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Reducing the Swelling Pressure Black Cotton Soil Using Aluminium Scrap

Sangram Keshari Sethy[1] , Kirti Sahu Tirpude[2]
M.Tech Student[1] , Assistant Professor[2]
Mail Id :- kirti.Sahu@kalingauniversity.ac.in[2]
Department of Civil Engineering , Kalinga University Naya Raipur(C.G)

ABSTRACT
In this world of rapid infrastructure growth its obvious to explore new possibilities via research work, most of the Indian regions are covered with black cotton soil specially in Deccan trap region which include Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh & Tamil Nadu. It has been observed that black cotton soil swell easily when come to contact with water and further shrink when water evaporates because of some chemical minerals present in this, Hence its always challenging to construct structures and pavements in this type of soil. However there are various techniques are being introduced to stabilize the soil behaviour under the heavy loads but most of the time it is uneconomical and time consuming. In this present research work introducing Aluminium Scrap which is by product of industries being used by various companies are easily available in reasonable cost. In this present work adding Aluminium Scrap by 5%, 10% & 15% with black cotton soil as a layer in order to reduce the swell pressure in soil. With the addition of Aluminium scrap, it also reduces the soil permeability hence reducing the swelling pressure and increasing the soil bearing capacity. To know the optimum dosage of scrap into the black cotton soil test and experiments need to be performed in laboratory.

Keywords: Aluminium Scrap, Black Cotton Soil; Swelling Pressure, Soil Stabilization.

INTRODUCTION

1.1 General

A pavement is a durable surface having materials laid down on an area subjected to sustain mainly the vehicular traffic, such as a road or highway. A pavement is typically a structure of various layers resting over soil either in embankment or in cutting. In the past, cobblestones and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete now-a-days.

A pavement is classified in general in two categories, i.e., namely a flexible pavement and a rigid pavement. The flexible pavement consists of granular layers of superior quality in upper layers with a preferably bituminous topping, while a concrete pavement consists of a cement concrete slab over occasional granular layers. The design of pavement has seen several modifications over the years. Traditionally the design of either kind of pavement is based on the strength of the compacted soil in the pavement, called subgrade. The design of the pavement layers laid over the subgrade soil starts off with the determination of subgrade strength and the traffic volume which is to be carried. The design of pavement is very much dependent on the subgrade strength of soil. Design criteria mainly needs thickness of layers.

Weaker subgrade needs thicker layers whereas stronger subgrade needs thinner pavement layers. The Indian Road Congress (IRC) provides the exact procedures for the pavement layers design which based upon the subgrade strength. The strength of a subgrade soil is normally expressed in terms of the California Bearing Ratio (CBR).

Due to variable nature of soil, the subgrade strength changes inconsistently, as a result engineers face so many difficulties or challenges during the design of a pavement. The sub grade strength is very much dependent on moisture content.
As the sub-grade is intended to variation of 12 moisture due to flood, precipitations or all other climatic changes, so it is necessary to enable or understand the sub-grade according to the variation of moisture. The CBR is the only test which can figure out the strength of a sub-grade. By this test we can compare the strength of different sub grade materials. The CBR test is done in a standard manner by which one can find out or design the strength or thickness of sub grade layer. CBR value is inversely proportional to thickness of the pavement layer. If the sub grade is stronger, the higher is the CBR value, so lesser thickness is required and vice-versa.

1.2 Objective of the study

This study was an attempt to reduce the swelling pressure. Black cotton (BC) soil is a problematic soil, as it is expansive in nature. The swelling and shrinking characteristics in Black Cotton (BC) soil is imparted due to the presence of the mineral component montmorillonite. It is predominantly clay, black in colour with a smooth texture. Construction over this soil type is always challenging due to its low strength and less drainage property. This soil type is always a threat to the strength and stability of pavements and highway.

1.3 Scope of the study

- Future scope of the work This investigation was done on Black cotton soil reinforced with aluminium, strips. The further study can include incorporation of a suitable admixture like lime, flyash, marble dust etc. along with the aluminium strips.
- Design of a suitable flexible pavement based on the improved CBR value. Study on the effect of length of aluminium strips on soil properties.
- Investigation of permeability and consolidation characteristics of the aluminium strip reinforced black cotton soil.

