iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54338

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Experimental Study on Subgrade Stabilization Using Geogrid and Perlite

R. Rithani[1], M. Kumar[2].
[1]PG Scholar, Geotechnical Engineering, [2]Professor, Department of Civil Engineering, Government College of Technology, Coimbatore

Abstract: This paper presents the summary of experimental program to evaluate the soil stabilized with perlite and the geogrid-reinforcement. Due to its pozzolanic properties, perlite, a glassy volcanic rock, may be utilised as a stabilising agent. The standard California bearing ratio (CBR) laboratory tests were performed on the soil samples with various combinations of perlite and single layer of geogrid reinforcement placed at various height. The laboratory experiments were undertaken to investigate the impact of using perlite (0%, 10%, 20%, 30%) and geogrid (single layer of geogrid reinforcement placed at H/2, 3H/4 and H/4). The effect of geogrid reinforcement with respect to the position and varying contents of perlite on the strength behaviour of subgrade soil has been examined. Furthermore, the test was carried out by optimum percentage of perlite with geogrid placed at optimum height. Results of the current study indicate that there is a significant increase in CBR values for subgrade soil stabilized with perlite and reinforced with geogrid. Maximum CBR value was observed in the soil sample reinforced with single geogrid layer placed at H/4 (where H is height of CBR mould) with 20% perlite.
Keywords: Subgrade Stabilization, Perlite, Geogrid.

I. INTRODUCTION

The presence of soft/loose soil at ground level is one of the main challenges faced by the engineers during the construction of highways. The need for greater granular material thickness when building roads over this loose soil drives up construction costs. Alternately, attempts to produce a construction that is more cost-effective by reducing the thickness of the pavement layer may result in early pavement deterioration, which will render the road impassable soon after construction.

Some states in India that are located in areas with high rainfall suffer from inadequate drainage and weak subgrade conditions. When exposed to moisture instability, expansive soil's volume variations are more harmful. Due to their behaviour during swelling and shrinking, expansive soils can cause structural failure. Low engineering qualities and bearing capacity are found in expanding clayey soils. On the other side, high settlement of expansive soil is bad for geotechnical projects and building structures. In order to lessen their harmful impact, expansive soils must be amended.

For the stabilisation of soft, expanding clayey soils, lime can be utilised as an additional ingredient. Studies on lime stabilisation are regularly conducted, according to the literature. Other than lime, pozzolanic additives have started to be used in recent studies. In the presence of water and especially when combined with lime, pozzolans are substances that, at normal temperature levels, may exhibit binding capabilities. Lime-induced chemical reactions result in the formation of compounds that are insoluble in water. In this stabilization study, perlite was used as a pozzolanic additive and geogrid is used as a reinforcement.

II. MATERIALS

A. Soil

For the present study, soil for laboratory testing was collected from the GCT campus, Coimbatore which is of Latitude N 11° 0' 50.0004“and longitude E 76° 56' 49.9992“. The natural water content of soil is 17.05% and is classified as a medium compressible clay (CI). The detailed engineering properties of soil sample are listed in table 1.

Table 1 : Engineering Characteristics Of Subgrade Soil

PROPERTIES	SUBGRADE SOIL
% of Gravel	8
% of Sand	40.4
% of Clay and Silt	51.6
Specific Gravity	2.75

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Liquid limit (%)	40.8
Plastic limit (%)	20
Plasticity Index	20.8
Optimum Moisture Content (%)	16
Maximum Dry Density (g/cc)	1.823
IS Classification	CI

B. Geogrid

Geogrid is a geosynthetic material, made of polymers, that is used to reinforce soil. Geogrids are made from high molecular weight, high tenacity polyester multifilament yarns. The yarns are woven on tension in machine direction and finished with a polymeric coating, geogrids are polymeric in nature with tensile strength varying from 100 to 220KN. Engineering properties of geogrid material used in this study are mentioned in table 2. The interlocking of the base aggregate and geogrid is a function of the gradation and angularity of the aggregate and the geometry of the geo-grid. It has been noted that for geogrids, the interlocking of soil particles through the geogrid apertures creates an efficient interlocking effect.

Table 2 : Engineering Features Of Geogrid Material

PROPERTIES	VALUE
Ultimate tensile strength	14 kN/m³
Strain at Ultimate strength	55%
Thickness	2mm
Aperture size	(39*39) mm
Mass	200 g/ m³

C. Perlite

Perlite is an amorphous volcanic glass that has a relatively high water content, typically formed by the hydration of obsidian. Perlite is a non-renewable resource. The world reserves of perlite are estimated at 6700 million tonnes. Although perlite possesses pozzolanic properties. Because of its low density and relatively low price, many commercial applications for perlite have developed. Properties of perlite used in this study are mentioned in table 3.

