main conclusions of the study together with recommended future work are presented in the following:

Used engine oil can act as a chemical plasticizer similar to superplasticizer to improve workability higher than control sample. The result achieved from the slump and flow test indicates that the used engine oil the concrete act as lubricant that makes the concrete more workable.

The results on compressive strength using used engine oil shows that it maintained the strength of the mix with the negligible loss of about 1-2% in its strength when the used engine oil dosages 0.8% and 1.0% at the age of 28-days. As a comparison between used engine oil concrete when compared with OPC concrete gives almost similar strength in 1% dosage of used engine oil. Therefore, it can be concluded that used engine oil has potential to improve concrete strength as water reducing admixture.

Recommended that the researches in this area to be continued in order to investigate a number of different parameters which were not explore in this study, such as the effects of used engine oil on density and permeability for fresh concrete. However, the properties splitting tensile and flexural strength for hardened concrete.

Recommended that the researches should inclusion of both used engine oil as chemical admixtures and mineral admixtures since used engine oil help to increase workability of concrete, their usage on concrete containing mineral admixtures such as silica fume or metakaolin should be studied in depth to determine whether ultra-high strength concrete (100 – 150 MPa) can be produced.

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