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Influences of Fly-Ash and Eggshell Powder on Some of Engineering Properties of Al-Umara Soil.

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Abstract:

The purpose of this study was to investigate the influences of adding each of fly-ash and eggshell powder on the Atterberg Limits, Cohesion and Angle of Internal Friction of the tested soil.

The tested soil is (CL) group according to the unified soil classification system obtained from a site located near Al-Sader Teaching Hospital in Al-Umara City. Each of fly-ash and eggshell powder were added to the soil samples in (2, 4, 8, 12, 16, 20 & 24 %) by weight of samples.

The study shows that as the percentages of adding fly –ash and eggshell powder increases, the reduction in the plasticity index amount for all soil samples increases too at different rates. The values of cohesion decreased when the soil samples mixed with fly-ash, while there was an increase in the values of internal angle of friction. In case of using eggshell powder, there was a small increase in cohesion values, but there was a small decrease in the internal angle of friction values for the tested soil.

الخلاصة:

ان الغرض من هذه الدراسة هو التحري عن تاثيرات اضافة كل من الرماد المتطاير ومسحوق قشر البيض على حدود قوام الطين, التماسك و زاوية الاحتكاك الداخلي للتربة المفحوصة.

التربة المفحوصة هي من نوع (CL) حسب نظام التصنيف الموحد للتربة, جلبت من موقع قريب من مستشفى الصدر التعليمي في مدينة العمارة. كل من الرماد المتطاير ومسحوق قشر البيض قد تم اضافتهما الى نماذج التربة بنسب (2, 4, 8, 12, 16, 20, 24%) من وزن النماذج .

الدراسة اظهرت انه كلما زادت نسب اضافة الرماد المتطاير ومسحوق قشر البيض فان النقصان في قيم معامل اللدونة لكل نماذج التربة سوف يزداد ايضا بمعدلات مختلفة. ان قيم التماسك سوف تقل عند مزج نماذج التربة مع الرماد المتطاير, بينما هنالك زيادة في قيم زاوية الاحتكاك الداخلي. في حالة استخدام مسحوق قشر البيض, فان هنالك زيادة قليلة في قيم التماسك, ولكن هنالك نقصان بسيط في قيم زاوية الاحتكاك الداخلي للتربة المفحوصة.

1- Introduction:

Where a poor soil is encountered, it is evident that a probable solution be sought for the options of available alternatives. The options may include leaving the poor soil for a new site, excavation to deep foundation level, removal of the poor soil and subsequent replacement with a more suitable one, redesigning the structure for the poor condition or treating the poor soil to improve it's properties, otherwise known as stabilization[1]. Stabilization of soil or (soil improvement) to obtain the desired properties would be the most probable solution in situations where suitable alternative sites are not available and cost of borrow material is high[2].

Some of the materials that have been used to improve the engineering properties of soil include (cement, lime, fly-ash, etc……).

2- Influence of Fly-Ash and Eggshell Powder on Soil:.

The using of industrial wastes, recently have the attention of researchers because of the cheapness of material cost in compare with other material that maybe mixed with poor soil[3] such as fly-ash and eggshell powder (ESP).

The use of these materials results in two fold advantages – conservation of natural resources and disposal or reduction in size of waste[4]. Fly-Ash improves the physical and chemical properties of soil [5]. The amount of fly ash has a pronounced effect on the plasticity index and other physical properties [6].

Eggshell power (ESP) improved the quality of the soil by significantly reducing their plastic indices[4], as well as subsequent findings revealed that (ESP) was used for improvement the physical properties of a cohesion less soil in Japan[7].

3- Aim of the Study:

The purpose of this work is to study and comparison of the effect of adding fly-ash and eggshell powder at different rates on the atterberg limits, cohesion and angle of internal friction of the tested soil.

4- Experimental Work:.

4-1 Materials and their Properties:.

4-1-1 Soil:

The soil used in this work was obtained from a site located near Al-Sader Teaching Hospital in AL-Umara City. The general properties of this soil that achieved in ASTM[8] standard are shown in table (1).

Table (1) Soil properties that use in this work

Specific Gravity (Gs)	2.72
Liquid limit L.L.	44%
Plastic limit P.L.	23%
Plasticity index P.I.	21%
Unified soil classification system	(CL)
C	45 kN/m^2
Ø	29 Deg.

4-1-2 Fly-Ash:

Fly-ash is a very cheap and available material in Iraq[9]. It is composed of very fine, spherical particles (0.5µm to 100µm) and contains SiO_2 (55%), Al_2O_3 (20.3%), Fe_2O_3 (6.3%), CaO (12%), MgO (3.5%), Alkali (1%), SO_3 (1.5%) and heavy metals[10].

