Stabilisation of an Expansive Soil by Using Sea Water and Bagasse Ash

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Abstract— In this study, we have observed the effects of sea water and bagasse ash on expansive soil. The sea water is collected from Arabian sea and soil sample is collected from farm at Mula road. Free swell index test was performed on the soil which concluded that it is a highly expansive soil. Tests that were carried out showed major improvement by adding sea water and bagasse ash. Plasticity index is 15.01% for sea water and bagasse ash. Free swell index is significantly reduced by adding sea water and bagasse ash. There is 10.2% increase in specific gravity of soil. There is rise in MDD and OMC by 5.51% and 37.03% respectively by adding the sea water and bagasse ash. Unconfined compressive strength also increased 37.22%.

Key words: Standard Proctor Compaction Test, Liquid Limit, Free Swell Index

I. INTRODUCTION

Expansive soil means, the soil which have characteristics of shrink and swell under the influence of moisture content. When the content of moisture is high the soil swells and lifts the structure and during low moisture content the soil shrinks and there could be settlement of the structure. In both these scenario it is not good for the structure as it could do damage.

In India almost 20% of soil is expansive soil. So we cannot ignore the fact, there is need for soil stabilization before construction of any structure because of its shrink-swell nature. Soil stabilization can be done by various method. But we have to find out if any of that method is effective as well as economical which can done in short period of time.

In this study we have used sea water which is available in abundance and bagasse ash which is industrial waste and is generated on large scale. So there is need of proper disposal of this industrial waste, if not done, it can lead to pollution and land infertility. There is a possibility we can use bagasse ash as a soil stabilizer which can help us for its proper disposal.

II. METHODOLOGY

The methodology comprises of collection of soil, sea water and bagasse ash from the desired locations. The collected soil, ash and water samples are subjected to laboratory investigations to find their physical properties. All the tests were conducted as per IS codes. Then the experimental investigation part of finding out the various engineering properties is carried out using the ash and sea water sample.

III. EXPERIMENTAL STUDY

The experimental study involves the study of effect of sea water and bagasse ash on the various properties of soil namely specific gravity, free swell index, liquid limit, maximum dry density, optimum moisture content, shear and compression strength.

A. *Properties of Expansive Soil:*

- Highly clayey, blackish in color.
- Plastic and compressible in nature.
- High shrinkage and swelling characterstics.
- Soil is OH (Highly compressible organic soil) as per IS 1498, 1970.

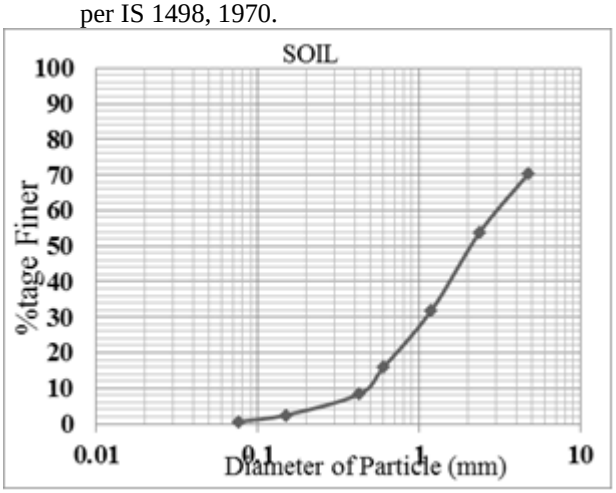

Fig. 1: Sieve analysis of soil.

B. *Properties of Bagasse Ash:*

- Greyish in color.
- Contains high amounts of unburned matter, silicon and aluminum oxides as main components.
- Shrinkage and swelling characteristics is Nil.

Fig. 2: Sieve analysis of bagasse ash.

C. *Characteristics of Sea Water:*

- This observation table is taken from reference paper.

Salt species	Sea water
Sodium carbonate	No traces
Sodium bicarbonate	0.18
Sodium chloride	436.04
Calcium carbonate	0.80
Calcium bicarbonate	1.20

Calcium sulphate	No traces
Magnesium carbonate	0.24
Magnesium bicarbonate	0.15
Magnesium chloride	118.70
Magnesium sulphate	No traces
Potassium carbonate	No traces
Potassium bicarbonate	0.10
Potassium chloride	No traces
Potassium sulphate	No traces

Table 1: Contents of sea water

D. Symbols:

- Various mixture that were used (Percentage by weight)
- These symbols are created for easy understanding.

