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Study on Effect of Fly Ash on Index Properties of Expensive Soils

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Abstract: Soil is the most important engineering material that is used in construction industries Infrastructure projects such as highway, railway and water reservoir ete. required earth material in very large quantity. In urban areas borrow earth is not easily available. Quite often, large areas are covered with highly plastic and expensive soil, which is not suitable for such purpose. Expensive soils always create problems more for lightly loaded structures than moderately loaded structures. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. As a result damage to foundation systems, structural element and architectural features defeat the purpose for which the structures are erected.

The present paper describes a study carried out to check the improvements in the properties of expansive soil with fly ash in varying percentages. As fly ash freely available for project in the vicinity of thermal power plant it can be used for stabilization of expensive soil for various use.

Expensive soils of India are commonly known as "Black Cotton" soil. Their name is derived because of their black colour and immense fertility for growing cotton, is one of the residual soil of India. The black colour is not due to the presence of organic matter, which is negligible but may be due to the presence of iron and **titanium that** exist in small quantity. About 20% of the land area in India is covered by expensive soils. Expensive soils deposits in India are a boom to farmer but problem to civil engineers. Actually "Expensive Soils" are those which swell considerably on absorption of water from outside and shrink on the removal of water. Civil engineering structures appearance large scale damages due to having accompanied by loss of strength of these soils during rainy session and shrinkage during summer. Heavy investments are made for the constructions of dams, canals, cross drainage structures, roads and buildings. The annual cost of damage done to non-military engineering structures constructed on expensive soils are estimated at $220 million in the United Kingdom and many billions of dollars worldwide, It is due to this that the present work is taken up.The major regions of expensive soils in India are Gujarat , Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Madhya Pradesh. All these states engaged in increasing the irrigation potential of their states. Thermal power is regarded as one of the most significant methods to generate electric energy. However, this process is frequently used to produce a large amount offlyash in a solid waste, which makes a safe and effective treatment [1–3]. Part of the fly ash is utilized as an additive in other production activities to improve the performance of concrete. Otherwise, the fly ash could end up in landfills [4, 5].

Fly ash was successfully used for stabilizing expensive soils. Effect of Fly ash on expansive soil was studied by Irdal Cokea 2000 Fly ash consists of often hollow spheres of silicon, aluminium and iron oxides and unoxidized carbon . There are two major classes of fly ash, class C and class F. The former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sub bituminous coal. Both the classes of fly ash are puzzolans, which are defined as siliceous and aluminous material. Thus Fly ash can provide an array of divalent and trivalent cations (Ca^{2+}, Al^{3+}, Fe^{3+} etc) under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive soils can be potentially Stabilized effectively by cation exchange using fly ash. In India thermal power plants produce abundant quantities of fly ash, Thermal power plants produce about 100 million tons of fly ash per year. The annual production of fly ash from power plats in the word about 1000 million tons, this has resulted in several problems such as land use, health hazards and environmental dangers. Disposal of this huge quantities of fly ash is becoming very difficult as the particles are very fine which are easily blown off by air and possess toxic elements and can cause environmental hazards. But the pazzolanic reactivity of fly ash play an important role in improving geotechnical properties of soil. Fly ash has several advantages such as low unit weight. high shear strength, low compressibility, insensitivity to moisture variation and pazzolanic properties.

MATERIES USED

Soil: The soil used in this investigation is expensive clay, collected kota local. Rajasthan. The physical properties of the soil are presented in table-1&2

Fly ash: The Fly ash is obtained from the Kota Thermal power station, Kota (Rajasthan).

EXPERIMENTAL INVESTIGATION

Laboratory tests are essential for knowing the suitability of material, which is used for the proposed engineering works and for preparing adequate and economic design. Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on natural soil and stabilized soil with fly ash collected from Kota thermal power station, Kota (Rajasthan).

(I) Grain Size Analysis (ii) Atterberg Limit Test (iii) Cone Penetrometer Test (iv) Permeability Test.

After removing impurities like vegetation, stones etc. the soil was mixed with fly ah in varying proportion. The Mixing was thoroughly carried out manually and the tests were conducted as per standard procedures.

(a) Liquid Limit:

Cone Penetrometer test is to be used for determination of liquid limit of soil sample and soil sample with fly ash in different proportion. The soil is passing through 4.75mm sieve

(b) Plastic Limit:

This test is to be done for determination of plastic limit of the soil sample and soil sample with fly ash in different proportion. By plastic limit we could calculate the plastic index toughness index, liquidity index and consistency index. As per IS:2720 Part V 1965: the soil is passing through 425 micron sieve.

(c) Shrinkage limit:

Mercury displacement method is t be used for determination of shrinkage limit of the soil sample and soil sample with fly ash in different proportion

(d) Dry density:

For determining the dry density of soil sample and soil sample with fly ash in different proportion the "Standard Proctor Test is to be performed .

(c) Swelling index:

Free swell of soil is defined as the increase in volume of a soil, without any external constrain, on submergence in water. It is determine the laboratory by test as per the IS.2720 Part 40, 1977. It is to be carried out by using 10gm soil with distilled water and kerosene oil.

RESULTS AND DISCUSSION

The present investigation gives an idea about the index properties of the expensive soils. Based on laboratory tests following conclusions have been made:

The Optimum Moisture Contents (OMC) of the soil was 12.2%. The Specific Gravity (SG) of the soil was found to be 2.69, which is within the range given by Braja for an expensive soil, such as Illite (2.8) Montmorillonite (2.65-2.80) and Vermiculite (2.6-2.9).

The Liquid Limit (L.L.) and Plastic Lamin (P.L.) of natural soil sample are 53.20 and 16.70 respectively and its Plastic Index (P.I.) 36.5. High plastic show that soil is highly plastic in nature.

The addition of fly ash reduced the plasticity index of expensive soil from 36.5 to 12.13% at 20% which is optimal mixture of fly ash with soil. The plastic index starts increasing again with further addition of fly ash. The Shrinkage Limit firstly increases and then decrease on addition of fly ash.

Table-1 Practical size of soil and fly ash

S.No.	Partical	Soil	Fly Ash
1.	Clay %	4.0	2.0
2.	Silt %	47	44
3.	Sand %	30	44

Table-2 Index properties of soil and fly ash

S.No.	Properties	Soil	Fly Ash
1.	L.L.	53.20	26.18
2.	P.L.	16.70	N.P.
3.	S.L.	10.15	N.P
4.	M.D.D	1.72	1.20
5.	O.M.C.	12.20	27.2
6.	S.I.	23.03	16.0

N.P. – Not Present

Table-3 Index properties of % of fly ash

S.No.	Properties	% of Fly Ash				
	% of Fly Ash	5	10	15	20	25
1.	L.L.	38.8	37.3	36.2	34.2	36.4
2.	P.L.	17.5	18.0	22.2	22.0	19.4
3.	S.L.	10.9	12.16	13.10	18.69	17.5
4.	M.D.D	1.74	1.69	1.69	1.70	1.67
5.	O.M.C.	13.6	15.2	16.6	19.0	16.5
6.	S.I.	21.0	15	12	8.7	9.0

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