NEGATIVE IMPACT OF DIESEL AND USED ENGINE OIL SOAKING ON THE COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

Concrete is one of the most important material used in construction. The concrete used for the construction should resist all types of loads imposed on it. Concrete tanks are used to store petroleum products. This paper attempts aims at the study of effect on compressive strength of concrete prepared with 30% Fly ash by weight of cement when soaked in water, soaked in diesel and soaked in used engine oil for 90 days and comparison of variation with water soaking. The change in compressive strength is indicative of the petroleum products on concrete. The non-randomness and ambiguity in results was analysed statistically.

Keywords:-Fly Ash, Concrete, Petroleum Products, Compressive Strength.

I INTRODUCTION

The exploitation of fly ash as cement replacement material in concrete or as an additive in cement introduces many benefits from economical, technical and the environmental points of view. Depending on the burning temperature, coal type and some other factors, fly ash shows different properties in different size fractions. In this study, different composition of fly ash varying from 0% to 40% by weight was taken. One of the previous studies showed that granulometry of fly ash has important effects on mortar strength [1]. In another study, concrete strengths were correlated to fly ash addition, amount and fineness [3]. Utilization of industrial solid wastes in concrete would help environmental abatement, in solving solid waste disposal problems.

Fly ash is the waste from the coal industries and poses serious problems of disposing. This present study focuses on the utilization of fly ash in concrete soaked in diesel and used engine oil. There has been a very comprehensive relation between concrete and petroleum products. Concrete tanks are used to store petroleum products. The cracking and deterioration of concrete due to spillage of petroleum products has been an area of interest in research. Spillage of petroleum products adversely affects marine life and environment [2]. Also petroleum comes in contact with concrete in areas like garages, automobile servicing stations, storage tanks, etc. The bore hole used in oil extraction may be lined up with concrete. Petroleum products poses a high degree of adverse effects on properties of concrete and thus degrades it. Petroleum products gets penetrated into concrete and thereby flows into underground water. The spillage of petroleum on roads leads to cracking. The study aims at avoiding these effects by mixing concrete with Fly-ash to an optimum extent. This technique is applied in the construction of roads, garage floorings and petroleum product's storage tanks. In all of the above mentioned instances, petroleum products come in contact with concrete in one way or the other and have a specific impact on its characteristic behaviour.

The rest of the paper is organised as follows. Section 2 deals with the related work. Section 3 elaborates the materials used in the implementation. Section 4 deals with the results and discussion. The paper concludes in Section 5.

II RELATED WORK

Concrete is one of the most important materials used in construction. The concrete used for the construction should resist all the type of loads imposing on it. The service life and durability of concrete structure strongly depend on its transport material properties like permeability, sorptivity, diffusivity and water absorption [4]. The effect of oil soaking on the dynamic modulus of elasticity of concrete was investigated to study the deterioration rate due to concrete contact with crude oil [5](M.A.Matti ,1983). He has also studied the shrinkage of oil soaked concrete. He has found that the volume of concrete decreases when it comes in contact with crude oil [6](M.A Matti, 1982). [7](F. I. Faiyadh, 1985), investigated the bond characteristics of oil saturated concrete. The average bond strength of oil soaked specimens decreased with the soaking period. [8](Ramzi B.Abdul et al, 2000) analysed the compressive and tensile strength of concrete loaded and soaked in crude oil. Based on short and long term loading, the effect of crude oil on compressive, splitting tensile and flexural tensile strength of concrete was investigated. He found that the rate of crude oil absorption is high at the early stage of soaking, but later on, the rate decreases. This shows the reduction in the absorption by 30 to 40 % strength in specimens under loading versus unloaded specimens. Usage of fly ash in concrete considerably increases the compressive strength of concrete [9].

III MATERIALS AND METHODOLOGY

This section gives the details of the composition of the materials used for the experimentation. The details of Ordinary Portland cement, 43 grades conforming IS: 8112-1989 are provided in Table 1. Fly ash was obtained from Raichur Thermal Power Station, Shaktinagar, composition of Fly ash is given in Table 2. Locally available sand of specific gravity 2.64 and coarse aggregates of (10 mm and 20 mm) 2.90 were used. Water from city source is used for both concreting and for curing. Petroleum products like diesel and used engine oil are obtained from automobile service stations, composition of diesel and used engine oil given in Table 3 and 4.

