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Comparative Study of Kaolinite Clay stabilized with Cement and Waste Beverage Cans

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Abstract: *Soil stabilization is physical or chemical process which increase the stability of a soil or improve its engineering properties. Waste Beverage Cans (WBC) and Cement used as stabilizing agent to stabilize the kaolinite clay. Aluminium Beverage cans are produced in huge amount. Aluminium cans are the largest sourceof aluminium waste. Aluminium recycling affects its quality. This attempt was a comparative study of kaolinite clay stabilized with cement and WBC. It is a cost effective and eco friendly method. The use of aluminium strips increases tensile strength and engineering properties as a Subgrade. The different percentages of WBC and Cement is mixed with Kaolinite clay in order to observe the changes in the geotechnical properties of thesoil. WBC is cut in to 5 mm strips and mixed with clay. The Compaction, CBR and UCC were conducted on the WBC and cement reinforced soil. The results expecting from this study is a significant enhancement in the soil properties such as maximum dry density, shear strength and CBR value.*

Keywords: WBC, Cement, Kaolinite Clay

I. Introduction

Soils that are expansive in nature are always challenging for the construction of foundations for buildings, bridges and pavements. The poor strength and stability characteristics of such soils have made them of least preference by engineers. However, with massive developments, construction sites with good soil properties are fewer and also construction of pavements might be required to be done on highly cohesive soils which can lead to damage of constructed roads later. There are various stabilization techniques which are commonly used in practice such as physical stabilization, chemical stabilization, biological stabilization, ground improvement etc. to increase the index properties and engineering properties of such soils. Here we reinforce the Kaolin clay (Calcined Clay) soil using waste aluminium cans, thereby improving its swelling potential, compaction characteristics and CBR value. WBC were cut into 5mm strips and were mixed into the soil in 2, 4, 6 and 8% by dry weight. Cement is mixed in to the clay as 2.5, 5, 7.5, 9, 12.5%. The compaction test, UCS test, CBR test were carried out on the cement, aluminium strips reinforced soil. This comparative study shows an eco-friendly and effective method of disposing aluminium cans which are highly threatening to the environment. The clay stabilized with WBC improve the life of pavements when used as subgrade. Kaolinite is a clay mineral, with the chemical composition $Al_2Si_2O_5(OH)_4$. It is an important industrial mineral. It isa layered silicate mineral, with one tetrahedral sheet of silica (SiO_4) linked through oxygen atoms to one octahedral sheet of alumina (AlO_6) octahedra. Rocks that are rich in kaolinite are known as kaolin or china clay. Kaolinite has a low shrink–swell capacity and a low cation-exchange capacity (1–15 meq/100 g). It is a soft, earthy, usually white, mineral (dioctahedral phyllosilicate clay), produced by the chemical weathering of aluminium silicate minerals like feldspar. In many parts of the world it is colored pink-orange-red by iron oxide, giving it a distinct rust hue. Lower concentrations yield white, yellow, or light orange colors. Alternating layers are sometimes found, as at Providence Canyon State Park in Georgia, United States. Commercial grades of kaolin are supplied and transported as dry powder, semi-dry noodle, or liquid slurry. Kaolin is pure clay mineral, having a fired chemistry of 1 molar part Al_2O_3 and 2 parts SiO_2. But the raw clay crystals are hydrated, having 12% crystal-bound water. This is the secret to their plasticity.

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II. Materials Used

2.1 Kaolinite Clay

Kaolinite is a clay mineral, with the chemical composition $Al_2Si_2O_5(OH)_4$. It is an important industrial mineral. It is layered silicate mineral, with one tetrahedral sheet of silica linked through oxygen atoms to one octahedral sheet of alumina octahedra. Here we are taking Calcined clay, or metakaolin from Travancore Clays and Minerals Vanjiyoor, Tvpm. It is produced by heating a source of kaolinite to between 650°C and 750°C. Kaolin is both naturally occurring, as in china clay deposits and some tropical soils, as well as in industrial by-products, such as some paper sludge waste and oil sands tailings.