4-1-3 Eggshell Powder:

Eggshell powder (ESP) has not being in use as a stabilizing material and it could be a good replacement for industrial lime, since it's chemical composition is similar to that of lime. Chicken eggshell is a waste material from domestic sources such as fast food joints and homes. Literature has shown that eggshell powder primarily contains CaO (99.83%) and the remaining consist of Al_2O_3, SiO_2, Cl, Cr_2O_3, MnO and CuO[11].

The eggshell waste was washed and dried before grinding. The eggshell powder was sieved using No. 200 ASTM[8] sieve, and the protein passing the sieve was used. This sieve was chosen in order to achieve a uniform powdery.

4-2 Influence of Fly-Ash and Eggshell Powder on Atterberg Limits:

Fly-ash & eggshell powder were added to the soil samples in 2, 4, 8, 12, 16, 20 and 24% by weight of samples. The result of fly-ash and eggshell powder influences on the Atterberg's limits test [8] (liquid limits & plastic limits) of the soil samples are shown in table (2) and table (3) respectively.

Table (2) Influences of fly-ash on the Atterberg's limits

Fly Ash %	L.L. %	P.L. %	P.I. %
0	44	23	21
2	39	21	18
4	36	19	17
8	34	18	16
12	31	16	15
16	29	15	14
20	28	14	14
24	27	14	13

Table (3) Influences of eggshell powder on the Atterberg's limits

Eggshell %	L.L. %	P.L. %	P.I. %
0	44	23	21
2	42	22	20
4	41	22	19
8	41	24	17
12	39	26	13
16	38	27	11
20	37	27	10
24	37	27	10

The addition of fly-ash in (2% -24%) to the soil samples caused changes in the liquid and plastic limits of the soil as shown in figure (1). It shows that the addition of fly-ash caused a decrease in the liquid limit & plastic limit and hence the plasticity index of all the soil samples at rates of (39%, 39% and 39%) respectively.

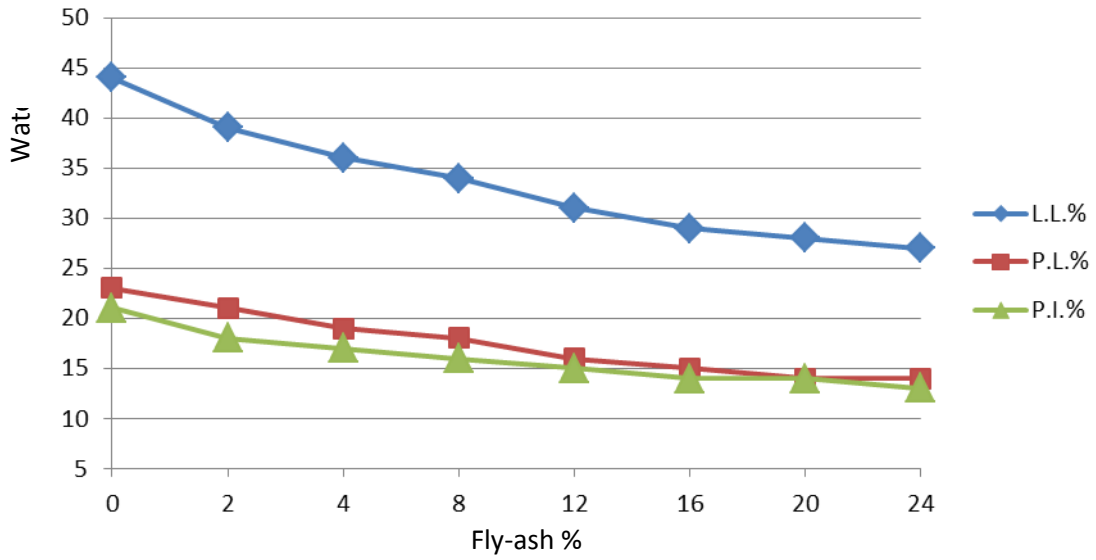

Figure (1) Effect of fly-ash on water contents

The effect of adding eggshell powder to the same soil is also quite obvious especially from figure (2). An increase in eggshell powder (2% -24%) causes a decrease in the liquid limit at a rate of (16%), while cause an increasing in the plastic limit at a rate of (17%). The reduction in the plasticity index amount for all soil samples increase at a rates of (5% - 52%) as the percentages of eggshell powder increases.