Table 3 : Mineral Composition Of Perlite

MINERAL COMPOSITION	PERCENTAGE
Silicon dioxide: SiO_2	70–75%
% Aluminium oxide: Al_2O_3	12–15%
% Sodium oxide: Na_2O	3–4%
Potassium oxide: K_2O	3–5%
% Iron oxide: Fe_2O_3	0.5-2%
% Magnesium oxide: MgO	0.2–0.7%
Calcium oxide: CaO	0.5–1.5%
Loss on ignition (chemical / combined water)	3–5%

Fig. 1 : Perlite

Fig. 2 : Geogrid

III. METHODOLOGY

The clay soil was oven dried then dry sieve analysis of soil was performed initially to determine the classification of soil (table 1). Subsequently, Atterberg limits, specific gravity, optimum moisture content and maximum dry density though standard proctor test were determined for soil sample. Then the soil was thoroughly mixed with various percentage of perlite (10%, 20%, 30%). The clay soil mixed with perlite is subjected to Standard Proctor Compaction Test and California Bearing Ratio Test. The optimum quantity of perlite found from the experimental study is mixed with soil where the geogrid is placed at the height of (H/4) (optimum height) from the top of the mould to find the CBR value of stabilized soil.

IV. EXPERIMENTAL WORK

A. Standard Proctor Compaction Test

The Standard Compaction Tests were conducted to determine compaction properties of soil-perlite mixtures. Table.4 shows the variation of the maximum dry density with different percentage of perlite based on Standard Proctor Compaction Test Result.

Table 4 : Standard Procter Compaction Test Result

SAMPLE	OPTIMUM MOISTURE CONTENT (%)	MAXIMUM DRY DENSITY (G/CC)
Untreated soil	16	1.2
Soil + 10 % perlite	20	1.67
Soil + 20 % perlite	22	1.83
Soil + 30 % perlite	26	1.7

It is seen that the OMC of normal soil was 16% whereas the OMC of the soil when mixed with 10%, 20% and 30% of perlite were 20%, 22%, and 26% respectively. Similarly the Maximum dry density of the normal soil and soil with 10%, 20% and 30% of perlite were 1.2g/cc, 1.67g/cc, 1.83g/cc, and 1.7g/cc respectively. The graph plotted between water content and dry density are shown in fig. 3.

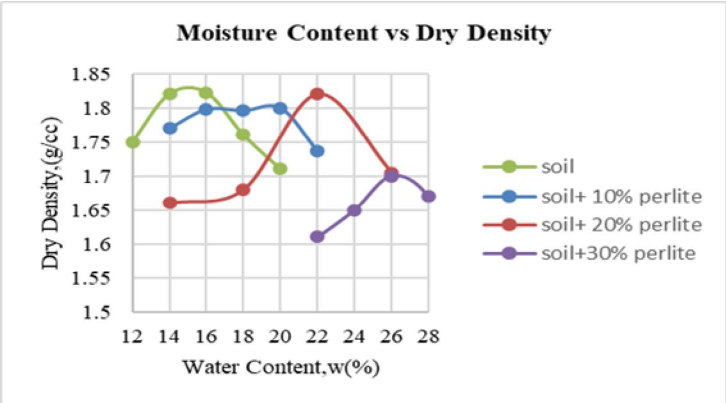


Fig. 3 : Moisture Content VS Dry Density Curve

The optimum moisture content and maximum dry density was obtained for soil mixed with 20% of perlite. The test result shows that there is no marginal improvement in the dry density of soil, whereas, increase in the optimum moisture content.

B. California Bearing Ratio Test

CBR is the ratio of force required to penetrate a soil mass with a standard circular piston to a specific depth at the rate of 1.25 mm/min., to that required for the corresponding penetration of a standard material, expressed as a percentage. Laboratory experiment were conducted to determine the optimum percentage of perlite and suitable position for placing a geogrid for subgrade stabilization. The test result were listed in table 5 and 6 respectively.

Table 5 : California Bearing Ratio Test Results For Perlite Mixture

SAMPLE	CBR VALUE (%)
Untreated soil	1.2
Soil + 10% perlite	1.73
Soil + 20% perlite	2.33
Soil + 30% perlite	1.8

Table 6 : California Bearing Ratio Test Results For Geogrid Reinforced

SAMPLE	CBR VALUE (%)
Soil + geogrid at (1/4)H from top	4.17
Soil + geogrid at (1/2)H from top	2.67
Soil + geogrid at (3/4)H from top	1.6
Soil + 20% perlite + geogrid at (1/4)H from top	6.25

Soaked California Bearing Ratio Test were done for the normal soil, soil with various percentage of perlite and geogrid placed at three different depth and it was found that 20% of perlite mix with geogrid placed at H/4 depth gives the maximum CBR value. Fig.4 and fig 5 shows the load penetration curve obtained from soaked CBR test conducted on soil specimen reinforced with geogrid placed at varying depth from top of the soil and using various percentage of perlite respectively.