Table 1: Basic Properties of Kaolinite Clayey soil

Sl No	Properties	Values
1	Liquid Limit(LL)	59.52%
2	Plastic Limit(PL)	21.73%
3	Plasticity Index(PI)	57.33%
4	Specific Gravity	2.3
5	Optimum Moisture Content(OMC)	33.25%
6	Maximum Dry Density(MDD)	1.35g/cc
7	California Bearing Ratio(CBR)	3.15%
8	Unconfined Compression Strength(UCS)	0.204kg/cm^2
9	Soil Classification	OH

2.2 Cement

A Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource. Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as non-hydraulic or hydraulic respectively, depending on the ability of the cement to set in the presence of water.

2.3 Waste Beverage Cans (WBC)

Waste aluminium cans are very light in weight, having a specific gravity of 2.7 (g/cm3) and 0 % water absorption. Aluminium beverage cans are manufactured and utilized in a large scale. Moreover, aluminium cans are resistant to corrosion. The properties of aluminium strips used in the study are uniform and are uniformly distributed in soil. Adding the aluminium stripsin soil improves the soil properties, provides a safer method of waste disposal, economical and also provides a clean environment. The length of the WBC fiber/strips used in the study was approximately 5 cm with aspect ratio 15-20. Mixing them in certain percentage with kaolinite clayey soil may improves soil properties like its density, strength, swelling and unconfined compressive strength and also making sure that the environment is safer and cleaner. Waste beverage cans (WBC) were mixed randomly with soil in 2, 4, 6, 8 and 10% (dry weight of soil) before use.

III. Experimental Work

3.1 Preparation of Sample

This work presents a comparison of the effect of Waste beverage Cans as strips and cement on strength properties of kaolinite clay. The Varying percentage of samples were prepared with the mixture of kaolinite clay and addition of 2%, 4%, 6%, 8%, 10% of WBC on the basis of dry weight of clayey soil. Proper care was taken while mixing to get the homogeneous samples. Then again prepare samples of kaolinite clay with addition of 2.5%, 5%, 7.5%, 10% and 12.5% of cement on the basis of dry weight of clay. The OMC, MDD, UCC and CBR value of different samples containing varying percentage of WBC and cement were determined.

3.2 Compaction Test

The modified proctor test was conducted as per IS 2720 (Part7) -1983. The soil was taken and various percentage of WBC were added. The appropriate quantity of water is added, WBC and kaolinite clay mixture was compacted in mould in 3 layers by modified proctor hammer of 2.6 kg. Again the soil was taken and various percentage of cement is added with the clay, appropriate amount of water is added. Cement and kaolinite clay mixture was compacted in mould for 3 layers by a hammer of weight 2.6 kg. The MDD and OMC for different samples were determined.

3.3 California Bearing Ratio (CBR)

The CBR test was performed as per IS 2720 (Part16). The samples were prepared in a cylindrical mould of 150 mm diameter and 175 mm height. Samples were made such a way that the soil with (2, 4, 6, 8, 10%) WBC and (2.5, 5, 7.5, 10, 12.5%) Cement. All the experiments were executed at a penetration rate of 2.5 mm was obtained.

3.4 Unconfined Compression Test

The UCS test were executed for different percentage of WBC and Cement as per IS 2720 (Part 10)-1991. A cylindrical clayey sample is prepared. Use a strain rate of 0.5-1.0 percent per minute. Apply the load until failure planes have definitely developed.

IV. Results And Discussions

According to experimental program, Compaction, CBR and UCS were performed on kaolinite clay with different percentage of WBC and Cement. The effect of OMC-MDD relationship, UCS and CBR values were considered. The outcomes are presented below.

