Behavior Of Concrete Mix With Virgin Oil Shale Powder

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ABSTRACT

In the process of the extraction oil from the oil rocks a huge amount of waste dust formed due to crushing and grinding of the virgin oil shale , causes an environmental pollution leads a hazard diseases to people ,animals and ruin the plants. So to eliminate the above mentioned oil shale waste , the produced grinded oil rocks in form of an Oil Shale Powder(OSP) , can be used as an admixture material , in producing cement concrete bricks. To study the possible use of OSP in producing concrete mix, an experimental tests were carried out . In this research, an OSP was used as an admixture of cement. The main aim of this study is to investigate the compressive strength and setting time properties of concrete mix with OSP (as a partial replacement of cement) . Experimental results showed that the compressive strength of concrete cubes that containing 5, 10 and 15% of virgin oil shale (by weight) , decreased by 14.2, 20.1 and 28.8% compared with the conventional concrete cubes, respectively after 7 days water curing , and also decreased by 9.1, 15.5 and 23.2% respectively after curing of 28 days. The reason of decreasing the compressive strength of concrete mix with OSP , is due to the lower content of ferrous components of OSP in their chemical compositions , also due to the existed oil in the voids of oil shale , that leads to separation between cement and other components of concrete mix. Setting time of cement paste increased by (25), (30) and (40) min when use concrete mix with 5, 10 and 15% OSP comparing with the conventional concrete mix, due to the delay of cement hydration. The OSP existed in the concrete strengthen the properties of its components. The final conclusions showed some perfections when utilizing cement with OSP in long term curing.

KEYWORDS : OSP , Conventional Concrete ,Compressive Strength, Setting Time ,hazard, pollution, Curing.

INTRODUCTION

In order to generate energy the first stage is to destroy , crush, and damage directly, and burning the oil rocks . This method requires appropriate power plants different from those powered by fuels. This way is used in different countries , particularly in Germany , Jordan, Estonia , after dependency . A lot of ash materials will be produced after oil rocks burning which cause a pollution in the air. The oil shale ash (OSA) might be used in producing cement production as an additive material.

Extraction and production of energy , to manufacture an electricity from oil shale , will produce large amounts of OSA after burning. Disposal of these amounts of OSA is costly , and leads to serious climate problems. Therefore, the study proceeded to supply safe conducting and re-use of OSA. Partial replacement of Ordinary Portland Cement (OPC) by virgin OSP in manufacturing a cement mortar that may promote some of its properties . Oil shale ash is formed from solid fuel mineral matter in the amount which depends on the combustion temperature and other conditions. Deposits of OSA and virgin OSP cause serious landscape adjustment in the area near

the power plants which use oil shale as fuel.

PREVIOUS RESEARCHES

The latest experimental researches of oil shale powder in cements have been carried out since some decades, also a lot of researches were conducted in the Europe, United States, China, the USSR as well as Estonia . The Jordanian study of Oil Shale extraction , started simple and very instructive . In Germany, clinker from the kiln and burnt oil shale , are used to produce an additives Portland Shale Cement . Studies showed that the addition of a very small portions of OSA into Portland cement clinker can enhance compressive strength of the ordinary Portland cement of mortar and concrete mixtures which prepared at different water to binder ratios, and different OSP replacements of cement and/or sand. The compressive strength of mortar and concrete mixes , cured in water at normal temperature, was determined over different curing periods which ranged from 7 to 28days. The results of these tests were subjected to a statistical analysis . The acquired results indicated that OSP partially replacement of cement, sand or both, by about 10% (by wt.) would yield the optimum compressive strength, and that its replacement of cement by up to 15% would not reduce its compressive strength, significantly. It was found that OSA on its own possesses a limited cementations value and that its contribution to mortar or concrete mixes comes through its involvement in the reactions [1] . The model developed showed an excellent predictability and durability of the concrete mix , and a good compressive strength for mortar and concrete mixes. Oil shale was used as an aggregate in producing concrete mix [2] . Other researchers studied the environmental hazard caused by the oil shale industry solid waste, hazard effect of oil shale is due to burning the oil shale in order to produce energy and power. The CO2 and other gases influenced the climate and make pollution in the air which causes a lot of diseases for the human beings, the animals and the plants on the earth sphere,[3]. Jordan's initial oil shale industry will be formed by authorization overlying mining , environmental protection, land owners, property rights limitations, financial subsidies and other incentives. The companies that will formulate this industry, including outside specialists, will be systematic and registered, as amended [4] .