Table 1. Physical Properties of Ordinary Portland Cement

Particulars	Experimental result	As per standard
Fineness	308 m^2/kg	Not less than 225 m^2/kg
Normal consistency	28.26	---
Soundness		
By Le-ChatelierExpn. (mm)	1.5 mm	Not more than 10 mm
By Autoclave Expn. (%)	0.070	Not more than 0.8

Setting time (minutes)		
Initial	180	Not less than 30
Final	250	Not more than 600
Compressive strength (MPa)		
3 days	23.98	Not less than 23
7 days	34.85	Not less than 33
28 days	45.36	Not less than 43

Table 2. Chemical Composition of fly ash

Chemical composition	Percentages
Silica (SiO_2)	56.88
Alumina (Al_2O_3)	27.65
Iron oxide (Fe_2O_3)	6.28
Alkalies (Na_2O+K_2O)	0.46
Calcium oxide (CaO)	3.62
Magnesium oxide (MgO)	0.34
Titanium oxide (TiO_2)	0.31

Table 3. Properties of diesel fuel of SAE 40

Properties	Results
Sp. Gravity @ 15.6 °c	0.897
Viscosity :cSt @ 40°C,cSt @ 100°C	142, 14.5
Viscosity Index	100
Flash Point, °c	230
Pour Point, °c	-12
Color (ASTM)	4.0
TBN	9.5
Sulfated ash, wt %	1.2

Table 4. Properties of used engine oil

Properties	Results
Kinematics viscosity at 40 ^{o}C	111.32
Kinematics viscosity at 100 ^{o}C	17.83
Viscosity index	99
Flash Point, °c	230
Pour Point, °c	-10
TBN	-
Sulfated ash, wt %	4.5
Specific gravity	0.928

3.1 Preparation of specimens

M 30 grade concrete designed as per IS: 10262-2009 which yielded a proportion of 1:1.76: 3.15 with a w/c ratio of 0.49 and Fly ash was added from 0 to 40 percent by weight of cement. Then the mix was placed layer by layer in the moulds to cast the specimens. The specimens were compacted by hand as well through vibrating table. The specimens were finished smooth and kept for 24 hours and then they were subjected to water curing for 28 days. After water curing, the specimens were soaked in diesel and used engine oil for 90 days. They were tested for their respective compressive strengths as per IS specifications Standards, 150 mm x 150 mm x 150 mm.

It is convenient to use fly ash pozzolanic mineral admixture to replace a large quantity of cement in concrete. It not only enhances the quality of concrete, but it also helps in the preservation of many resources as well as it is eco-friendly. Cement shows high compressive strength without fly ash in the early stages. But though initially the fly ash mixed concrete shows lower compressive strength values, but it increases with time later [10]. Fly ash significantly increases concrete's strength and workability. It can also nurture the durability and chemical resistance of concrete [11].