Description	Symbol
Natural Soil	S
Bagasse Ash	BA
Soil + 1% Bagasse Ash	S + 1%BA
Soil + 2% Bagasse Ash	S + 2%BA
Soil + 3% Bagasse Ash	S + 3%BA
Soil + 4% Bagasse Ash	S + 4%BA
Soil + 5% Bagasse Ash	S + 5%BA
Soil + 6% Bagasse Ash	S + 6%BA

Table 2: Symbols

E. Free Swell Index:

Free swell index test was performed on the expansive soil as per IS 2720 (Part XL) - 1980 by adding sea water and bagasse ash in various percentages. A comparison plot of free swell using the different percentage of bagasse ash is shown in the fig. 3

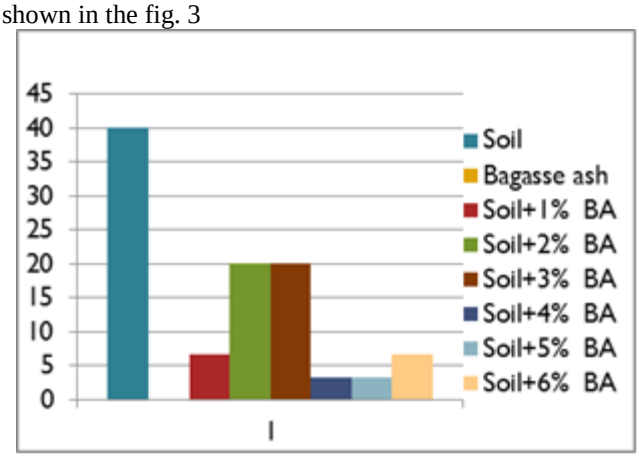

Fig. 3: Combine plot for result of free swell index

From the above plot it is conclude that as percentage of ash increases free swell index decreases it will helps to reduce the overall swell of the expansive soil.

F. Liquid Limit:

Liquid Limit Tests were conducted using sea water and various percentages of bagasse ash. The liquid limit graph is shown in fig. 4. From this it is clearly seen that liquid limit decreases as percentage of Ash increases in sea water and found minimum at 3%

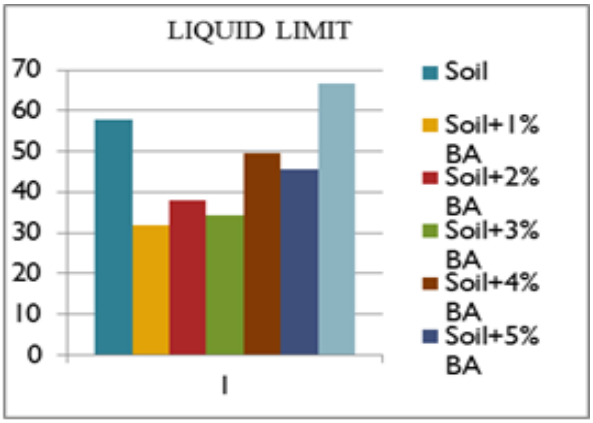

Fig. 4: Combine plot for result of Liquid Limit

G. Standard Proctor Compaction Test:

Standard proctor compaction test is performed to determine the optimum moisture content and maximum dry density for various percentages of bagasse ash.

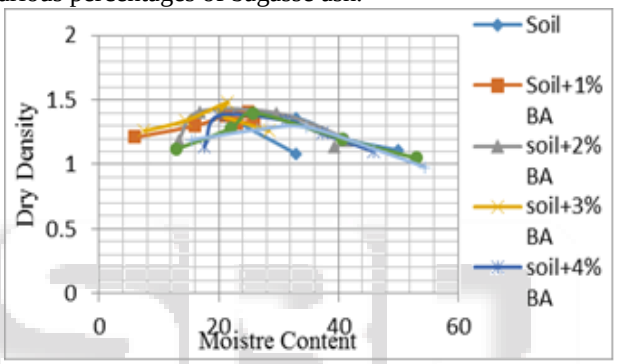

Fig. 5: Combined graph of standard proctor tests.

