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STABILIZATION OF EXPANSIVE SOIL USING FLY ASH

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Abstract - *Soil stabilization is a physical, chemical, biological or combined method of changing a natural soil to meet an engineering purpose. Expansive soil is a type of clay that is prone to large volume changes (swelling and shrinking) that are directly related to changes in water content. Soils with a high content of expansive minerals can form deep cracks in drier seasons .Such soils are called vertisols. Soils with smectite clay minerals, such as montmorillonite and bentonite, have the most dramatic shrink-swell behavior. Expansive soil is hard in dry state and loses its strength in wet state. Due to this property it causes massive damage to infrastructure and buildings. In this study the natural soil is mixed with certain percentage of bentonite for making it expansive and this expansive soil is stabilized using fly ash. Fly ash is a fine powder which is a byproduct from burning pulverized coal in electric generation power plants. This can overcome many foundation problems and increase the bearing capacity of soil.*

Key Words*: *Stabilizations, Fly ash, Bentonite.

1. INTRODUCTION

Stabilization of soil is the amendment of soils to intensify their physical properties. Shrink-swell properties and improvement of the load bearing capacity of a sub-grade by stabilization to support pavements and foundations. Sub-soils which are not suitable for construction such as roadways, parking areas, site development projects, airports and many other situations can be stabilized with suitable methods. Wide range of sub-grade materials, varying from expansive clays to granular materials can be stabilized. This process is consummate using a wide variety of additives, including lime, fly-ash and Portland cement. Advantages of stabilization of soil includes: Increase in resistance, Plasticity reduction, Permeability reduction, Decrease in pavement thickness, elimination of excavation etc.

A rounded structure, with a hard outer layer and a porous inner layer is known as expansive soil. It is clay that is liable to large volume changes that are greatly related to changes in water content. High content of expansive minerals in the soil can form deep cracks in drier seasons such soils are called vertosols. Smectite clay minerals such as montmorillonite and bentonite in the soil have the most dramatic shrink-swell capacity. The very common cause of foundation problems is the shrink-swell soil. Based on the moisture content in the ground, shrink-swell soils will experience volume changes of up to thirty percent or more. Soils in the foundation which are expansive are heave and cause rising of a structure during periods of high moisture content. Expansive soil will collapse during the period of falling moisture content which results in building settlement. Expansive soils are found in USA, South Africa, Australia, Spain, Israel, Myanmar and India.

Due to difficulty in collecting the expansive soil, artificially prepare the expansive soil in laboratory. Bentonite clay of certain percentage when added to natural soil can convert natural soil into expansive soil. Bentonite is clay generated from the volcanic ash, consisting of smectite, usually montmorillonite. Due to the swelling properties of bentonite it is used to make expansive soil.

Fly Ash is used for the stabilization of expansive soil. Fly Ash is a waste material extracted from the gases emerging from coal fired furnaces, generally of a thermal power plant. Disposal of huge quantities of fly ash require large tracts of cultivable land which causes major environmental problems. Fly ash because of its pozzolanic property, free of cost and availability makes it a better stabilizer.

2. MATERIALS USED

2.1 Bentonite

Bentonite is a valuable clay, formed by the decomposition of volcanic ash, it swells by absorbing water. It consisting of smectite minerals, usually montmorillonite. Other smectite minerals such as hectorite, saponite, beidelite and nontronite. Bentonites contain a variety of minerals in addition to montmorillonite include, calcite, quartz, feldspar, and gypsum. Increasing or decreasing the industrial value of a deposite depending upon the presence of this minerals and their application. Volume increases several times when coming into contact with water, creating a gelatinous and viscous fluid. For a wide range of uses and applications the properties of bentonite such as hydration, swelling, water absorption, viscosity, thixotropyetc make it a valuable material. Due to the swelling properties of bentonite it is used to make expansive soil.

2.2Flyash

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 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, class F fly ash is used.

3. METHODOLOGY

Keeping in mind the general objectives of the project a detailed methodology for undertaking the project is proposed which consist of a set of task as given below:

i. Collection of materials such as natural soil, bentonite and fly ash.
ii. Performance of laboratory test on natural soil and bentonite.
iii. Preparation of the sample.
iv. Performance of laboratory test on the prepared sample and sample mixed with varying percentage of fly ash.
v. Comparison of results.