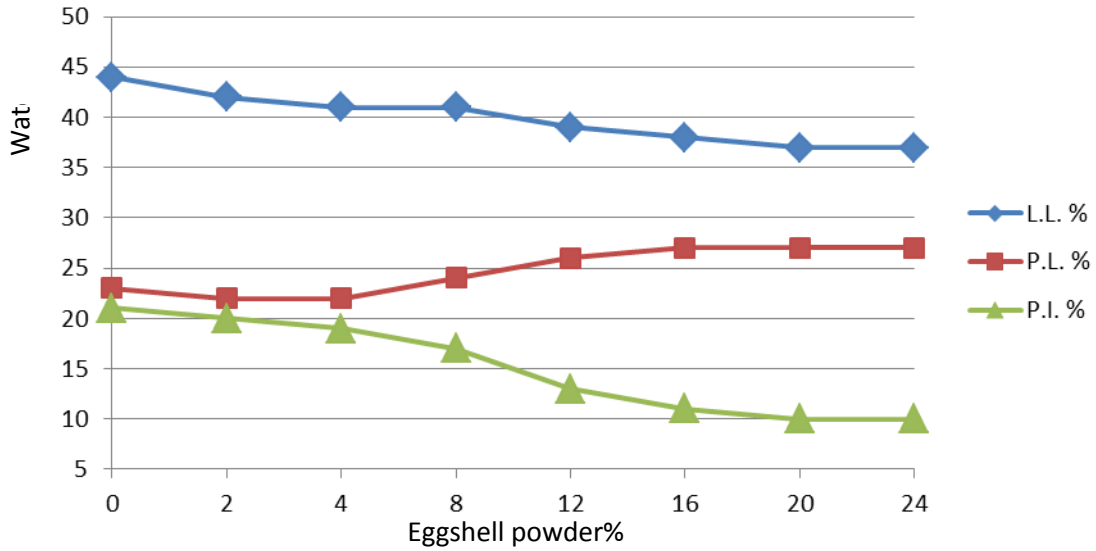

Figure (2) Effect of eggshell powder on water contents

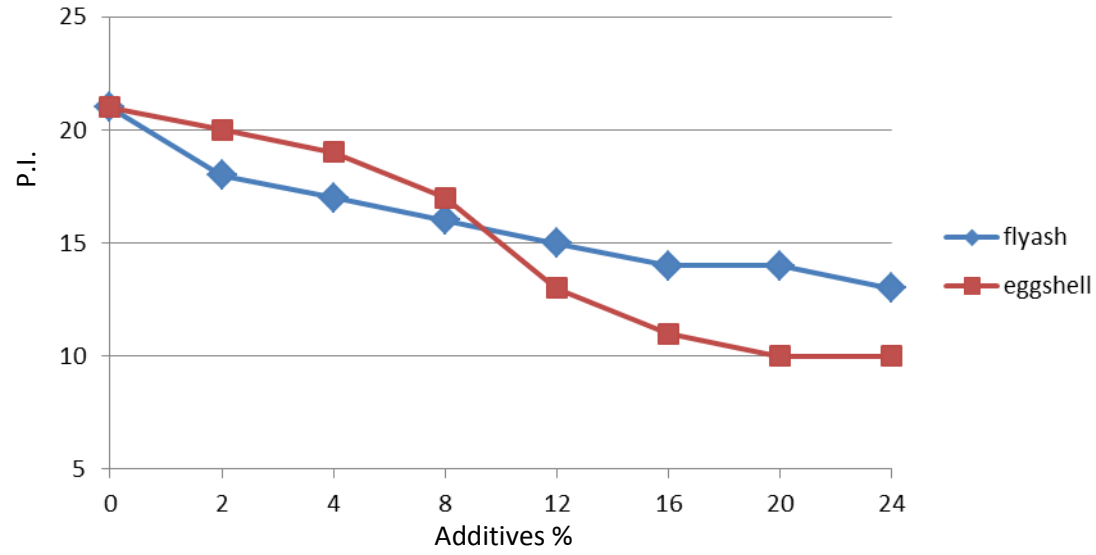

Figure (3) Effect of fly-ash and eggshell powder on the plasticity index

Figure (3) shows the significant effect of adding each of fly-ash and eggshell powder on the plasticity index of the tested soil. The loss in the plasticity index took place at a smaller rate at the first 4%, then the rate increased and became almost constant at 24% of additives for both

cases. This is maybe attributed to the fact that both fly-ash and eggshell powder acts as a drying agents. It is quite obvious that the loss in the plasticity index in the case of adding eggshell powder is greater than the loss in the case of adding fly-ash.