The procedure is conducted as per IS 2720 (Part 7) – 1980. Combined graph of standard proctor test is shown in fig.

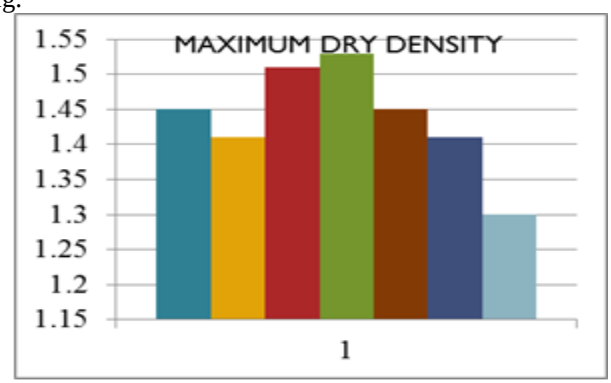

Figure 6 (a):

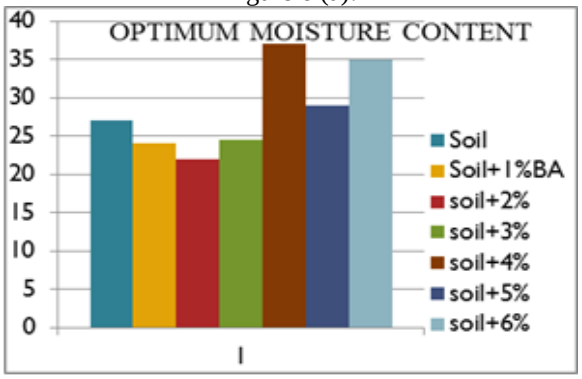

Figure 6 (b):

Figure 6(a) & (b) : Variation of results of MDD & OMC.

From fig 6(a) and (b) it is conclude that we got maximum MDD value at 3% with minimum OMC.

H. Unconfined Compression Test:

The Unconfined Compressive Strength is obtained by Unconfined Compression Test. The test was conducted as per IS 2720 (Part 10) 1991. In this test, various soil sample compacted in cylindrical block are prepared by adding various percentages of bagasse ash in a mould. Axial load is put on these cylindrical blocks and compressive strength is noted. Variation of unconfined compression strength shown in combined graph given below.

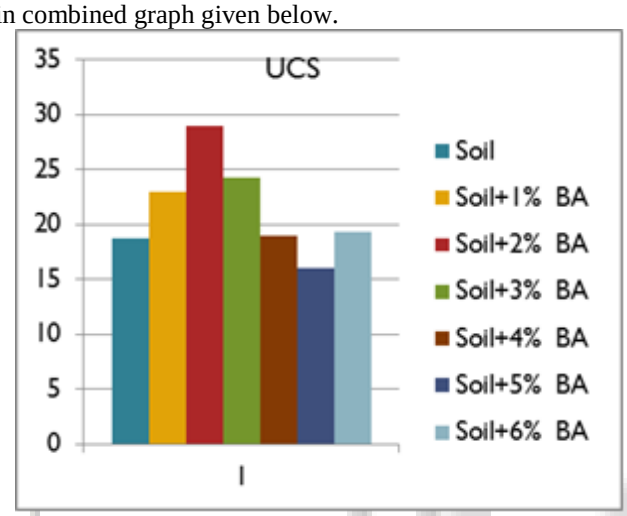

Fig. 7: Variation graph of unconfined compression test

From the variation it is conclude that as percentage of Ash increases in Sea water, increases the unconfined compression strength and found maximum at 3%.

I. Direct Shear Test:

The Direct Shear Test is performed IS 2720, Part 39/sec 1-1977 Reaffirmed 1987 for determining the Bearing Capacity of soil. Shear parameters like 'c' and 'ø' are also be determined by this test for various soil samples having different percentages of bagasse ash. Combined graph is plotted for the direct shear test and from that Cohesion and Internal Angle of Friction is determined.