Some researches studied the properties and structure of Oil Shale ash pastes , and the manufacturing concrete mix and mortars using a small amount of OSP. It was concluded that the structure and properties of the ash pastes can be described and explained by the same models which have been suggested for Portland cement paste. The only exception was the total porosity of the ash paste which remained unchanged with time. A suitable modification in the structural model of the Portland cement paste was suggested to allow for this specific behavior, [5]. An experimental study on mechanical and behavior of concrete made using oil shale ash and cement mixtures in addition of thermal properties of concrete made from oil shale ash, cement and sand and/or aggregate mixtures. The properties determined were compressive strength and thermal conductivity of the concrete mixtures. The used ash was obtained by direct combustion of oil shale, [6]. Using oil shale ash in concrete binder was studied by distinguish researchers . In these days many researches were concentrated on reusing OSA for different purposes such as construction material, soil offset for liming acid soil, molding cores, and supplement to animal food, etc. Partial replacement of ordinary Portland cement (OPC) by OSA in concrete mixes and its effect on the compressive strength of concrete has been reported in their conclusion, [7].

European researchers focused on Shale Ash concrete. They studied the composition and the

physical properties of oil shale ash, and compared with the properties of Ordinary Portland Cement . In the oil shale ash , the porosity remained unchanged with time, and the mechanical properties remained stable . Normally the portion of the oil shale is high in SiO2; So the outcome product was as ferrous properties. The additives of fly ash and burnt clay soil n the properties of Cement composites was discussed [8]. The results were that the Portland cement based mortars or concrete mixes hardened rapidly and attain high compressive strength , Using oil shale ash in concrete binder. was studied by some engineers , The results of of using OSA as a binder material showed that partial replacement of OPC in concrete mixes by OSA caused small reduction in compressive strength [8]. The reduction was proportional to the ratio of OPC replaced by OSA or OSP. The OSA used was obtained from burning oil shale at 750°C [9]. The chemical composition of the obtained ash and OPC has been determined . The effect of partial replacement on the compressive strength of mortar can be established by comparing the measured values of strength for a given curing time and ratio of OSA in binder,[10].

EXPERIMENTAL PROCEDURE

Concrete Mixes Preparations :

The concrete mix is composed from : Binder material (OPC), sand , medium aggregate, coarse aggregate and different portions of OSP (5, 10 and 15%) by the weight of binder material , in addition to tap water.

A binder material used in producing concrete mixes is an Ordinary Portland Cement (OPC).Oil shale powder was obtained from deposits due to crushing the oil shale virgin rocks Fig.1 . Oil Shale rocks were crushed (by a crusher machine in the laboratory of building materials) as shown in Fig. 2, and then sieved to a nominal size between 0.6 and 0.3 mm to form a virgin oil shale powder (without burning) , as shown in Fig. 3 . Chemical composition of OSP and OPC are shown in Table 1.

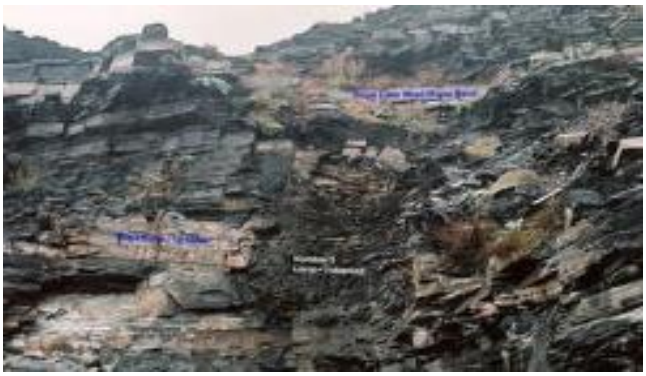

Fig. 1: Oil Shale Rocks

Fig 2: Oil Crushed Rocks

Fig. 3: Oil Shale Powder

Table 1 : . Chemical composition of OSP and OPC(%)

Component	Sio2	AL2O3	Fe2O3	CaO	MgO	SiO3	K2O	Na2O
OPC	19.1	5.1	3.2	64.1	2.6	2.9	0.84	0.11
OSP	16.2	4.8	2.2	48.2	2.1	3.1	0.66	0.09

The sand used in producing the concrete mix is natural standard sand, consisting of equaled particles and has silica content not less than 90% . The sand is sieved to a nominal size between 4.75mm and 2.4 mm according to the British Standard . The medium aggregate with angular shape is sieved to a nominal size between 12.5mm and 6.3 mm according to the British Standard . The coarse aggregate with angular shape is sieved to a nominal size between 20 mm and 12.5 mm according to the British Standard, and the water used was tap water, and water cement ratio was variable .

