Study On Dispersive Soil with Bottom Ash

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Abstract: Due to their increased sodium concentration, dispersive soils are particularly prone to erosion, and when there is moving water nearby, the soil deflocculates. The attractive forces are weaker than the repulsive forces when the system is saturated, which allows the particles to separate and move in suspension. In this experiment, bottom ash has been used to try to stabilize the dispersive soil. First, the compaction properties of four distinct bottom ash-soil combinations (10%, 15%, 20%, and 25%, by dry weight of soil) and the untreated soils were assessed at standard compaction energy. Unconfined compression experiments on untreated soils and four different bottom ash-soil mixtures (10%, 15%, 20%, and 25% by dry weight of soil) were conducted after 3,5,and 7 day curing periods in order to take compaction characteristics into consideration. Unconfined compression tests on a total of four distinct bottom ash-soil combinations were conducted, and the findings showed that increases the bottom ash percentage increases its strength and decreases the dispersitivity.It has been demonstrated that bottom ash can replace other materials used in soil stabilization, having significant positive effects on the economy and the environment.

Key words: Bentonite,Unconfined Compression strength,Bottom ash.

1. Introduction

Due to the existence of dispersive soils, numerous earth dams, hydraulic structures, and other structures like road way embankments have experienced severe erosion issues and failed. Despite the fact that the issue has recently been detected in numerous locations throughout the globe, design innovations and technical preventive measures have not yet been fully created and put into practice. Preventing failures brought on by the dispersibility of the soils has become one of the main concerns of geotechnical engineers due to the scope and magnitude of the problem which might result from the usage of dispersive soil. Reducing the soil's Na+ cation content is the most effective strategy for stabilizing dispersive soils. Various additions have been employed for this purpose, including lime, cement, aluminium, lignosulfate, fly ash, and zeliac . When these kinds of additions are used, the soil's Na+ cation content falls and the behavior of dispersants alters. In order to use dispersive soil for stable construction purposes, the engineering features of the soil can be modified in a way that is both economical and environmentally responsible.

2. Materials and Method

a) Bentonite

Bentonite is an aluminium phyllosilicate clay that is absorbent. It is named after Fort Benton, Wyoming, the location of its principal sources. Bentonite clay is a fine-grained rock composed primarily of montmorillonite minerals. During the creation of bentonite, volcanic ash is modified locally. Pyroclastic debris were ejected into the sky as a result of volcanic activity and settled as silt in a maritime setting. It can be used both orally and topically when combined with water to create a paste. It has long been used as a hair cleaner in some locations, such as Iran. Gtech Constructions in Trivandrum provided the bentonite for this inquiry.

FIG:1 Bentonite soil

The properties of the soil are studied and the results are tabulated in the table: 1

Table:1 Properties Of Bentonite

PROPERTY	VALUES
Specific Gravity	2.6
Maximum dry density (g/cc)	1.6
Optimum Moisture Content (%)	40
Liquid Limit (%)	380

Plastic Limit (%)	50
Plasticity Index (%)	350
% Clay	60
% Silt	30
% Sand	3
Unconfined compressive strength (kPa)	1.12
IS Classification	CH

b) Bottom ash

Bottom ash is a byproduct of combustion found in power plants, boilers, and incinerators. It has long been used to describe coal combustion in industrial settings, which includes flammable residue left on the hot side walls of a coal-burning boiler while it is in operation. The Hindustan News Prints Limited in Kottayam provided the ash at the bottom. The properties of the soil are studied and the results are tabulated in the table: 2

Table 2 Properties Of Bottom ash

PROPERTY	VALUE
Specific Gravity, G	2.24
Percentage of Coarse Particles(%)	8
Percentage of Medium Particles (%)	69
Percentage of Fine Particles (%)	23
Cu	2.5
Cc	0.976

3. METHODOLOGY

This paper explores the possibility of using standard tests such as ,crumb test ,double hydrometer ,liquid limit,plastic limit ,compaction and unconfined compressive strength tests to quantify the dispersivity of the soils .

The crumb test was conducted for the study. The sample was fully submerged in a 300 ml non-porous container that was set down on a horizontal work surface that should be relatively vibration-free for the next 6 hours. The soil dispersion grade was determined and recorded at 2min, 1h, and 6h using the following standards.

Grade 1 (Non dispersive): There is no reaction; The first hour is when all of the particles settle.

Grade 2 (Intermediate): Mild response; this grade is in transition. Near the areas of the soil crumb surface, turbid water is caused by a faint, scarcely perceptible colloidal suspension. Assign grade 3 if the cloud is plainly visible.If only a single little region of the cloud is visible, assign Grade 1

Grade 3 (Dispersive): Moderate response; the surface of the soil crumbs has a visible cloud of suspended clay colloids. The cloud could be up to 10mm away from the mass of dirt crumbs around the dish's bottom.

Grade 4 (Highly dispersive): Profound response; the entire dish's bottom is covered in a dense, profuse cloud of suspended clay colloids.

Result interpretation

The one-hour reading is often utilised for test evaluation overall, unless the dispersive grade altered during the test. Use the 6h reading if the grade shifts from 2 to 3 or from 3 to 4 between the 1h and 6h readings.

