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Laboratory Investigation on Black Cotton Soil by using Industrial Waste

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Abstract: Clayey soils, which are likewise called as swell-psychologist soil, tend to therapist and swell with variety in dampness content. As a consequence of this variety in the dirt, critical trouble happens in the dirt, which is hence trailed by harm to the overlying structures. Amid times of more prominent dampness, similar to storms, these dirt's guzzle the water, and swell; hence, they turn out to be delicate and their water holding limit reduces. Instead of this, in drier seasons, similar to summers, this dirt loses the dampness held in them because of dissipation, bringing about their getting to be harder. By and large found in semi-parched and dry areas of the globe, these kinds of soils are viewed as potential regular peril – if not treated, these can bring about broad harm to the structures based upon them, too creating misfortune in human life. Soils whose synthesis incorporates nearness of montmorillonite, when all is said in done, show these sorts of properties. Counted in billions of dollars yearly around the world, this dirt have brought about broad harm to structural building structures.
Keywords: black cotton soil, bearing capacity, liquid limit, plastic limit, cohesion

I. INTRODUCTION

Black Cotton soils or Regur soils, Clayey soils in the Indian subcontinent are mostly found over the Deccan trap (Deccan magma tract), which incorporates Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh, and some scattered places in Odisha. This dirt are additionally found in the stream valley of Narmada, Tapi, Godavari and Krishna. The profundity of dark cotton soil is vast in the upper parts of Godavari and Krishna, and the north-western piece of Deccan Plateau. Essentially, after the compound disintegration of rocks, for example, basalt by different deteriorating specialists, these are the remaining soils abandoned at the place of such an occasion. Cooling of volcanic emission (magma) and weathering another sort of shake– molten rocks – are additionally procedures of development of these kinds of soils. Rich in lime, alumina, magnesia, and iron, these dirts need in nitrogen, phosphorus and natural substance. Comprising of high rate of earth estimated particles, the shade of this dirt shifts from dark to chestnut cocoa. 20% of the aggregate land zone, on a normal, of this nation is roofed by Clayey soils. These dirts are appropriate for dry cultivating and for the development of products like cotton, rice, jowar, wheat, grain, tobacco, sugarcane, oilseeds, citrus leafy foods; the purpose for it is owed to the dampness retentive limit of extensive soils which is high In the semi-parched locales, just in the last couple of decades, harms because of the swelling- contracting activity of extensive soils have been watched unmistakably in type of making and break-laugh out loud of roadways, channel and store linings, asphalts, building establishments, water lines, water system frameworks, sewer lines, and piece on-level individuals.

A. Engineering Properties of Clay Soil

The following properties of soil are taken into consideration while dealing with soil as a construction material.

1) *Cohesion:* It is the internal molecular attraction which resists the rupture or shear of a material. Cohesion is derived in the fine-grained soils from the water films which bind together the individual particles in the soil mass. Cohesion is the property of the fine-grained soil with particle size below 0.002 mm. cohesion of a soil decreases as the moisture content increases. Cohesion is greater in well compacted clays and it is independent of the external load applied.
2) *Angle of Internal Friction:* The resistance in sliding of grain particles of a soil mass depends upon the angle of internal friction. It is usually considered that the value of the angle of internal friction is almost independent of the normal pressure but varies with the degree of packing of the particles, i.e. with the density. The soils subjected to the higher normal stresses will have lower moisture contents and higher bulk densities at failure than those subjected to lower normal stresses and the angle of internal friction may thus change. The true angle of internal friction of clay is seldom zero and may be as much as 26^0. The angle of internal friction from granular soils may vary in between 28^0 to 50^0.
3) *Capillarity:* It is the ability of soil to transmit moisture in all directions regardless of any gravitational force. Water rises up through soil pores due to capillary attraction. The maximum theoretical height of capillary rise depends upon the pressure which tends to force the water into the soil, and this force increases as the size of the soil particles decreases. The capillary rise

in a soil when wet may equal as much as 4 to 5 times the height of capillary rise in the same soil when dry. Coarse gravel has no capillary rise; coarse sand has up to 30 cm; fine sand and soils have capillary rise up to 1.2 m but dry sand has very little capillarity. Clays may have capillary rise up to 0.9 to 1.2 m but pure clays have very low value.