Table 2: OMC-MDD, CBR and UCS value of kaolinite clay with varying percentage of WBC

Soil + (%)WBC	Maximum Dry Density (g/cc)	Optimum Moisture Content (%)	CBR (%)	UCS (kg/cm^2)
Soil + 0% WBC	1.35	33.24	3.10	0.204
Soil + 2% WBC	1.38	31.62	4.32	0.212
Soil + 4% WBC	1.41	31.27	6.29	0.258
Soil + 6% WBC	1.45	30.85	8.37	0.279
Soil + 8% WBC	1.62	29.41	9.45	0.295
Soil + 10% WBC	1.78	27.69	10.94	0.323

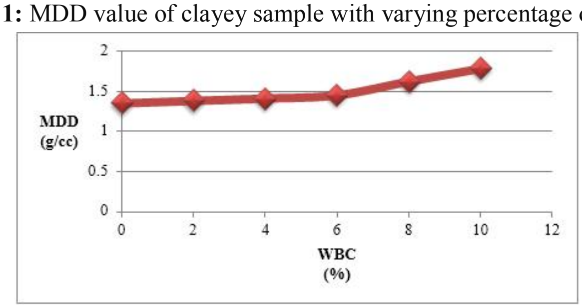
Table 3: OMC-MDD, CBR and UCS value of kaolinite clay with varying percentage of Cement

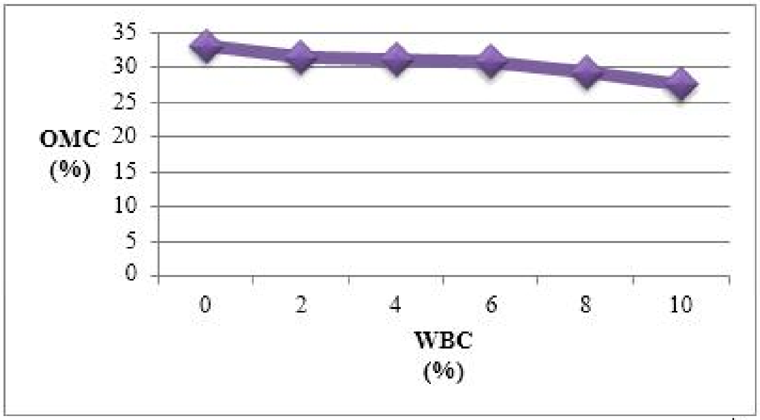
Soil + (%)Cement	Maximum Dry Density (g/cc)	Optimum Moisture Content (%)	CBR (%)	UCS (kg/cm^2)
Soil + 0% Cement	1.35	33.24	3.10	0.204
Soil + 2.5% Cement	1.31	37.57	5.23	0.250
Soil + 5% Cement	1.28	38.76	7.82	0.314
Soil + 7.5% Cement	1.24	40.01	8.51	0.385
Soil + 10% Cement	1.18	43.49	10.87	0.462
Soil + 12.5% Cement	1.20	41.86	9.82	0.531

4.1 Compaction Test with WBC

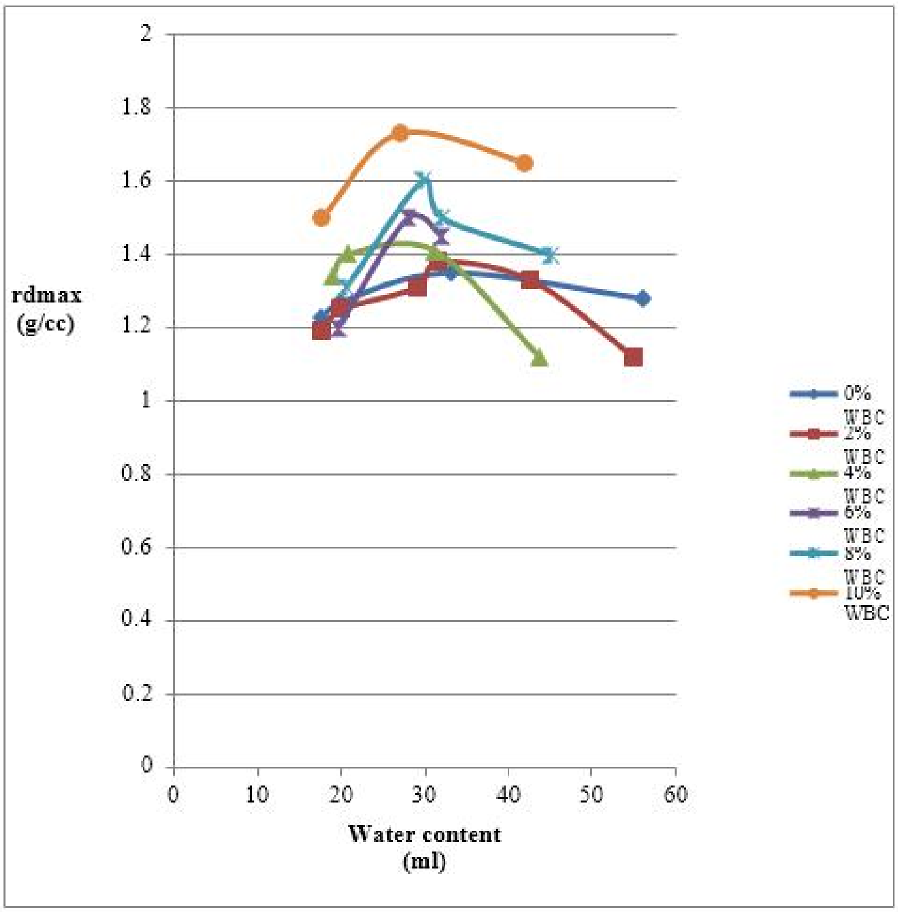
It was observed that Table 2 indicates, with the addition of WBC- the MDD increased. OMC decreases for increasing the WBC content. The sample containing 10 % WBC gives the maximum value of MDD and minimum value of OMC.