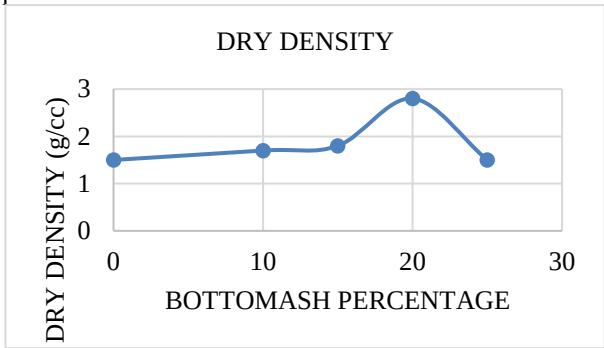
4. RESULT AND DISCUSSIONS

c) Crumb Test(ASTM D6572-12)

Here additives are added with the soil to reduce percentage of dispersion.10%,15%,20%,25% bottom ash are added to the soil as additives .the test results are shown in FIG 2.According to the figure ,the dispersion amount reduced considerably at 20% bottomash and modifies the dispersive soil into nondispersive soil. The best result is obtained with 20% bottom ash content.

FIG:2 Bentonite at different percentage of bottom ash 0 5,10,15,20,25 %

d) Compaction



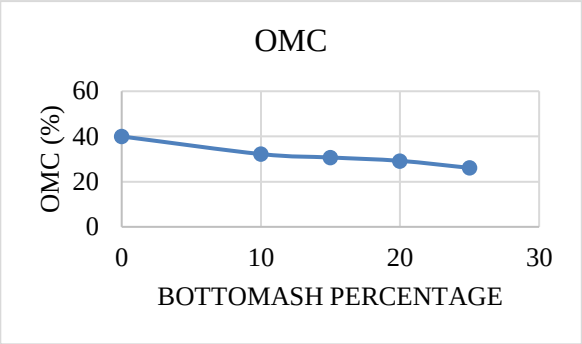


FIG 3:Variation of maximum dry density with bottom ash FIG 4: Variation of optimum moisture content with bottom ash

FIG 3& FIG 4 depicts the results of studies conducted at the standard Proctor test to ascertain the compaction properties utilised in the manufacture of soil specimens with additions. As can be seen, OMC decreases and ranges between 40% and 27.9%, while MDD increases and ranges between 1.6 g/cc and 2.37 g/cc, respectively.

e) Unconfined Compressive Strength

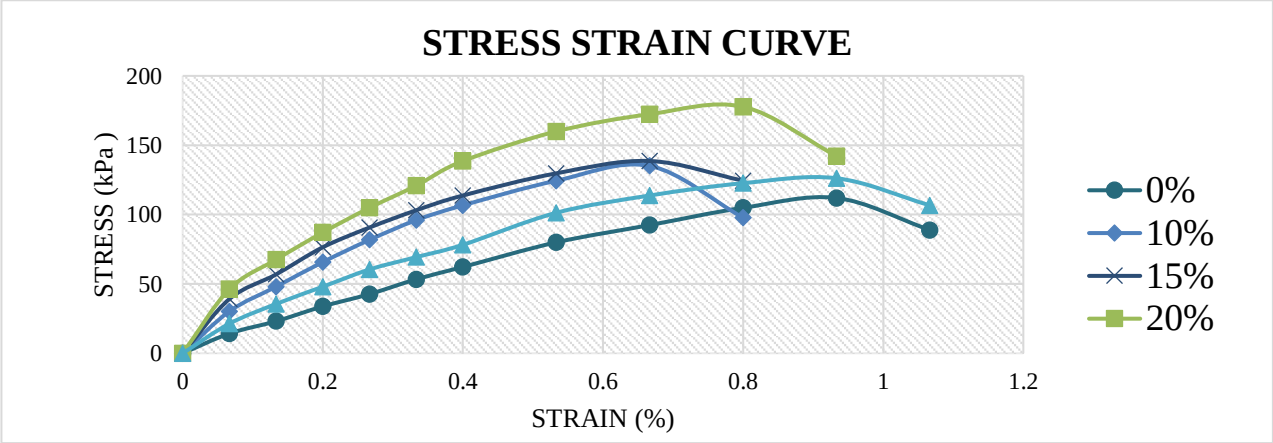


FIG 5:stress –strain curve for the bentonite with bottomash without curing

Results indicate that UCS values increased as curing periods and stabilising agents were increased. For example, for a 3-day curing period, UCS increases from 112 kPa. This significant increase in strength is primarily attributable to the combined effect of bottom ash on the dispersive soil, as a result of the hydration reaction and pozzolanic activity. The UCS is enhanced from 179.49kPa for the 20% mix to 378.4 kPa during 7days of curing periods.

5. Conclusions

i. The percent dispersion decreases with the increase of bottom ash content. It is observed that the flocculation process has improved with the addition of bottom ash which acted as a binding agent. It is clear from the tests that the addition of bottom ash improves the properties of the dispersive soil.

ii. Maximum dry density and optimum water content of soil specimens increase with an increase in bottomash content . The addition of 20% of bottom ash by weight increases the maximum dry unit weight of the bentonite mixture by 29.21%and optimum moisture content of the mixture by 2.8%.

iii. The mixture unconfined compressive values rises as the cure time lengthened. However, the curing period became far more efficient on the compressive strengths of mixtures with bottom ash that have a pozzolanic impact and that are self-cemented.

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