The portions of concrete mix components are : Binder material (OPC), sand, aggregate (medium aggregate and coarse) and different portions of OSP (5, 10 and 15%) by the weight of binder material

(1:2:3 in addition to OSP portions as admixture). As shown in Table 2.

Table 2 : Composition of Concrete Mix contain. Diff. portions

Batch No.	OPC (gm)	OSP (gm)	OSP (% OPC)	Sand (gm)	Med. Agg, (gm)	Coarse Agg. (gm)
1	5000	0.0	0	10000	5000	10000
2	4750	250	5	10000	5000	10000
3	4500	500	10	10000	5000	10000
4	4250	750	15	10000	5000	10000

Before determining the setting time of binders, the normal consistency for each binder paste was determined. Twelve binder paste samples (three samples from each mixture) were tested for setting time using Vicat apparatus, shown in Fig. 4.

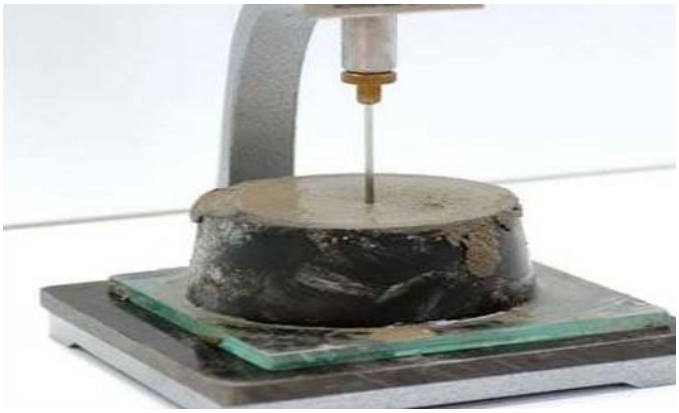

Fig 4 : Vicat Apparatus

The cubes dimensioned of (150x150x150mm) with the above concrete mixes were made and their compressive strength has been determined at ages of 7, 14 and 28 days. Concrete cubes prepared using pure OPC as binder to be considered as reference samples. Each concrete mix had made from 5000 g of binder (cement and OSP) and 10000 g of standard sand , and

15000g of aggregate, as well as water , as shown in Table 2. A total number of twenty four concrete cubes of size 150x150x150 mm as , shown in Fig. 5 , three cubes from each binder mixture were tested at each age to study the effect of OSP addition and curing time on compressive strength.

The concrete was mixed for 4 min in a laboratory mixer. The weight ratios of (binder: sand: gravel) were (1:2:3), for all samples.

Fig. 5: Concrete Cubes (150x150x150 mm)

The compressive strength of the concrete cubes was measured using compressive testing machine that shown in Fig.6, the recorded value is the average of three values for each age.

Fig. 6: Compressive testing machine

RESULTS AND DISCUSSION

The compressive strength of concrete mix that can be determined by comparing the calculated values of strength for a curing time and ratio of OSP in binder. Compressive strength of concrete mix as a function of curing time and percentage of OSP in binder.

Obviously it can be obtained that the compressive strength increases with increasing treatment date (curing) , and decreases with increasing OSP ratios in binder for all concrete cubes . These results compatible with the results presented in references previous researches. Increase of strength with time is due to the continuous hydration process of cement. Results showed that the compressive strength of concrete cubes containing 5, 10 and 15% OSP decreased by 14.2, 20.1 and 28.8% of cement conventional concrete cubes, respectively after 7 days and also decreased by 9.1, 15.5 and 23.2% of reference cement concrete cubes, respectively after 28 days as shown in Table 3 and Fig. 7 . Setting time of cement paste increased by 25,30 and 40 min when use cement concrete with 5, 10 and 15% OSP comparing with pure cement conventional concrete due to the slow hydration of cement with OSP as in Table 4 and Fig. 8.