LITERATURE REVIEW

2.1 GENRAL

In this part we have talked about the decreasing the swelling potential of black cotton soil and objective fact so the diverse creators by utilizing the diverse materials by literature review.

2.2 Literature Review

- Many industrialized countries have massive sources of waste materials such as fly ash, tire rubber, and different types of metal scrap. Instead of being disposed of in landfills, such wastes can have some applications in geotechnical engineering.
- Some of the earlier studies have given an insight into this experimental work to use aluminium cans as reinforcement.

1. D. Gardete, R. Luzia, M. Sousa (2019), evaluated the effect of plastic waste and tyre fibres on stabilization of clayey sand soil. Results show a decrease in the relative compaction with increasing waste content. Presence of plastic waste increased CBR value of the soil by more than 20%. Optimum waste plastic flakes content was 1%. CBR values decreased for higher contents. CBR values decreased with waste tyre fibre addition.

2. Veerubhotla Seshasai, M. Ramakrishna et al. (2016), studied the impact of polyester fibres on properties of expansive black cotton soil. After the stabilization with polypropylene fibers the density is increased gradually upto 3%, after 3% the dry density is decreased. The CBR value increased to 2.5.
3. Ajay Kumar Agarwal, Vaishali Rajurkar and Prerna Mokadam (2015) revealed the impact of synthetic waste cover pieces on the CBR value of expansive soil. Synthetic waste cover pieces of size 2 cm*2 cm were used at a proportion of 0.1% in the study. The CBR value obtained was 23.82% as maximum.
4. Stabilization of soil using waste fibres was done by Satyam Tiwari et al, in 2016, They had found that inclusion of fibres had increased the specific gravity of the soil, thereby enhancing the soil strength. The shrinkage potential of soil was found to be less due to the presence of polypropelene fibres. Effect of aluminium waste on the expansive soil was studied by B.Z. Mahasneh. He found that the aluminium waste and recycled asphalt when added to a silty clay soil has increased the bearing capacity and dry density of the soil after giving proper compaction.

5. Effect of GGBS (Granulated blast furnace slag) on the geotechnical behaviour of stabilized soft soils was studied by Laxmikant Yadu and R K Tripathi and they evaluated that optimum dosage of 9% of the slag gave 28% higher unconfined compressive strength value and has also improved the CBR value.
6. Mohammed Rosli Hainin, studied the benefits of using steel slag in the design of asphalt-based concrete for the construction of rigid pavements. The engineering properties of steel slag was reviewed in this paper. The utilization of this in road construction was also discussed. But it is quite expensive when used for rural roads.
7. Anzar Hamid and Huda Shafiq , studied the subgrade soil stabilization using jute fibres which are used as a reinforcing material. With the inclusion of jute fibres, the CBR value of soil was found to increase. A dosage of 0.75% of this natural fibre has given a tremendous improvement in the CBR value. The increase in length of fibre contributed to the increase in CBR value of soil. Compared to plain soil, California Bearing Ratio value of reinforced soil with fibre content of 0.75% was found to be greater than 200%.

MATERIAL & METHODOLOGY

3.1 GENERAL

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 construction of pavements might be required to be done on highly cohesive soils which can lead to damage of constructed roads later.

3.2 MATERIAL USED

SOIL: Soil Technically, the soil is a mixture that contains minerals, organic matter, and living organisms. But broadly speaking, soil can refer to any loose sediment.

Moreover, there are many types of soil that are distributed around the world and these are generally classified into the following.

1. Sandy Soil 2. Silt soil 3. Clay Soil 4. Loamy Soil

Aluminium scrap: Aluminium scrap has a complex chemical composition based on aluminium (> 90%). Magnesium, zinc, silicon, iron, etc., are the main impurities.

The sum of impurities for scrap aluminium materials “Pb+Cd+Hg (Lead +Cadmium + Mercury) should not exceed 300 ppm (%0,03).

