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Studies on Environmental Effects of Shear Strength of Soft Soil by Mixing Cement and Bagasse Ash

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Abstract - *Stabilization of soft soil using locally available admixture Ordinary Portland Cement is the most common stabilizer since it is readily available at a reasonable cost and the Bagasse ash, a type of industrial waste product from the sugar industry which can be used as an admixture which will accelerate the reaction of Ordinary Portland Cement. Once they are stabilized, the Influence of salt concentration on treated soil is evaluated in the study. Investigation of this study is carried out by mixing the soft soil with Sodium Chloride [NaCl]of varying concentration 0, 1, 2 & 3% and then stabilized with the ratios such as cement (0, 5, 7.5 & 10%) and bagasse ash in the ratio of (0, 15, 20 & 25%) to the dry weight of the sample. The change in properties of the soft soil can found using laboratory experiments such as index properties, engineering properties, and percentage of Sodium Chloride [NaCl]. The results will indicate the interaction of the admixture added can be studied. Hence the appropriate salt concentration on the treated soft soil can be found.*

***Key Words*: Soft Soil; Bagasse Ash; Ordinary Portland Cement; Sodium Chloride.**

1. INTRODUCTION

Soft soil is defined as soils with a large fraction of fine particles such as silty and clayey soils that have high moisture content, peat foundation, loose sand deposits located near or above the water table (***Kamon and Bergado 1991***). For small particles, the electric force acting on the surface of the particles is much greater than the gravitational force called the colloidal state. The main group of mineral classification is Kaolinite, Illite, Montmorillonite, and Palygorskite. Among these montmorillonites is responsible for expansive soil problems. Absorption of water by clay leads to expansion depends upon the amount of clay mineral, exchangeable ions, the electrolyte content of the aqueous phase, and the initial structure. Clay minerals have the property of sorping certain anion and cation and retain them in an exchangeable state. These take place on the outer structure of the clay mineral and does not affect the structure. Ca^{+}, Mg^{+}, H^{+}, K^{+}, NH_4^{+}, Na^{+} are most frequent cations. Cations are absorbed by anions. The surface of clay predominantly has negative charges which are not permanently attached to the clay hence can be removed. *(**F. H. Chen**).*

Soft soils are characterized as soil with low shear strength, high compressibility, and low permeability. Construction problems in this deposit are insufficient bearing capacity, excessive post-settlement construction, and instability on excavation and embankment forming. Theoretically, the settlement problem can be defined as a deformation in the soil due to the applied stresses. As a result of the settlement, the geometry of the load-carrying system will be changed, and if the groundwater level is high, a part of the fill material will become buoyancy which will influence the total surcharge loading and the stability of the soil (***Mohamad et al 2016***). Soft soils are a well-known category of problematic soils. The lack of bearing capacity, high compressibility, and very longtime consolidation are the typical properties of soft clays. (***Bouassida 2009***).

Generally, soil stabilization is a method of improving soil properties by blending and mixing other materials**.** The improvement includes increasing the dry unit weight, bearing capacities, and volume change. Soil cement can be defined as a mixture of soil and measured the amount of Portland cement and water and compacted to the desired density (***Croft J. B 1967***). The new performance is based on the admixtures which react with the mixing soil. Four main properties of the soil are the strength, permeability, volume stability, and durability test. When water is mixed with cement hydration occurs, means the cementing compound of CSH, CAH is formed and excess calcium hydroxide is released approximately 31% by weight. CSH, CAH- occurs when crystals begin forming a few hours after the cement and water are mixed. Crystals will continue to form if unreacted cement particles and free water remain within the mixture (***Estabragh AR, et al 2013 & Anggraini V et al 2014***). When Sand and highly plastic clay treated with cement shows maximum dry density. When silt soils treated with cement shows a decrease in dry density (**kezhi 1979**). Cement increases, the plastic limit decreases the liquid limit which reduces the plasticity index of the soil (***Deng SP 1997***). Reduction in the shrinkage swelling potential and Increases strength, elastic modulus, and resistance against the effect of moisture, freezing, and thawing is the importance, significance (***Jones LD et al 2012 & Al Revs' AA et al 2012***).