4. EXPERIMENTAL WORKS

Following experimental results were carried out as per IS: 2720. The tests were carried out on both expansive soil and fly ash mixed soil.

5. PROPERTIES OF SOIL

Properties of soil is determined by varying test results

Table 5.1 Test results for soil

PROPERTY	VALUE
OMC	31%
Dry density	1.4g/cc
Specific Gravity	2.693
Liquid limit	68%
Plastic limit	40%
Compressive stress	1414N/m^2
Particle size distribution	

6. PROPERTIES OF SOIL MIXED WITH BENTONITE

Expansive soil is difficult to collect from the field, so the natural soil is mixed with bentonite to obtain expansive soil.Free swell index test was conducted to determine that at which quantity of bentonite is added with the natural soil gives expansive soil. As a trial 10%, 15% of bentonite by weight of soil was taken. As per IS 2720 (Part XL)-1977, if the value of the swell index is greater than 50% then the soil is expansive. So by the addition of 15% of bentonite to the soil it becomes expansive.

6.1 Free Swell Index Test

Table 6.1. Test result of free swell index of expansive soil

	In kerosene	In distilled water		
Volume of soil specimen	14ml	Sample 1	Sample 2	Sample 3
		18ml	20ml	24ml

Free swell index value of soil is obtained as 71.42%, the soil is obtained as expansive

6.2. Other Test results

Table 6.2. Test results

PROPERTY	VALUES
OMC	25%
Dry density	1.579g/cc
Liquid limit	62%
Plastic limit	50%
Swell pressure test	64.7%
Compressive stress	64N/m^2
Particle size distribution	25% gravel, 60% sand, 11%silt

7. COMPARISON OF EXPANSIVE SOIL WITH FLYASH MIXED SOIL

Table 7.1. Test result of free swell index for 10% flyash

	In kerosene	In distilled water	
Volume of soil specimen	20ml	Sample 1	Sample2
		29ml	29.5ml

Table 7.2. Test results for 15% fly ash

	In kerosene	In distilled water	
Volume of soil specimen	18ml	Sample 1	Sample2
		24.5ml	25ml

Free swell index value of expansive soil is reduced from 71.42% to 38.8% by the addition of 15% fly ash. If value is less than 50% the expansiveness get reduced.

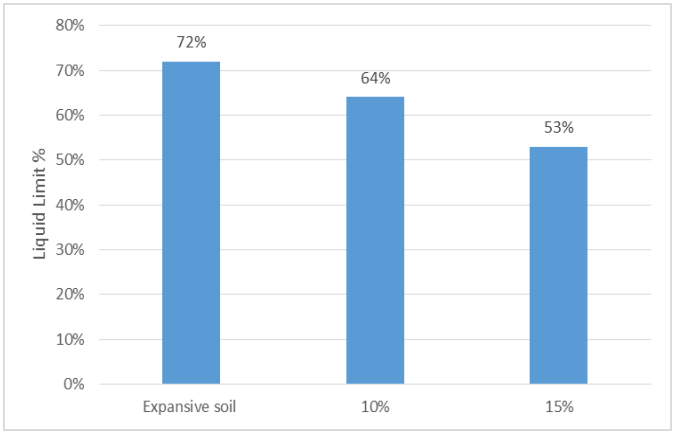

Fig.7.1 Liquid limit for 10% and 15%

Liquid limit of expansive soil reduced from 72% to 53%. When liquid limit decreases then the soil changes from liquid state to plastic state and attain more stability.

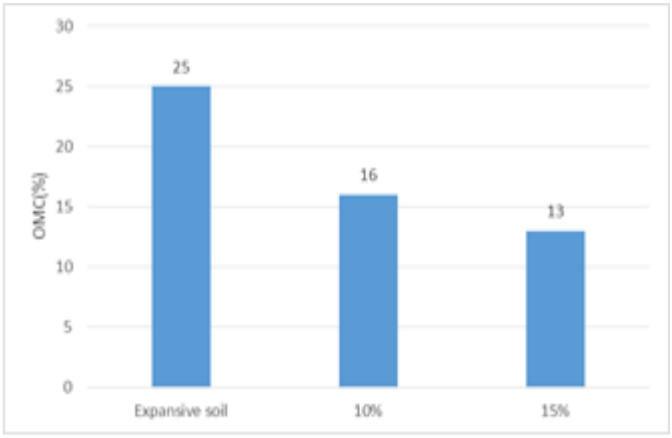

Fig. 7.2 OMC Value

OMC value varies from 25% to 13% when fly ash added with the soil. Shows a large variation in OMC value.