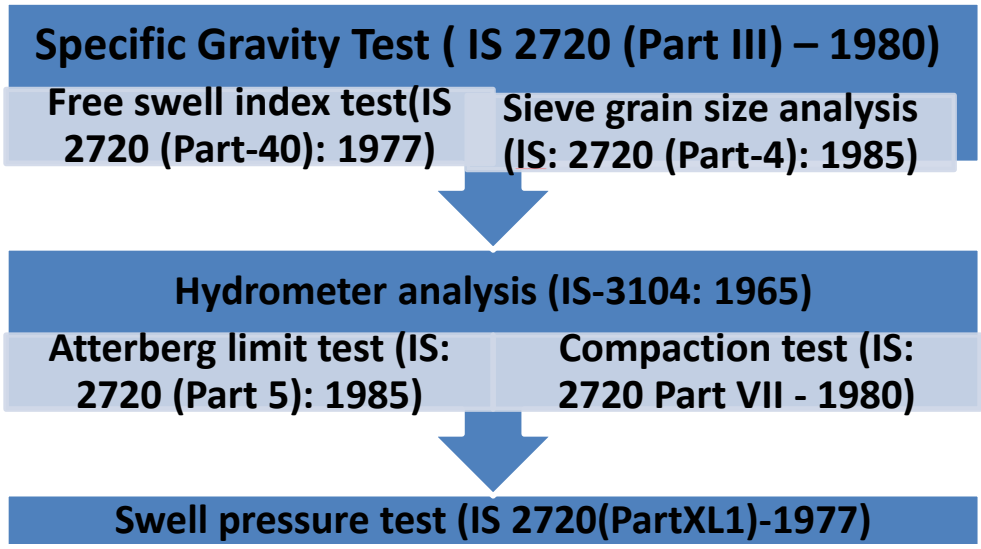
Vanadium content should not exceed 100 ppm (%0,01). Titanium content should not exceed 100 ppm (%0,01).

ELEMENT	PERCENTAGE COMPOSITION
Mg	0.018
Si	0.4617
Mn	0.2504
Be	0.134
Fe	0.00002
Cu	0.014
Al	99.12218

Chemical Composition of Aluminium Scrap

Aluminium Scrap

- In order to know the soil behaviour and their index properties by using aluminium scrap in black cotton soil, we will perform various laboratory test names are as following:



RESULT AND DISCUSSION

4.1 General

- The following chapter covers the results of the testing packages. The effects that are presented include soil homes admixture percentages and the diverse checking out effects for the soil additive combinations

1. **SPECIFIC GRAVITY TEST**

- The specific gravity (GS) of a soil refers to the ratio of the solid particles' unit weight to the unit weight of water.

Specific gravity = W2-W1/ (W3-W4)-(W2-W1)Specific gravity of soil=2.65

S.No	PARTICULARS	WEIGHT (Grams)
1	Weight of pycnometer(W1)	470
2	Weight of pycnometer + samle(W2)	670.5
3	Weight of pycnometer + samle+water(W3)	1389
4	Weight of pycnometer +water(W4)	1264

Table 4.1 Specific gravity of soil

4.2 INDEX PROPERTIES OF SOIL-As per IS:2720(PART-5)-1985

Soil Type	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX

Parent Soil	58	28	30

Table 4.2 Index Property of soil

FREE SWELL INDEX : Free swell index dedication of soil enables to identify the capacity of a soil to swell which might want similarly designated research regarding swelling and swelling pressures underneath distinctive subject conditions

- **PERCENTAGE OF FREE SWELL INDEX= 44 %**

4.4 PROCTOR COMPACTION TEST

- The Proctor compaction take a look at is a laboratory technique of experimentally determining the foremost moisture content at which a given soil kind will become densest and acquire its most dry density
- IS heavy compaction take a look at accomplished on clayey subgrade soil mixed with lime are supplied here in table

sample no.	max dry density	water content(%)
1	1.698	12.2
2	1.745	14
3	1.775	16.4
4	1.723	18.5
5	1.656	20.2