Graph 1: MDD value of clayey sample with varying percentage of WBC.





Graph 2: OMC value of clayey sample with varying percentage of WBC



Graph 3: Compaction Curve of clayey soil with different percentage of WBC

4.2 Compaction Test with Cement

It was observed that Table 3 indicates, with the addition of Cement- the OMC increased and then decreases. MDD decreases for increasing the Cement content and then increases. The sample containing 10% Cement gives the maximum value of OMC and minimum value of MDD.

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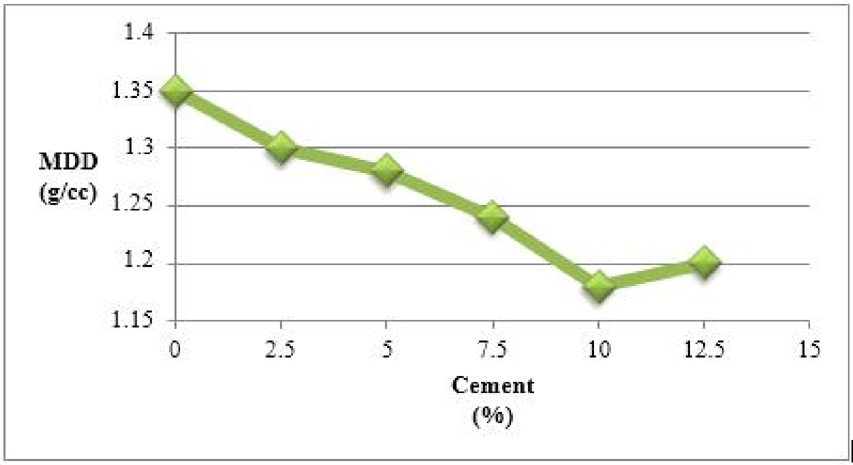
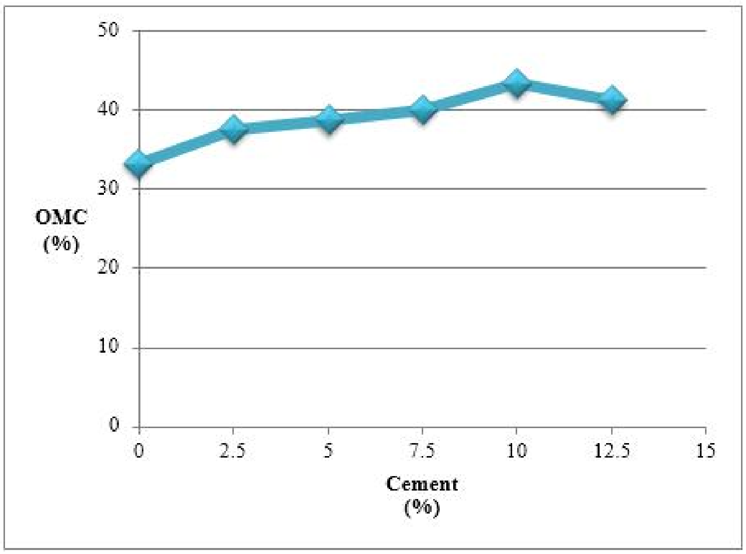
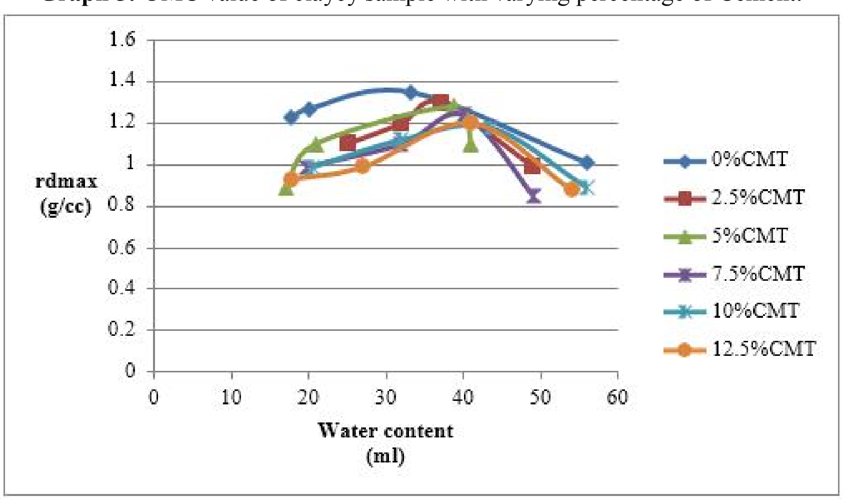