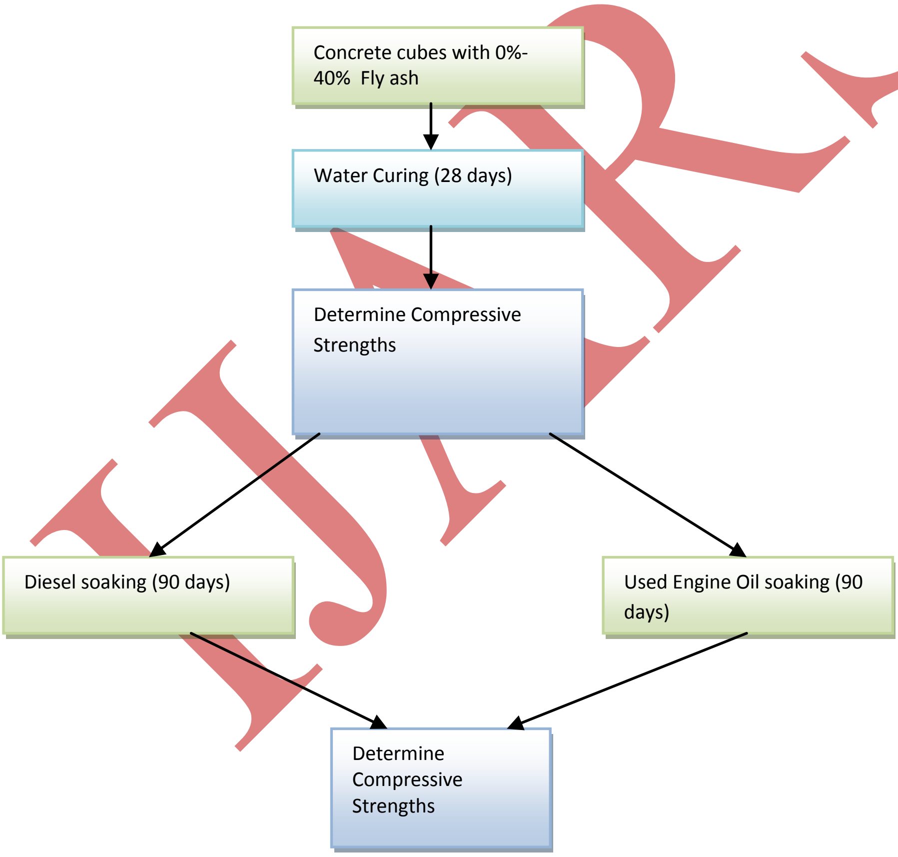

Fig. 1 Overall System Implementation Schema

Fig. 1 shows the system implementation. As is evident from the figure, concrete cubes were subjected to water curing for 28 days and the compressive strengths of few samples were noted (since all the other samples were identical in composition and size, their strengths)

IV RESULTS AND DISCUSSIONS

Studies reveal the fact that compressive strength of concrete increases when cured in water. It has been observed experimentally that the addition of fly ash exhibit considerable increase in compressive strength and durability characteristics. Fig. 2 indicates the variation in compressive strength of concrete specimens prepared with 30% of fly ash by weight of cement cured 28 days in water and soaked in diesel oil for total period of 90 days.

Similarly, Fig. 3 shows the variation in compressive strength of concrete specimens prepared with 30% of fly ash cured in water for the first 28 days and soaked in used engine oil for a total period of 90 days.

Variations of compressive strength results of concrete indicate the effect of petroleum products, Results exhibit considerable reduction in strength of concrete. The sharp decrease in compressive strength due to petroleum products curing is an indicative of the degradation that concrete undergoes after being used in contact with petroleum products.

Since there is not enough work available on petroleum products curing of concrete, we use statistical analysis to judge the relation and non-randomness of the data sets.

In case of diesel curing, the regression analysis was as follows:-

Co-relation factor R^2=0.5373.

Slope= -0.1164.

The relation can be obtained as:-

Y=-0.1164x+43.375.

Similarly in case of used engine oil curing, the regression analysis bore:-

Co-relation factor R^2=0.406.

Slope= -0.0981

The relation can be obtained as:-

Y=-0.0981x+42.35

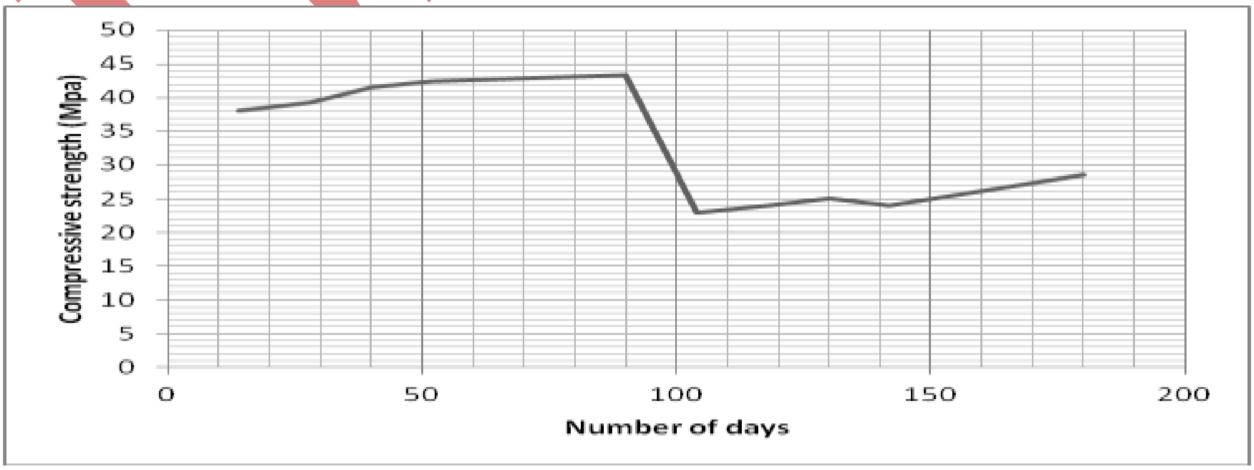

Fig 2. Variation in compressive of Diesel cured concrete.