4-3 Influences of Fly-Ash and Eggshell Powder on the Cohesion & Internal Angle of Friction:

Tables (4) & (5) show the results of cohesion (C) and internal angle of friction (Ø) after adding each of fly-ash and eggshell powder to the soil samples of direct shear test[8] at a rate of (2-24%) by weight.

Table (4) Influences of fly-ash on cohesion and internal angle of friction

Fly-ash %	(C) kN/m^2	(Ø)
0	45	29
2	42	31
4	41	32
8	40	34
12	33	37
16	32	37
20	30	38
24	30	38

Table (5) Influences of eggshell powder on cohesion and internal angle of friction

Eggshell powder %	(C) kN/m^2	(Ø)
0	45	29
2	46	28
4	49	28
8	53	27
12	54	26
16	55	25
20	56	25
24	56	25

When the soil samples mixed with fly-ash the value of cohesion decreased, while there was a small increase in cohesion when mixed with eggshell powder as shown in figure (4).

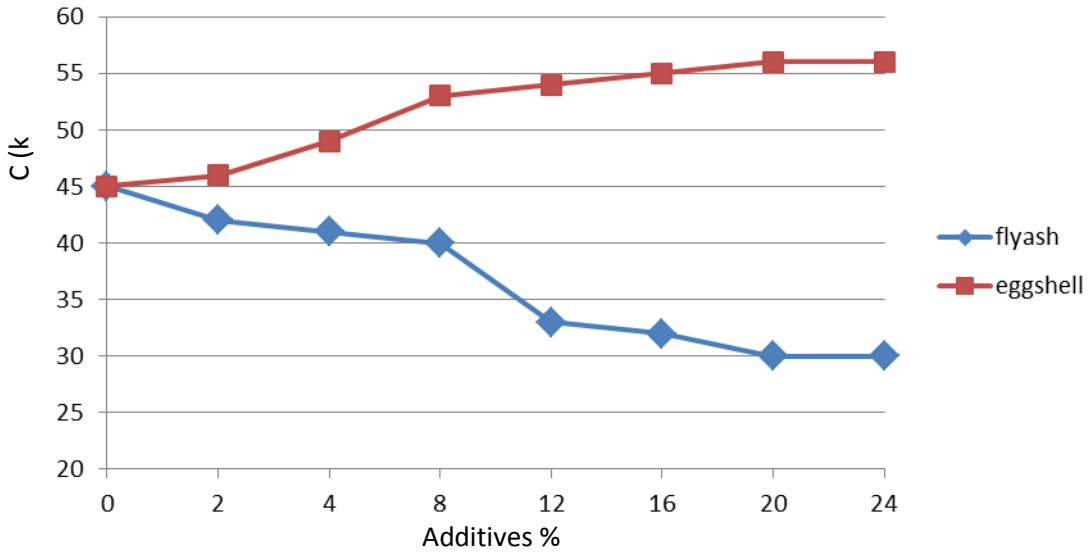

Figure (4) Effect of fly-ash and eggshell powder on cohesion

The drop in cohesion of the tested soil samples when mixed with (24%) of fly-ash was (33%), while the value of increasing in cohesion for the same soil samples was (25%) mixed with the same amount but of eggshell powder.

In figure (5) there was a remarkable increase in the internal angle of friction in case of fly-ash, but there was a small decrease in the internal angle of friction in case of eggshell powder.