Graph 4: MDD value of clayey sample with varying percentage of Cement.



Graph 5: OMC value of clayey sample with varying percentage of Cement.



Graph 6: Compaction Curve of Clayey Soil with different percentage of Cement.

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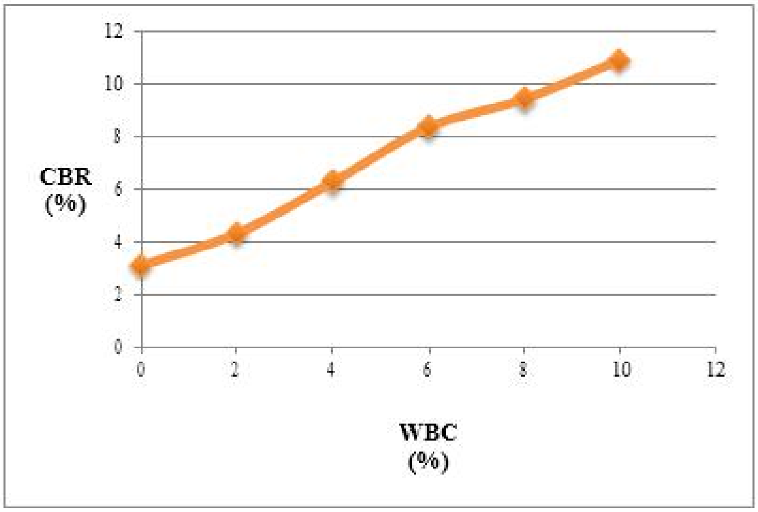
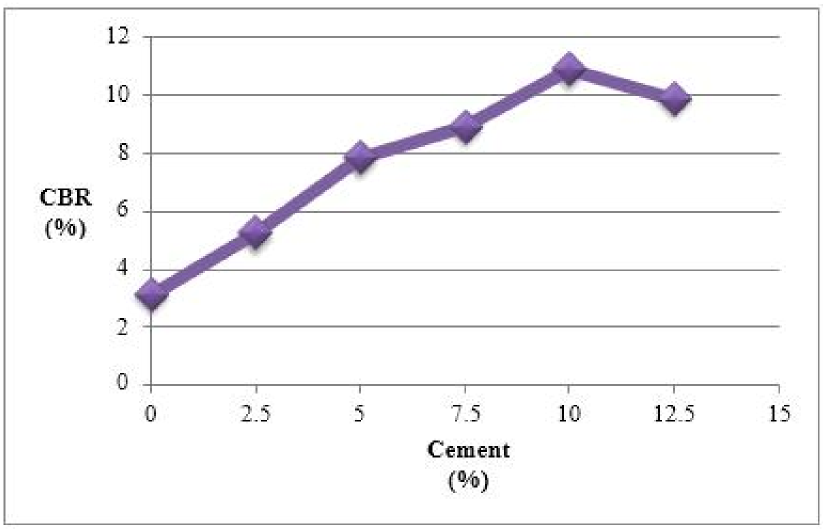
4.3 California Bearing Ratio (CBR)