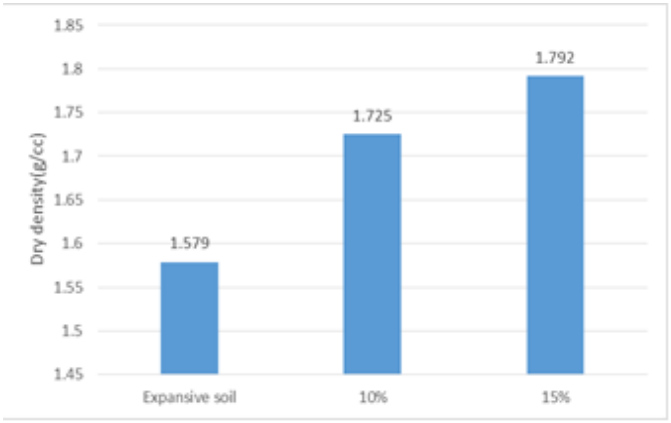

Fig 7.3 Dry Density

Dry density value varies from 1.579 to 1.792.

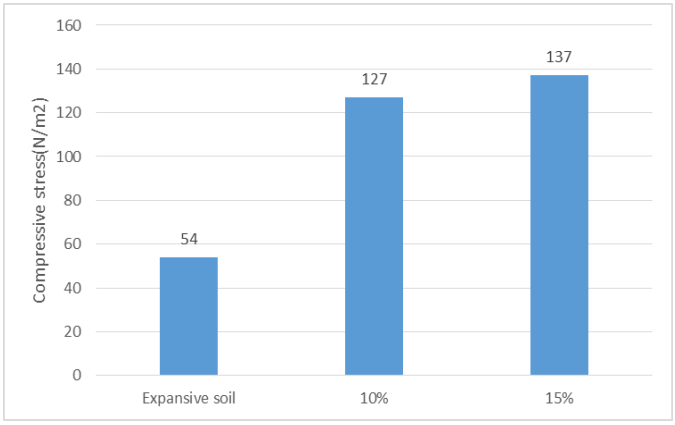

Fig.7.4 Compressive Stress

Compressive stress is directly proportional to compressive stress of soil. UCC test is to find the strength of soil. The value increased to 137N/m^2 from 54N/m^2.

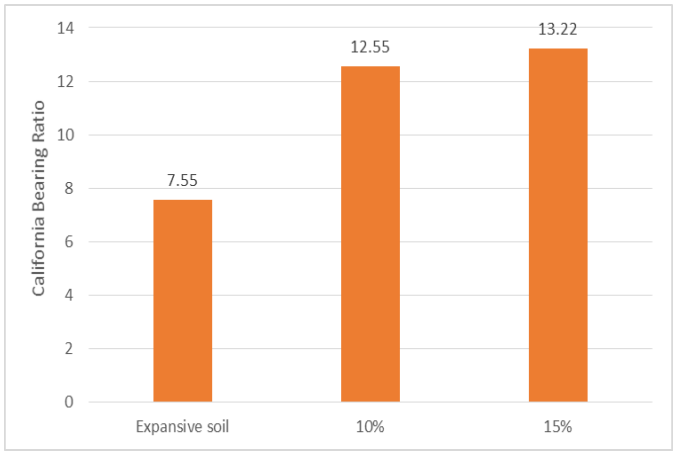

Fig.7.5 Strength of subgrade soil

CBR test is to conduct the strength of sub grade soil. CBR value varies from 7.55 to 13.22 after addition of fly ash.

8. CONCLUSIONS

Liquid limit value of expansive soil is 72% and value of 15% fly ash added with it is 53% and there is 35.84% decrease in liquid limit the soil changes from liquid state to plastic state. OMC value is decreased to 92.3% and dry density value is increased to 13.48%. Soil shows a 60.58% increase in compressive stress, since stress is directly proportional to strain compressive strength of soil increased by addition of fly ash. 42.88% increase in strength of subgrade soil is shown by fly ash addition.

9. REFERENCES

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