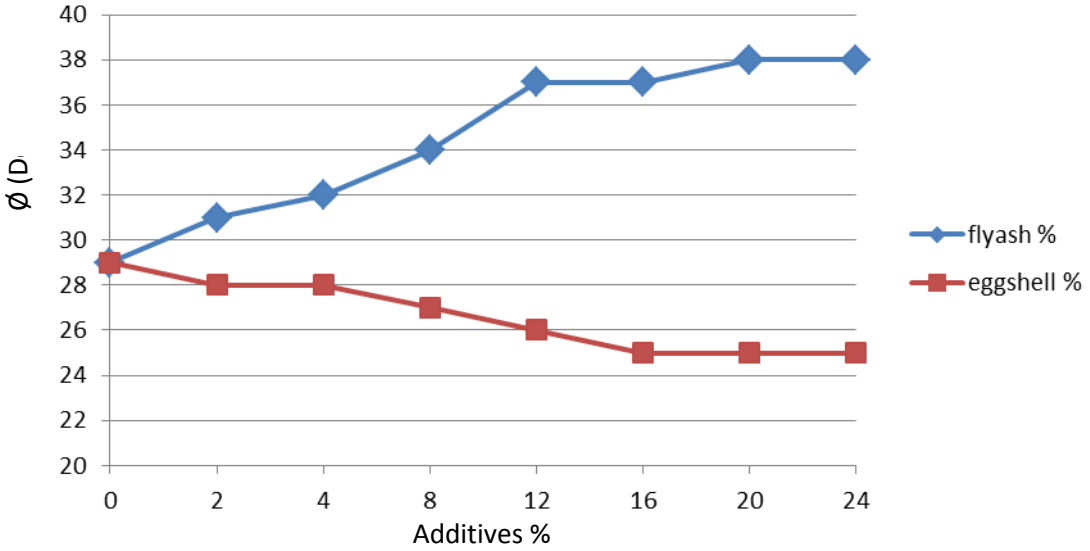

Figure (5) Effect of fly-ash and eggshell powder on internal angle of friction

The decrease in cohesion and an increase in internal angle of friction in case of adding fly-ash to the tested soil may be attributed to the fact that fly-ash is a cohesionless material but with a reasonable amount of angle of friction.

The increase in cohesion is a result of adding fine material (eggshell powder) to the same soil, and it is also the reason for the decrease in the internal angle of friction.

5- Conclusions:.

From the laboratory testing results of Al-Umara soil, the following conclusions can be drawn:.

1- According to the unified soil classification system, the tested soil is a (CL) soil with a specific gravity of 2.72.
2- The values of the liquid limit, plastic limit and plasticity index of the tested soil are (44%, 23% and 21%) respectively.
3- The cohesion value of the soil tested is 45(kN/m^2), while the internal angle of friction is 29 (Deg.).
4- The addition of fly-ash from 2% - 24% to the soil samples caused a decrease in the liquid limit, plastic limit and hence the plasticity index of all the soil samples at rates of (39%, 39% and 38%) respectively.
5- The effect of adding eggshell powder to the same soil is also quite obvious. An increase in eggshell powder (2% - 24%) causes a decrease in the liquid limit at a rate of 16%, while cause an increasing in the plastic limit at a rate of 17%.
6- The reduction in the plasticity index amount for all soil samples increases at a rates of (5% - 52%) as the percentages of eggshell powder increases.
7- The values of cohesion decreased when the soil samples mixed with fly-ash, while there was a small increase in cohesion values when mixed with eggshell powder.
8- There was an increase in the internal angle of friction in case of fly-ash, but there was a small decrease in the internal angle of friction in case of eggshell powder.

6- References:.

[1]Bowles, J.E. "**Physical and Geotechnical Properties for Soils**", 2nd Edn. McGraw Hill Book Company New York, 1998, pp: 112-134.

[2]Amu, O.O., Fajobi, A.B. and Oke, B.O. "**Effect of Eggshell Powder on the Stabilizing Potential of Lime on an Expansive Clay Soil**", Research Journal of Agriculture and Biological Sciences 1 (2005), pp: 80-84.

[3]Parker, D. G., Thornton, S.I. , and Cheng, C.W. "**Permeability of Fly-Ash Stabilized Soils**", Proceeding of the Specialty Conference of the Geotechnical Engineering Division of ASCE on Geotechnical Practice for Disposal of Solid Waste materials, 1977, pp: 63-70.

[4]Amu, O.O. and Salami, B.A. "**Effect of Common Salt on Some Engineering Properties of Eggshell Stabilized lateritic Soil**" , ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 9, September 2010, pp: 64-73.

[5]Sudhir K. Sharma and Naveen Kalra, "**Effect of Fly-Ash Incorporation on Soil Properties and Productivity** ", Journal of Scientific and Industrial Research, Vol. 65, May 2006, pp: 383-390.

[6]Al-Dahlaki, M.H. "**Effect of Fly-Ash on the Enginnering Properties of Swelling Soils**", Vol. 11, No. 3, December (2007), pp: 1-11.

[7]Croft, C. P., McGeory, D. and Carlson, D.H. "**Physical Geology**", 8 Edn. McGraw Hill Compnies Inc. New York, 1999, pp: 48-56.

[8]American Society for Testing and Materials ASTM (2003), (Soil and Rock).

[9]Al-Dulaimy, A.A. "**Treatment of Expansive Clayey Soil with Fly-Ash**", M.Sc. thesis, Department of Civil Engineering, college of Engineering, University of Baghdad, 2003.

[10]Zachary, G. T. "**Engineering Properties of Soil-Fly-Ash Subgrade Mixtures**", Midwest Transportation Consortium, October 18, 2002, pp: 1-15.

[11]Tocan, A.G.J. "**Utilization of Chick Hatchery Waste: The Nutritional Characteristics of Day old Chick and Eggshells**", Agricultural Wastes Vol. 4, 1999, pp: 335-343.