Bagasse ash is a non-plastic material, which can reduce the swelling potential of expansive soil. Bagasse ash has a high silica content (amorphous silica). Reduces the cl diffusion by more than 50 % without negatively affecting the other properties of the hardened concrete *(**Jamsawang et al 2017**)*. Maximum dry density decreases with an increase also

of BA& L due to flocculation and agglomeration of clay particles due to cation exchange leads to the corresponding decrease in dry density (***Sadeeq et al 2015***). The addition of Bagasse ash increased the immediate, early, and delayed strength of lime stabilized the soil. The addition of Bagasse Ash resulted in better utilization of quartz in lime-soil reactions leading to the formation of CSH and CAH minerals (***James et al 2018***). Hydrated lime and bagasse ash improved the strength and bearing capacity of the stabilized expansive soil also significantly reduced the linear shrinkage (***Dang et al 2016***).

Salt act as a soil flocculent. The salt may be spread on the surface or incorporated into the soil by mix-in-place and plant mix methods. Sodium has the opposite effect of salinity on the soils. The primary physical processes associated with high sodium ion are soil dispersion and clay platelet and aggregate swelling. The forces that bind clay particles together are disputed when too many large sodium ions come between, then separation occurs, clay expands causes swelling a soil dispersion *(**Manjunath 2012***). Chloride salt increases the number of coarse soil properties and decreased the total surface area of the soil. Also found that an increase in salt content decreases the plastic limit, liquid limit, plasticity index, OMC, and swelling potential, similarly, there is an increase in UCS, CBR & MDD *(**Abood et al 2007, Swetha 2016, Min Li 2016**)*.

In this study addition of ordinary Portland Cement and Bagasse ash are added in different ratios, to enhance the shear strength of the soft soil. Once the shear strength is achieved, they are treated with Sodium chloride thereby the influence of salt concentration and the breaking point of shear strength for the treated soft soil can be determined.

2. Materials and Methodology

The locally available clay soil was collected from the fields of town Ariyankuppam is one of the communes in Pondicherry district in the Indian territory of Puducherry. The samples were air-dried and sieved through 4.75mm to eliminate gravel fraction. The soil was oven-dried for 24hrs before it was mixed with admixtures. Physical properties of natural soft soil presented in table 1. The Bagasse Ash is collected from the sugarcane industry located at Kanchipuram district, Tamil Nadu. The air-dried Bagasse Ash is passed through 4.25micron sieve.

Table -1: Physical properties of soft soil

Property	Soft soil
Liquid limit(%)	72.48
Plastic limit(%)	32.96
Plasticity index(%)	39.5
Specific gravity	2.73
Clay(%)	70.48
Silt(%)	29.52
Free swell index	60
Optimum moisture content (%)	23.63
Maximum dry density(kN/m³)	17.14
Unconfined compressive strength (kN/m²)	116.98

The study was planned to investigate the index properties, compaction, and compressive strength of soft soil admixed with ordinary Portland cement, Bagasse Ash, and sodium chloride are mixed in different ratios listed in Table 2.

Table -2: Mix Ratios

Identification number	Ordinary Portland cement(%)	Bagasse Ash(%)
1	5	0
2	7.5	0
3	10	0
4	0	15
5	0	20
6	0	25
7	5	15
8	5	20
9	5	25
10	7.5	15
11	7.5	20
12	7.5	25
13	10	15
14	10	20
15	10	25

The liquid limit and plastic limit of the soil sample was determined according to the Indian standards, IS 2720 (Part V) 1970. The shrinkage limit of the soil sample following IS 2720 (Part VI) 1972. The specific gravity of the soil samples was determined using IS: 2720 (Part III) 1980. To determine the shear strength, an unconfined compressive strength of soil sample IS 2720 (Part VIII) 1983 is used. To determine the compaction characteristics followed by Indian standards, IS 2720 (Part VII) 1980. The free swell index of the soil sample determined using IS: 2720 (Part 40) 1977. These are the standards followed for testing the soil sample.

3. Results and discussion

3.1 Effect of admixture on Atterberg's limit

Atterberg limits test with different admixtures were done to determine the effect of stabilizer content on Atterberg limits of the soil. The liquid limit, plastic limit, and shrinkage limit of the treated soil samples are shown in chart 1 initially the liquid limit of the soil specimen is tested further treated with different % of admixtures such as cement, bagasse ash, and NaCl. The liquid limit reduced from 72.48% to 62.67% on addition of 7.5% cement and 25% bagasse ash to the dry weight of the soil sample which is 13.53% reduction. While the plastic limit increased slightly, relatively constant. The

shrinkage limit shows a gradual increase by adding different mix ratios.