Table 3 : Effect of OPC with OSP and Curing Time on Concrete Compressive Strength

OSP (%)	Time (day)			
	0.0	7	14	28
0.0	0.0	28	42	48
5.0	0.0	25	38	44
10.0	0.0	21	33	40
15.0	0.0	20	27	36

Table 4: Relation between OSP % in binder and the setting Time

% OSP	Setting Time (min.)
0.0	170
5.0	195
10.0	200
15.0	210

Table 5: Relation between OSP % in binder and the required water cement ratio

Batch No.	OPC (gm)	OSP (gm)	OSP (%OPC)	H2O (mL)	W/C
1	5000	0.0	0	2300	0.46
2	4750	250	5	2400	0.48
3	4500	500	10	2600	0.52
4	4250	750	15	2700	0.54

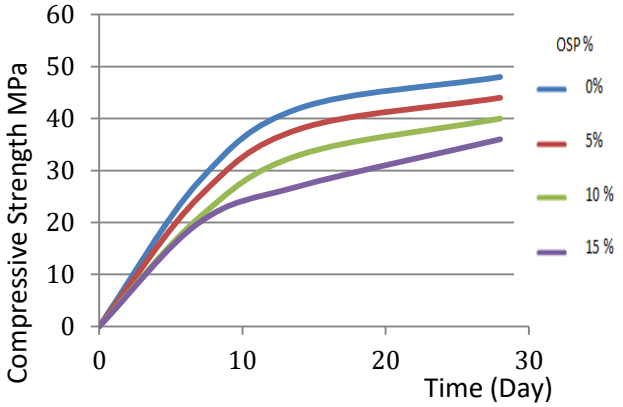

Fig. 7: Effect of binder OSP content and curing time on compressive strength (Mpa)

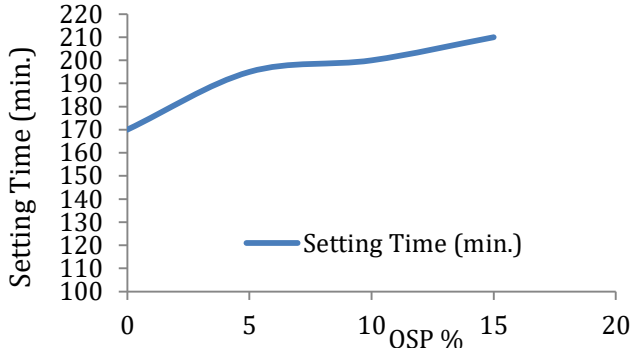

Fig. 8: Relation between the setting time and the ratio of OSP in binder

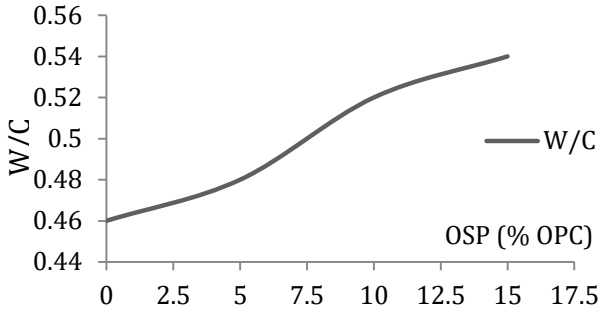

Fig 9 : Relation between OSP % in binder and the required water cement ratio

The results observed that the strength gaining of concrete mix containing OSP is slower than that of concrete mix without OSP due to mix water. It is expected that a significant reduction in the difference between the ultimate strength of concrete with and without OSP can be observed. The high water content can improve the workability of concrete where increase of setting time provides adequate time for transportation of concrete mix before casting. The estimated volume of water required to produce pastes of normal consistency for binders containing OSP ratios of 5, 10 and 15% increases by 100, 300 and 400 mL, respectively compared with binders containing 0% OSP (pure cement binder) as shown in Table 5 and Fig 9. This case is related to the void composition of OSP particles and their fineness due to hydration.

CONCLUSION

The results of the carried out tests are complemented that : The results of the conducted tests of concrete mix with OPC as a binder material in cement concrete mix , showed lower values of compression strength than when using conventional concrete mix , due to the oil that is found in the voids of virgin shale which leads to prevent the full bond between cement and aggregate . The longer is the curing period, the higher is the increase in compressive strength for

oil shale binder (OSP). Partial replacing cement by OSP, even with small amounts is an effective way to increase setting time. The results of the complemented tests assured the possibility of reuse virgin oil shale powder as replacement in ratios up to 15% without causing significant effects on the studied properties of cement. Climate protection and progress of the economics of oil shale placing can be achieved by a partial replacement of OPC

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