Table 4.3 MDD and OMC value of clay

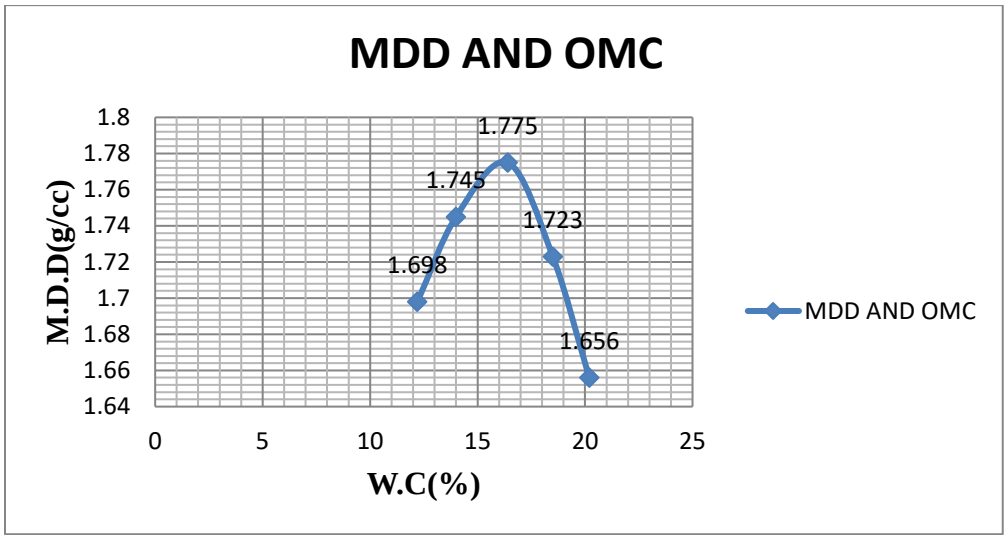


Fig.4.1 Variation in MDD and OMC with different water content

Maximum dry density of soil =1.775g/cc

Optimum moisture content of soil=16.4

- **Swelling pressure value of pure black cotton soil:**

TIME IN MIN.	PRESSURE (N/mm)
0	0
1	0.01566
2	0.047
4	0.0783
8	0.36
16	0.6737
30	1.0184
60	1.4571
90	1.66
120	1.87
1260	3.384
1440	3.4

Table 4.5 Swelling pressure on clay+5% Al scrap

- **Swelling pressure variation with time:**

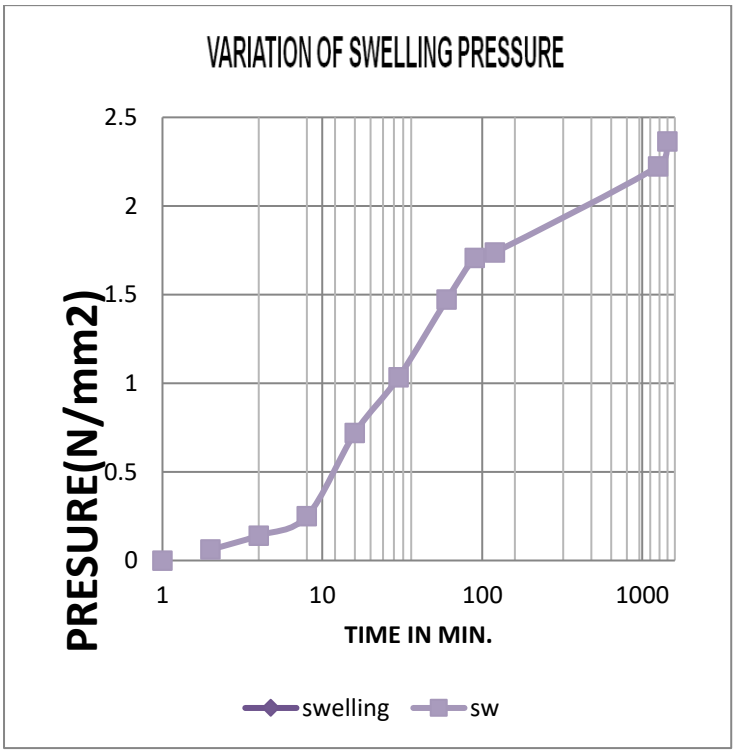


Fig.4.3 Graph between time and pressure (clay+5%AL scrap)