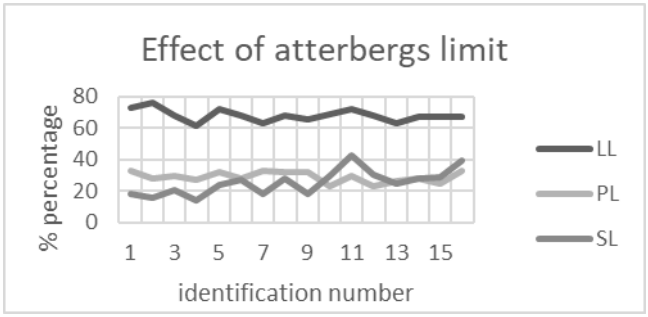

Chart -1: Effect of Atterberg's limit

3.2 Effect of admixtures on compaction parameter

A standard proctor compaction test is done to minimize variation in compaction energy. The results of the compaction test were shown in chart 2. compaction is very pertinent to soil stabilization and maximum dry density obtained through compaction is directly related to the strength of the compacted soil. The maximum dry density increased from 17.14 to 17.43 kN/m^3 on addition of 5% cement and 20% bagasse ash to the dry weight of the soil sample.

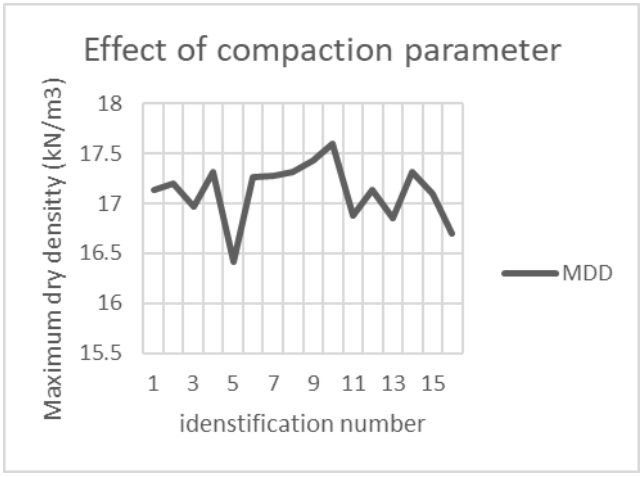

Chart -2 Effect of compaction parameter

3.3 Effect of admixture on unconfined compressive strength

The unconfined compressive strength is used to determine the shear resistance of the soil. The results' unconfined compressive strength was shown in chart 3. The test results show an increase in shear strength by adding different admixtures. The values of the Unconfined Compressive Strength of soil sample vary from 116.98 to 221.26 kN/m^2 with the addition of 10% cement and 20% Bagasse Ash.