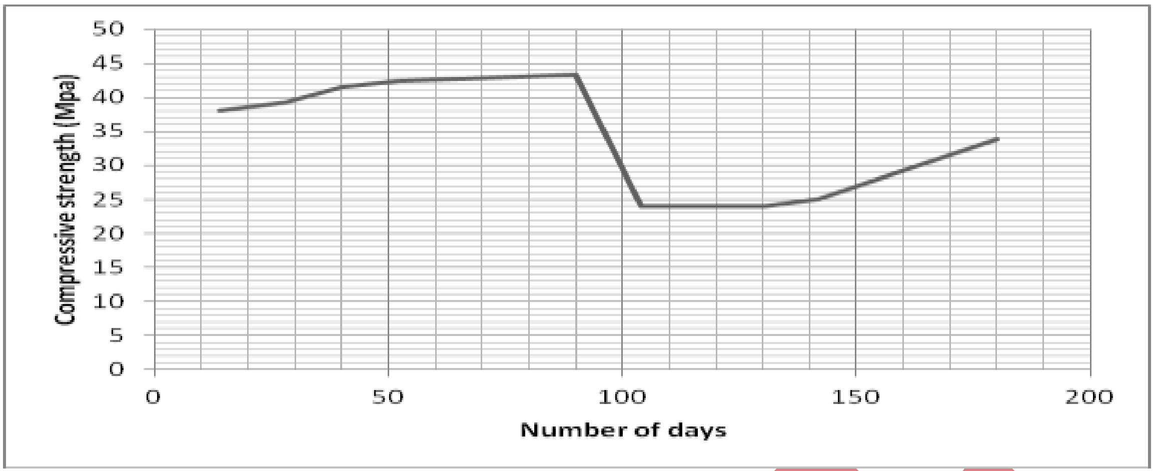

Fig 3. Variation in compressive strength of Used engine oil cured concrete.

Randomness checking in this case is of paramount importance as it yields us the conclusion whether or not obtained data is random. Proving randomness of this data is indicative of wrong experimentation. But the data were not random here. Runs test was used in this context. It is basically a statistical procedure which examines whether the data in a given distribution occurs randomly.

Randomness is doubted when there are too many or too few runs.

Hypothesis:

H_0: The observations in the sample are random.

H_1: The observations in the sample are not random.

The procedure requires calculating the values for the following variables:

n=Total sample size.

n_0=Number of sample members of one type (number of samples below mean).

n_1=Number of sample members of another type (number of samples above mean).

Calculate $n=n_0+n_1$.

Reject H_0,

If R<=lower critical values (few runs)

If R>=upper critical values (many runs).

If both n_0 and n_1 are <=20, the small sample runs test is appropriate.

The algorithm for carrying out the runs test is as follows:

Small Sample Runs test:

$\alpha=0.05$

Calculate R.

If $n_0-1 < R < n_1-1$, do not reject the null hypothesis, H_0.

Else reject H_0.

Large Sample Runs test:

If n_0 or n_1 is greater than 20, then calculate

Mean= $\frac{2\times n0\times n1}{n+1}$

Variance= $\frac{2\times n0\times n1\times(2\times n0\times n1-n)}{(n-1)\times n^2}$

Standard Deviation=√Variance

Z= $\frac{R-Mean}{Standard\ deviation}$

If -1.96<=Z<=1.96, do not reject H_0,

Otherwise, reject H_0.

The runs test a result on the above cases is as follows:

1). Diesel curing

Number of runs=2

Z-value= 2.01

2). Used engine oil curing

Number of runs=3

Z-value=1.99

It can be observed that the fewest number of runs and the value of Z are indicative of the non-randomness of the datasets. Also the larger value of R^2, holds this argument.

V CONCLUSION

The negative impact of diesel and used engine oil on fly ash concrete was assessed. The non-randomness in the datasets was assessed using the correlation test and the runs test.

VI ACKNOWLEDGEMENTS

The authors are immensely grateful to the Principal, KLE Dr. M. S. S. College of Engineering and Technology, Belgaum, and to the Department of Technology, Shivaji University, Kolhapur; for all the crucial amenities provided for the experimentation.

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