4) *Permeability:* Permeability of a soil is the rate at which water flows through it under action of hydraulic gradient. The passage of moisture through the inter-spaces or pores of the soil is called '*percolation*'. Soils having porous enough for percolation to occur are termed '*pervious*' or '*permeable*', while those which do not permit the passage of water are termed '*impervious*' or '*impermeable*'. The rate of flow is directly proportional to the head of water. Permeability is a property of soil mass and not of individual particles. The permeability of cohesive soil is, in general, very small. Knowledge of permeability is required not only for seepage, drainage and ground water problems but also for the rate of settlement of structures on saturated soils.
5) *Elasticity:* A soil is said to be elastic when it suffers a reduction in volume (or is changed shape & bulk) while the load is applied, but recovers its initial volume immediately when the load is removed. The most important characteristic of the elastic behaviour of soil is that no matter how many repetitions of load are applied to it, provided that the stress set up in the soil do not exceed the yield stress, the soil does not become permanently deformed. This elastic behaviour is characteristic of peat.
6) *Compressibility:* Gravels, sands & silts are incompressible, i.e. if a moist mass of those materials is subjected to compression; they suffer no significant volume change. Clays are compressible, i.e. if a moist mass of clay is subjected to compression, moisture & air may be expelled, resulting in a reduction in volume which is not immediately recovered when the compression load is withdrawn. The decrease in volume per unit increase of pressure is defined as the compressibility of soil, and a measure of the rate at which consolidation proceeds is given by the '*co-efficient of consolidation*' of the soil. Compressibility of sand & silt varies with density & compressibility of clay varies directly with water content & inversely with cohesive strength.

II. LITERATURE REVIEW

Erdal Cokca (2001) Impact of Fly ash on expansive soil was studied by Erdal Cokca, Fly ash consists of typically hollow spheres of chemical element, metal and iron oxides and unoxidized carbon. Thereare 2 major categories of fly ash, category C and sophistication F. the previous is created from burning anthracite coal or soft coal and therefore the latter is created from burning coal and sub soft coal. each the categories of ash ar puzzolans, that ar outlined as oxide and aluminous materials. so ash will offer AN array of power and power cations (Ca^{2+},Al^{3+},Fe^{3+}etc) below ionised conditions which will promote natural process of spread clay particles. so expansive soils may be probably stable effectively by ion exchange exploitation fly ash. He distributed investigations exploitation Soma Fly ash and Tuncbilek flyash and adscititious it to expansive soil at 0-25%. Specimens with fly ash were cured for 7days and twenty eight days once that they were subjected to Oedometer free swell tests. And his experimental findings confirmed that the physical property index, activity and swelling potential of the samples minimized with increasing % stabilizer and activity time and therefore the optimum content offlays in decreasing the swell potential was found to be 2 hundredth. The changes within the physical properties and swelling potential could be a results of further silt size particles to some extent and because of chemical reactions that cause immediate natural process of clay particles and therefore the time dependent pozzolanic and self-hardening properties of fly ash and he terminated that each high –calcium and low Ca category C fly ashes may be counselled as effective helpful agents for improvement for improvement of expansive soils.

Pandian et.al. (2002). Studied the impact of 2 kinds of ashes Raichur ash (Class F) and Neyveli fly ash (Class C) on the cosmic background radiation characteristics of the black cotton soil. The ash content was accrued from zero to 100 percent. usually the CBR/strength is contributed by its cohesion and friction. The cosmic background radiation of before Christ soil, that consists of preponderantly of finer particles, is contributed by cohesion. The cosmic background radiation of ash, that consists preponderantly of coarser particles, is contributed by its resistance element. The low cosmic background radiation of before Christ soil is attributed to the inherent low strength, that is because of the dominance of clay fraction. The addition of ash to before Christ soil will increase the cosmic background radiation of the combo up to the primary optimum level because of the resistance resistance from ash additionally to the cohesion from before Christ soil. any addition of ash on the far side the optimum level causes a decrease up to hr then up to the second optimum level there's a rise. so the variation of cosmic background radiation of ash-BC soil mixes may be attributed to the relative contribution of resistance or cohesive resistance from fly ash or before Christ soil, severally. In Neyveli ash additionally there's a rise of strength with the rise within the ash content, here there'll be further puzzolonic reaction forming building material compounds leading to sensible binding between before Christ soil and ash particles.