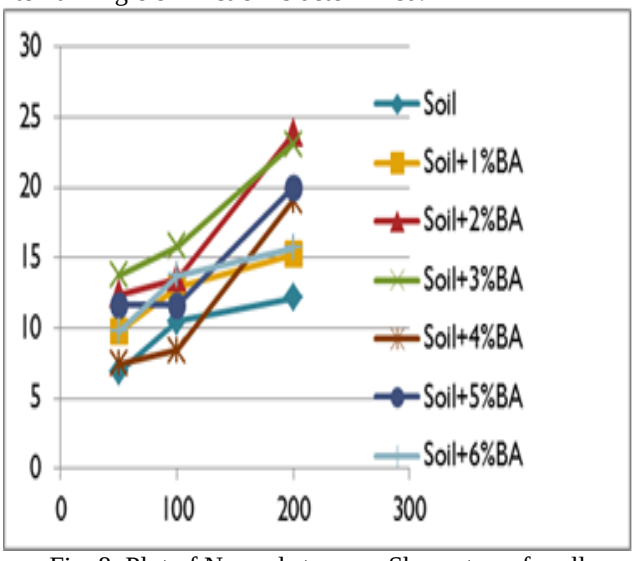

Fig. 8: Plot of Normal stress vs Shear stress for all percentage variation.

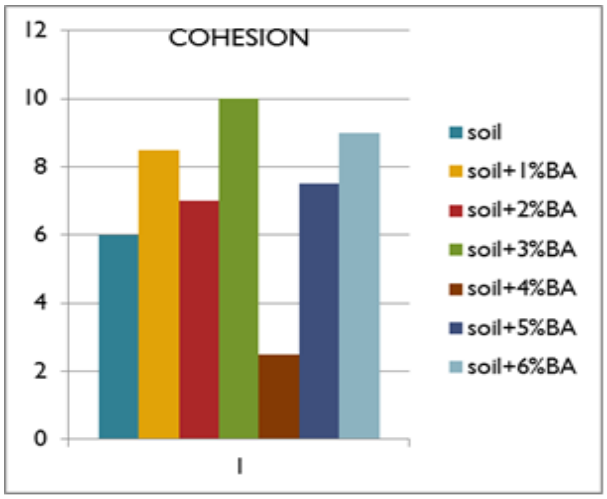

Figure (9a): Variation of Cohesion for all tests

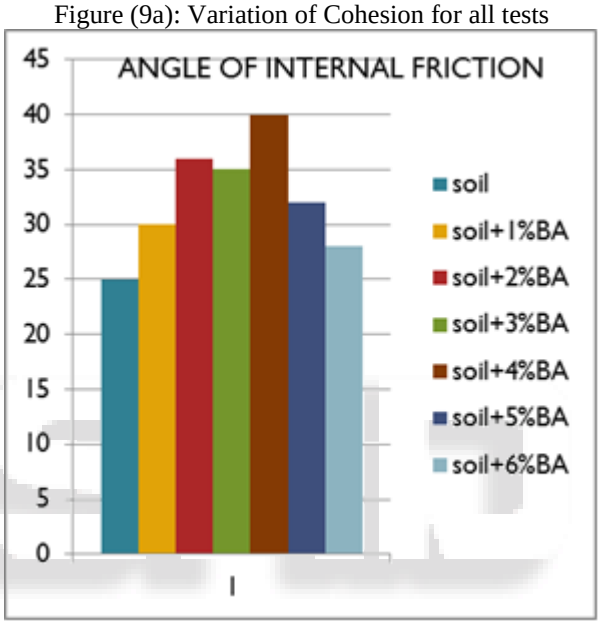

Figure 9(b): Variation of Angle of internal friction for all tests

As the percentage of bagasse ash changes the value of cohesion and angle of internal friction also changes.

IV. Conclusion

Considering the observed values of various test results, we can safely Conclude that there is a variation in the values of properties of soil due to the addition of Sea water and Bagasse Ash.

- Soil is OH and it is converted into CH due to mixing of Bagasse Ash.
- There is no pozzalonic reaction after addition of sea water.
- There is 50% decrease in free swell value of B.C. soil.
- Maximum dry density increases with reduction in optimum moisture content.
- Variation observed in unconfined compression strength and values of cohesion and angle of internal friction.
- From the research work also conclude that it will be a great utilization of waste like Bagasse Ash in construction field.

V. ACKNOWLEDGEMENT

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