The results of CBR test indicated that the CBR value continuously increased upon the addition of WBC and Cement. For WBC, the maximum value of CBR is 10.94%, and that of Cement is 10.87%.



Graph 7: CBR value of clayey sample with varying percentage of WBC.



Graph 8: CBR value of clayey sample with varying percentage of Cement.

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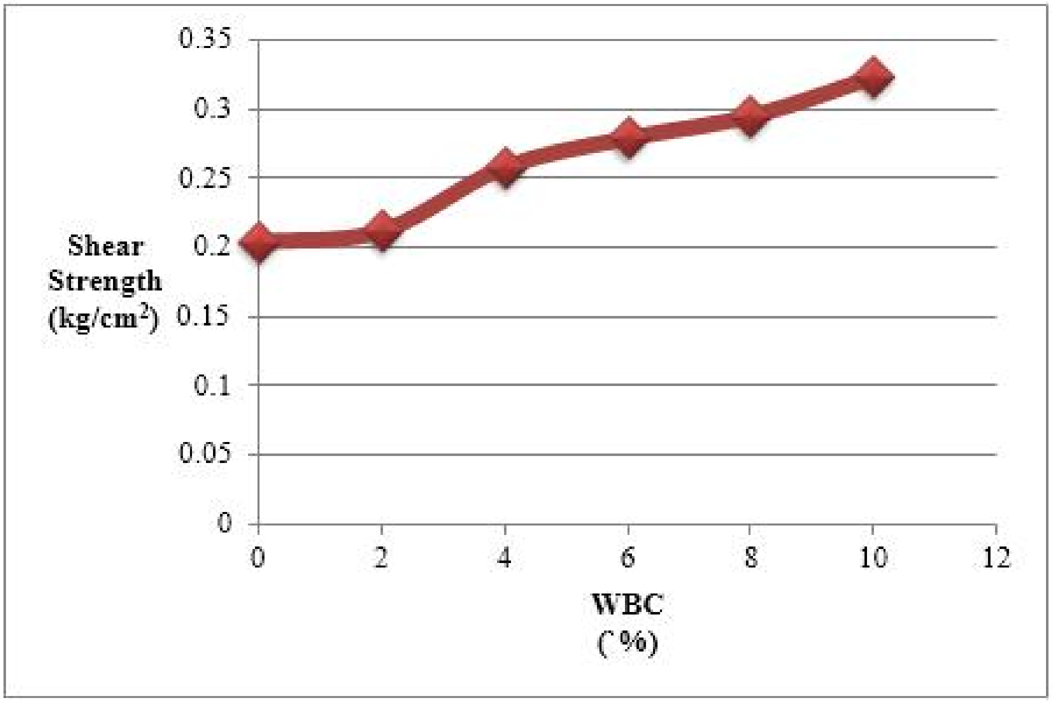
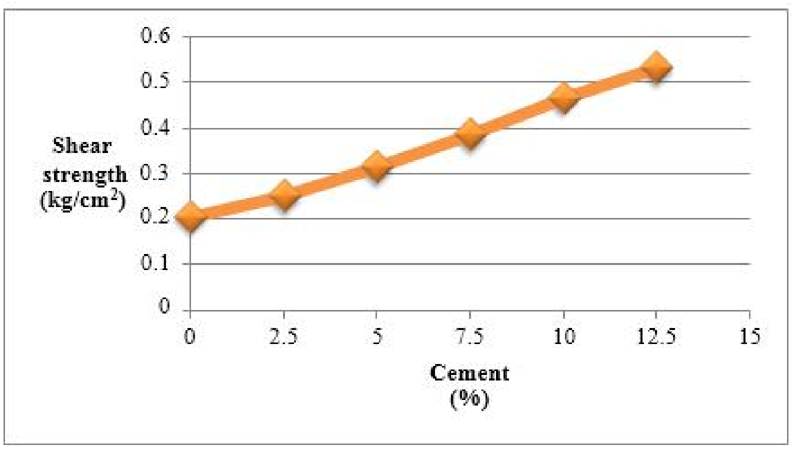
4.4 Unconfined Compression Test