- **COMPARISON OF SWELLING PRESSURE VARIATION**

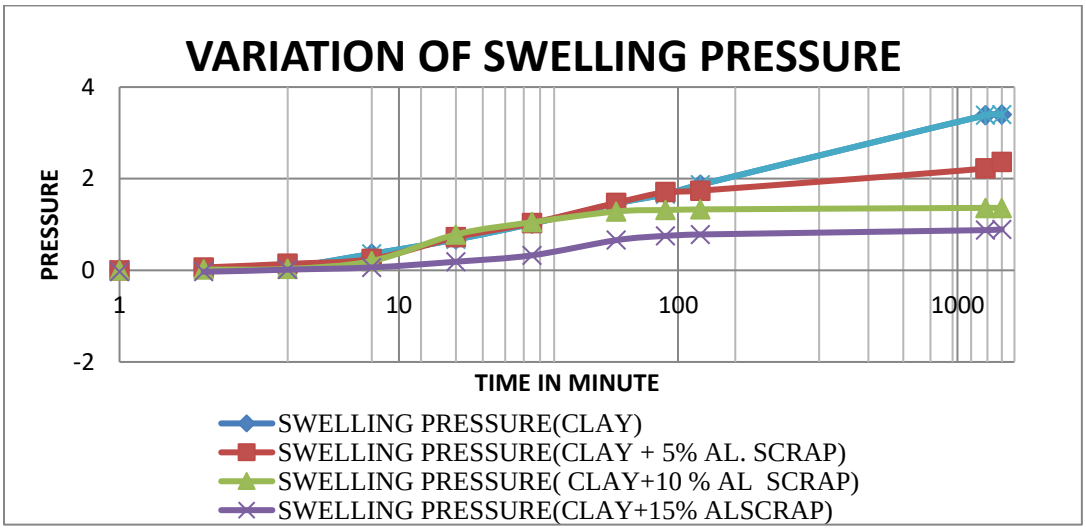


Fig. 4.6 Comparison of swelling pressure variation

Conclusion & Future Scope

5.1 GENERAL

- The potential for aluminium making-scrap, a by-product of the Aluminium industry, for use in the modification of expansive soils was investigated. To enhance the improvement efficiency, the components of the scrap were adjusted and then activated with an activator agent to form a scrap-based composite with excellent performance. Subsequently, this composite was used to modify the expansive soils. Evaluated to understand the engineering behavior and microstructural mechanism. The main results are listed as follows:
- Modified expansive soil reduce the swelling pressure and decrease the swelling force by soil.
- Pure black cotton soil most expansive soil due to different combination of structure such as montmorillonite, kaolinite, and elite etc.

5.2 Future Scope

1. Present time we have million-ton misuse materials being developed industry and many research done waste material reutilizing, so in this examination we grasped that work, reutilization of waste material like aluminium waste.
2. In future we can use that material for enhancing the swelling property and decrease cost of development.
3. Incorporation of a suitable admixture like lime, fly ash, marble dust etc. along with the aluminium scrap.
4. The similar experimental investigation on other soil types like lithomarge clays.
5. Investigation of permeability and consolidation characteristics of the aluminium strip reinforced black cotton soil.

REFERENCES

[1] Gheris, A., & Hamrouni, A. (2020). Treatment of an expansive soil using vegetable (DISS) fibre. *Innovative Infrastructure Solutions*, *5*(1), 1-17.

[2] Gardete, D., Luzia, R., Sousa, M., Carronda, S., & Simão, A. (2019). Soil stabilization with waste plastic and waste tyre fibres. In *Proceedings of the XVII European Conference on Soil Mechanics and Geotechnical Engineering (ECSMGE). ISBN* (pp. 978-9935).

[3] Hamid, A., & Shafiq, H. (2017). Subgrade soil stabilization using jute fibre as a reinforcing material. *International Journal of Engineering Development and Research*, *5*(1), 74-80.

[4] Veerubhotla Seshasai, M. R. M., & Ramakrishna, M. (2016). Stabilization of expansive soils using fibres. *International Journal for Technological Research In Engineering*, *4*(4), 694-699.

[5] Tiwari, S., & Tiwari, N. (2016). Soil stabilization using waste fiber materials. *Int J Innov Technol Res*, *4*(3), 2927-2930.

[6] Mahasneh, B. Z. (2015). Assessment of using cement, Dead Sea sand and oil shale in treating soft clay soil. *European Journal of Scientific Research*, *128*(4), 245-255.

[7] Hainin, M. R., Aziz, M. M. A., Ali, Z., Jaya, R. P., El-Sergany, M. M., & Yaacob, H. (2015). Steel slag as a road construction material. *Jurnal Teknologi*, *73*(4).

[8] Agarwal, A. K., Rajurkar, V., & Mokadam, P. (2015). Effect of waste synthetic bag pieces on the CBR value of expansive Soil. *Journal of Materials and Engineering Structures «JMES»*, *2*(1), 26-32.

[9] KS Tirpude - Harbin Gongye Daxue Xuebao/Journal of Harbin …, 2022. An Experimental study on partial replacement of Cement by Red Mud for M-30 Concrete.