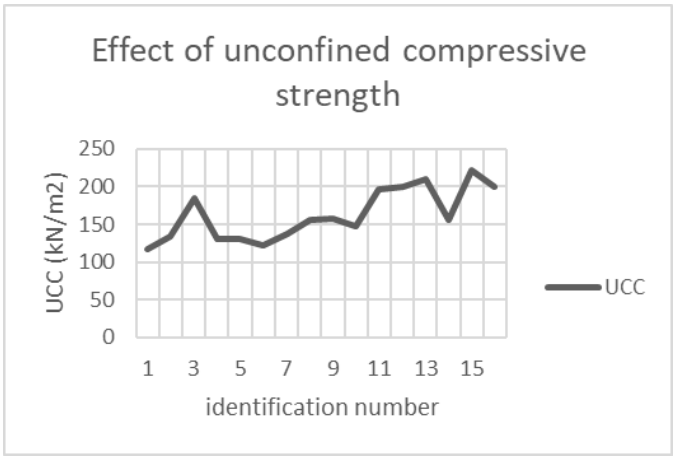

Chart -3 Effect of unconfined compressive strength

4. Conclusion

Soft soil treated with ordinary Portland cement shows a reduction in free swell index and shrinkage limit at 10% addition. Unconfined compressive strength shows an increase in strength property by increasing the percentage of cement addition. Similarly, soft soil treated with Bagasse Ash shows an increase in Maximum Dry Density by increasing the percentage of Bagasse Ash. The combination of ordinary Portland cement and Bagasse Ash shows an increase in shear strength of soft soil and reduction of swelling potential was achieved at 10% ordinary cement and 20% Bagasse Ash addition. Increasing the Bagasse Ash percentage affects the shear strength so, 20% of Bagasse Ash usage tends to be optimum. Again, the soft soil treated with sodium chloride at 1%, 2%, and 3% shows a decrease in unconfined compressive strength with an increase in sodium chloride concentration, reduction in plastic limit is achieved, also reduced the swelling potential. Hence the 10% ordinary Portland cement + 20% Bagasse Ash + 2% sodium chloride is most suitable for stabilizing the soft soil and the influence of salt concentration of treated soft soil should not exceed more than 2% of sodium chloride presence, in case it exceeds the shear strength achieved by adding admixture will tend to decrease so, appropriate addition of admixture is important for improving the soft soil.

REFERENCES

1) Abood, T.T., Kasa Bin Anuar., Chik Bin Zamri.,(2007)," **stabilization of silty clay using chlorine compounds**", Journal of engineering science and technology, vol. 2, no. 1, pp.102-110.

2) Anggraini, V; Huat, BBK; Asadi, A; Nahzanam, H (2014), " **Effect of coir fiber and lime on geotechnical properties of marine clay soil** " 17 Th International congress on environment Geotech, ICEG 2014, Engineers Australia pp.1430.

3) Bouassida, Mounir (2009), "**Improvement of soft clays**", Keynote Lecture, International Seminar of ISSMGE "Ground improvement For Accelerated

Development–Accra (Ghana), 2nd–4th February, pp.147-158.

4) Croft J.B (1967) " **The Influence of soil mineralogical composition on cement stabilization**" Geo technique, vol. 17, no. 02, pp. 119- 135.
5) Dang, Liet Chi., Hasan, Hayder., Fatahi, Behzad., Jones, Robert., Khabbaz, Hadi 2016, "**Enhancing the engineering properties of expansive soil using Bagasse ash and hydrated lime**", International Journal of GEO MATE, vol.11, no.25, pp.2447-2454.
6) Deng, S. P; Tabatabai, M. A, (1997) " **Effect of tillage and residue management on enzyme activities on soils: III phosphates and Aryl sulfatase**", Bio Fertile Soils, vol. 24, no.02, pp. 141-146.
7) F.H. Chan., "**Foundations on Expansive soil**."
8) James, Jijo., Pandian, P Kasinatha 2018, "**Bagasse ash as an auxiliary additive to lime stabilization of an expansive soil: strength and microstructural investigation**", Advances in Civil Engineering.
9) Jamsawang, Pitthaya., Poorahong, Hatairat., Yoobanpot, Naphol., Songpiriyakij, Smith., Jongpradist, Pornkasem 2017, "**Improvement of soft clay with cement and Bagasse ash waste**", Construction and Building Materials, vol.154, pp. 61-71.
10) Kamon, M., and Bergado, D. T., (1991)," **Ground Improvement Techniques**", Proceedings Of the ninth Asian Regional conference of soil mechanics and foundation engineering, Bangkok, Thailand, vol. 2, pp. 526-546.
11) Kezdi, A (1979), " **Stabilized earth roads development in geotechnical engineering**", Elsevier, London.
12) Manjunath. R, Vinay, k.s., varunRaj, N.A., Vibish, P.R., (2012), "**stabilization of lithomargic clay using sodium chloride salt**", Proceedings of International Conference on Advances in Architecture and Civil Engineering, vol. 2, pp.384-386.
13) Sadeeq, JA., Ochepo, J., Salahudeen, AB., Tijjani, ST 2015, "**Effect of Bagasse ash on lime stabilized lateritic soil",** Jordan Journal of Civil Engineering, vol. 159, no. 3091, pp. 1-11.
14) Swarna Swetha kolaventi., Sanjay Gokul venigalla, D. Rakesh., (2016), "stabilization **of black cotton soil using salts and their comparative analysis**", International Journal of Engineering Development and Research