It is observed that, the UCS value increased by the addition of WBC and Cement. Kaolinite is a poor shear strength clay, by the addition of WBC and Cement its shear strength increased.



Graph 9: Shear strength vls percentage of WBC.



Graph 10: Shear strength v/s various percentage of Cement.

V. Conclusion

For the Stabilization of Kaolinite Clay, the Optimum percentage of WBC was found to be 10%. In WBC- Kaolinite Clay Stabilization, the Maximum dry density increased from 1.35 g/cc to 1.78 g/cc while the value of OMC decrease from 33.24 to 27.69%. The CBR value increased from 3.10 to 10.94%. The UCS value increased from 0.204 to 0.323 kg/cm2.

The Optimum percentage of Cement for the stabilization of kaolinite clay is 10%. For Cement- Kaolinite Stabilization the Maximum dry density decreased from 1.35 to 1.18 g/cc and then increases, while the OMC increases from 33.24 to 41.86 %. The CBR value increased from 3.10 to 9.87% and then decreases. The UCS value increased from 0.204 to 0.531 kg/cm2.

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References

[1]. Gheris, A., Hamrouni, A, "Treatment of an expansive soil using vegetable (DISS) fibre". Innov. Infrastruct.Solut.5,30 (2020).

[2]. D. Gardete, R. Luzia, M. Sousa (2019), "Soil stabilization with waste plastic and waste tyre fibres", Proceedings of the XVII ECSMGE- 2019 Geotechnical Engineering foundation of the future.

[3]. Hanifi Canakci, Effect of waste beverage can pieces on the CBR value of expansive soil, WMCAUS 2016.

[4]. Mahasneh, Assessment of using Cement, Dead Sea Sand and Oil Shale in Treating Soft Clay Soil,European Journal of Scientific Research, 2015, 128(4):245-255

[5]. A.K.Agarwal, V.Rajurkar, P.Mokadam (2015), "Effect of waste synthetic bag pieces on the CBR value of expansive soil", Journal of Materials and Engineering Structures, pp. 26-32.

[6]. H. Bairagi, R. Yadav, R. Jain, Effect of Jute Fibers on Engineering characteristics of Black Cotton Soil, Ratio, 15, 20 International Journal of Engineering Science and Research Technology,2014,ISSN:2277-9655.

[7]. G.S. Utami, Clay soil stabilization with lime effect the value CBR and swelling, ARPN Journal of Engineering and Applied Sciences, 2014, 9(10):17441748.

[8]. Sabat A.K. (2012): "A Study on Some Geotechnical Properties of Lime Stabilized Expansive Soil" International Journal of Emerging trends in Engineering and Development. (ISSN 2249-6149), Vol.1. pp 42-49, Issue 2012

[9]. IS: 2720 (Part-5)-1985 Determination of liquid limit and plastic limit, Bureau of Indian Standard.

[10]. IS 2720 (Part-7)1980 Determination of Compaction parameters, Bureau of Indian Standard.

[11]. IS: 2720 (Part-16)1987 Laboratory determination of CBR, Bureau of Indian Standard