Study The Consequence of Fly Ash on Some of Physical Soil Characteristics

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Abstract: Study the consequence of adding fly ash (FA) on the Atterberg limit; cohesions and internal friction of angles of the verified soil was the aim of this search. The tested soil according to the system of unified soil classification was (CH) group. Fly ash (FA) was added to the tested soil samples in 1, 3, 6, 9, 12, 15 & 18 \% by weight of samples. This study shows that once the tested soil mixed with (FA); the values of cohesion reduced; while the values of the angles of internal frictions increases. The drop in the soil sample cohesion when mixed with 18\% of (FA) was 34\%, were noteworthy increase in the angles of internal friction. For all soil samples as the percentages of adding (FA) increase, the decrease in the index of plasticity amounts increase also at different rates. The adding of (FA) produced a reduction in the liquid limits; plastic limits and henceforth the plasticity index of the tested soil sample at rate of 43\%, 48\% and 37\% correspondingly. The plasticity index losses took place at the first 3\%, at a lesser rate, then the rate increased at 18\% of additive and because nearly constant.

Key Wards: Fly ash; Atterberg limits; cohesions; internal friction of angles.

1. Introduction:

Soil is used as a building material for roads, canals, dams, pavements and as a fill behind retaining wall. It would be ideal to discover a soil at a specific site to be acceptable for the intended use as it exists in nature but inappropriately such thing is of occasional occurrence (1). So, it is very vital for the engineer to know about the degree to which soil properties may be improved or to think of another possibility for the construction in the planned structure at the existing site.

It is obvious that a possible resolution be required for the options of existing alternatives where a poor soil is met. The options may contain diggings to deep foundations stages, leaving the unfortunate soils for a new alternative place, subtraction of the unfortunate soils and succeeding replacement with a
appropriate one and treating the unfortunate soils to improve its properties identified as improvement of soil (2).
Some of these materials such as (fly ash, lime, cement and etc.) have been used for improving some of the soil physical engineering characteristics.

2. Consequence of (FA) on soil:

Newly the using of waste industrial materials attract of investigator because of their cheapness in comparison with other materials that may be mixed with needy poor soil (3) such as (FA).
Two-fold advantages result from the usage of waste industrial materials: natural resources will be preservation and the size of waste materials will be reduced (4). (FA) improving the chemical and physical characteristics of soils (5). The amounts of (FA) have a marked consequence on the index of plasticity and extra physical soil characteristics (6,7).
At the recent time; since (FA) has a wide spread obtainability, it is gaining more importance. Soil improvement by (FA) is inexpensive and takes less time than any further procedures. It is an engineering material which has a long history of use and successfully employed in the applications of geotechnical (8).

3. Investigational Work:

3.1. Materials:

3.1.1. Soil:

According to the ASTM standard (9), the over-all physical soil properties of the tested soil are revealed in table 1.

| Table 1. Tested physical Soil Properties |
|------------------------------------------|
| Unified soil classification system | (CH) |
| Specific Gravity Gs                  | 2.68 |
| Cohesion C                           | 41 KN/m² |
| Angle of internal friction Ø         | 27 Deg. |
| Plasticity index (P.I.)              | 19 % |
| Liquid limit (L.L.)                  | 40 % |
| Plastic limit (P.L.)                 | 21 % |

3.1.2, Fly Ash:

In Iraq (FA) is an actual cheap and obtainable material (10). It is composed of actual fine sphere-shaped particles and contains high percentages of:
Fe, Ca, Al, Si, K and Mg (11,12). (FA) chemical and physical properties rely on the parent coal type.

3.2. Consequence of (FA) on Atterberg Limits:

(FA) was added to the tested soil in 1, 3, 6, 9, 12, 15 and 18 % by samples weight. The results of (FA) influences on the test of Atterberg's limits (9) on the tested soil are revealed in table (2).
Table 2. Consequence of (FA) addition on the Atterberg limit

| (FA) % | Liquid limit % L.L. | Plastic limit % P.L. | Plasticity index % P.I. |
|--------|---------------------|----------------------|------------------------|
| 0      | 40                  | 21                   | 19                     |
| 1      | 38                  | 20                   | 18                     |
| 3      | 36                  | 19                   | 17                     |
| 6      | 33                  | 18                   | 15                     |
| 9      | 28                  | 14                   | 14                     |
| 12     | 25                  | 13                   | 12                     |
| 15     | 24                  | 12                   | 12                     |
| 18     | 23                  | 11                   | 12                     |

Variations in the Atterberg's limit “liquid and plastic limit” of the tested soil samples caused by the addition of (FA) (1% -18%) as revealed in Fig (1). It is clear that the adding of (FA) produced a reduction in the liquid limits; plastic limits and henceforth the plasticity index of the tested soil sample at rate of 43%, 48% and 37% correspondingly. The plasticity index losses took place at the first 3%, at a lesser rate, then the rate increased at 18% of additive and became nearly constant. This change may be attributed to the fact that (FA) performances as a drying agent.

Figure 1. Consequence of (FA) addition on the Atterberg limits

3.3 Consequence of (FA) on the Cohesions and Angles of Internal Friction:

Table (3) shows the results of cohesion C and angle of internal friction Ø afterward the addition of (FA) to the tested soil samples of direct shear test at rates of (1-18%) by weight.
Table 3. Consequence of (FA) addition on Cohesion and Angle of Internal Friction

| (FA) %  | (C) KN/m² | (Ø)  |
|---------|-----------|------|
| 0       | 41        | 27   |
| 1       | 40        | 28   |
| 3       | 37        | 31   |
| 6       | 32        | 36   |
| 9       | 30        | 38   |
| 12      | 29        | 39   |
| 15      | 27        | 40   |
| 18      | 27        | 40   |

When the (FA) mixed the tested soil samples; the values of cohesion reduced. The drop in the soil sample cohesion when mixed with 18% of (FA) was 34% as revealed in Fig (2).

Figure 2. Consequence of (FA) on cohesion

As shown in Fig (3) there were noteworthy increase in the angles of internal friction.
In the case of the addition of (FA), the reductions in the cohesion and an increase in the angles of internal friction of the soil samples might be attributed to the fact that (FA) is a cohesionless; but with reasonable amounts of internal angles of friction material.

4. Conclusions:

Following the USCS (Unified Soil Classification System); the soil was a (CH) soil with a specific gravity GS of 2.68. The values of the liquid limit; plastic limit and the plasticity index of the verified soil samples were 40%, 21% and 19% respectively. A reduction in the liquid limits; plastic limits and hence the plasticity index of all the tested soil samples after the adding of (FA) from 1 % - 18 % to the tested soil samples were at rates of (43%, 48% and 37%) correspondingly. The value of the cohesion of the tested soil sample was 41(KN/m2), whereas the internal friction angle was 29 (Deg.). when the tested soil samples mixed with (FA) at the same rates, the values of the cohesion reduced. whereas there were remarkable increases in the values of internal friction angles.

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