III.MATERIALS

A. Expansive Soil

The black cotton soil thus obtained was carried to the laboratory in sacks. A small amount of soil was taken, sieved through 4.75 mm sieve, weighed, and air-dried before weighing again to determine the natural moisture content of the same. The various geotechnical properties of the procured soil are as follows.

Table I Geotechnical properties of Expansive soil

Sl. No.	Properties	Code referred	Value
1	Specific Gravity	IS 2720 (Part 3/Sec 1) - 1980	2.44
2	Maximum Dry Density (MDD)	IS 2720 (Part 7) - 1980	1.52gm/cc
3	Optimum Moisture Content (OMC)	IS 2720 (Part 7) - 1980	22.65%
4	Natural Moisture Content	IS 2720 (Part 2) - 1973	7.28%
5	Free Swell Index	IS 2720 (Part 40) - 1977	105%
6	Liquid Limit	IS 2720 (Part 5) - 1985	65%
7	Plastic Limit	IS 2720 (Part 5) - 1985	37.08%
8	Shrinkage Limit	IS 2720 (Part 6) -: 1972	17.37%

B. Fly Ash

A waste material extracted from the gases emanating from coal fired furnaces, generally of a thermal power plant, is called fly ash. The mineral residue that is left behind after the burning of coal is the fly ash. The Electro Static Precipitator (ESP) of the power plants collect these fly ashes. Essentially consisting of alumina, silica and iron, fly ashes are micro-sized particles. Fly ash particles are generally spherical in size, and this property makes it easy for them to blend and flow, to make a suitable concoction. Both amorphous and crystalline nature of minerals are the content of fly ash generated. Its content varies with the change in nature of the coal used for the burning process, but it basically is a non-plastic silt. For the purpose of investigations in this study, fly ash was obtained from Sesa Sterlite, Jharsuguda, Odisha. To separate out the vegetation and foreign material, this fly ash was screen through a 2 mm sieve. The samples were dried in the oven for about 24 hours before further usage.

IV.LABORATORY INVESTIGATION

Table II RESULT

Fly Ash %	LL	PL	OMC	MDD	CBR 2.5mm	CBR 5.0 mm
0	41.6	19.06	20.25	1.75	2.08	1.89
5	38.4	18.37	20.11	1.74	2.93	2.01
10	36.3	17.5	19.63	1.73	3.15	2.59
15	34.5	18.2	19.29	1.62	3.32	2.94
20	32.6	16.8	18.88	1.68	3.67	2.91

V. RESULT & CONCLUSION

A. Black cotton soil is combined with altering percentage of fly ash (from 0% to 30%, intervals in multiples of 5) by weight to observe its effect as an additive on the expansive soil.

B. Maximum Dry Density (MDD) was found to change with varying content of fly ash. The highest value observed being at fly ash content of 30% by weight.

C. Both un-soaked and soaked California Bearing Ratio (CBR) tests are conducted with varying content of fly ash in the Clayey Soil. From the graphical comparison of these values against the varying fly ash content, it can be observed that 30% fly ash content gave the maximum value of CBR intensity in un-soaked and soaked soil-fly ash mixture respectively.

D. The liquid limit and plastic limit of the soil-fly ash mixture varied with the changing fly ash content. Plasticity index values were computed from these experiments, which showed a consistent decreasing pattern with the increase of fly ash content.

Table III Final Result

Fly Ash %	LL	PL	OMC	MDD	CBR 2.5mm	CBR 5.0 Mm
0	41.6	19.06	20.25	1.75	2.08	1.93
5	38.4	18.37	20.11	1.74	2.19	2.01
10	36.3	17.5	19.63	1.73	2.4	2.2
15	34.5	18.2	19.29	1.62	2.8	2.6
20	32.6	16.8	18.88	1.68	2.85	2.7
25	30.3	18.6	18.68	1.69	3.2	2.98

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