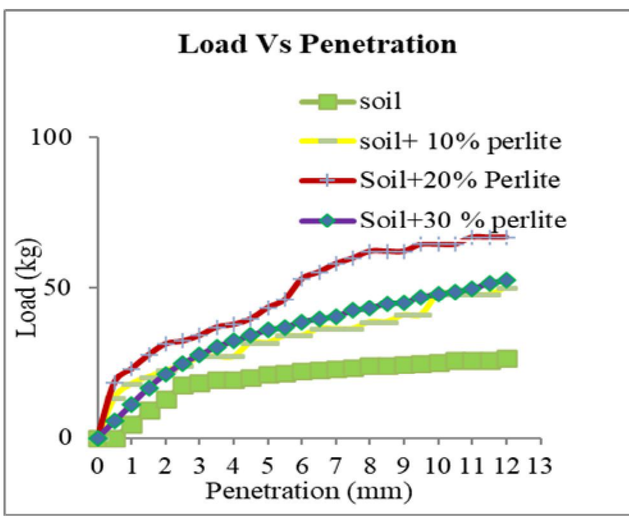


Fig. 4 : Load Penetration Curve Of Soaked Cbr Test For Soil With Geogrid Placed At Varying Depths From The Top.

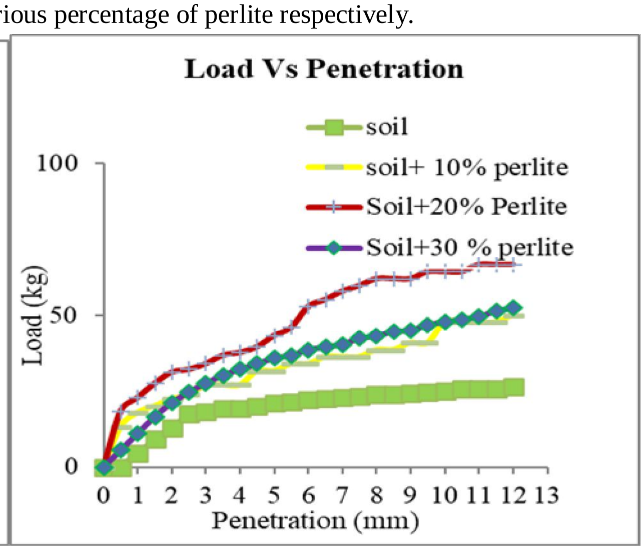


Fig. 5 : Load Penetration Curve Of Soaked Cbr Test For Soil Stabilized With Perlite.

Then the optimum quantity of perlite found from the experimental study is mixed with soil where the geogrid is placed at the height of (H/4) (optimum height) from the top of the mould to find the CBR value of stabilised soil. Fig 6 shows the load penetration curve obtained from soaked CBR test conducted on soil specimen reinforced with geogrid placed at H/4 from top of the soil with optimum percentage of perlite.

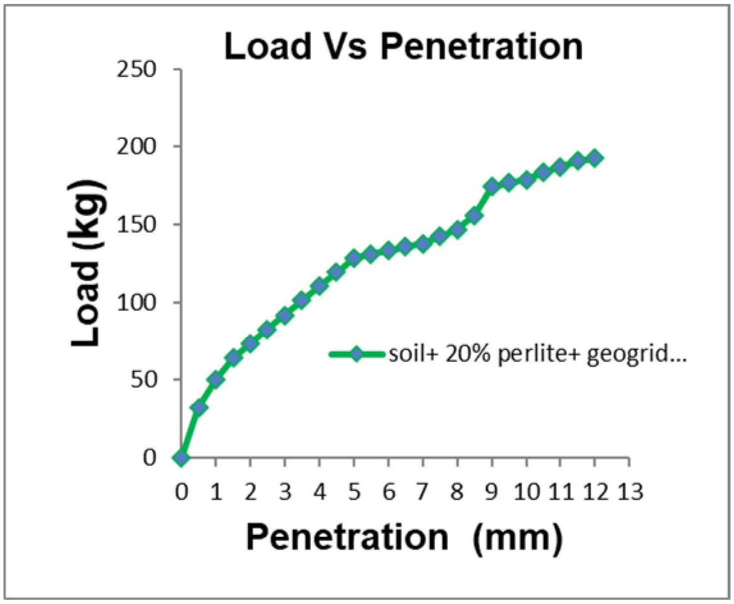


Fig. 6 : Load Penetration Curve Of Soaked Cbr Test For Soil Treated With Optimum Percentage Of Perlite With Geogrid Placed At H/4 From The Top.

V. RESULTS

A. Soaked California Bearing Ratio Test Results

Soaked California Bearing Ratio tests is conducted on soil samples prepared under light compaction to determine CBR value of soil using perlite as an admixture and geogrid as an reinforcing material.

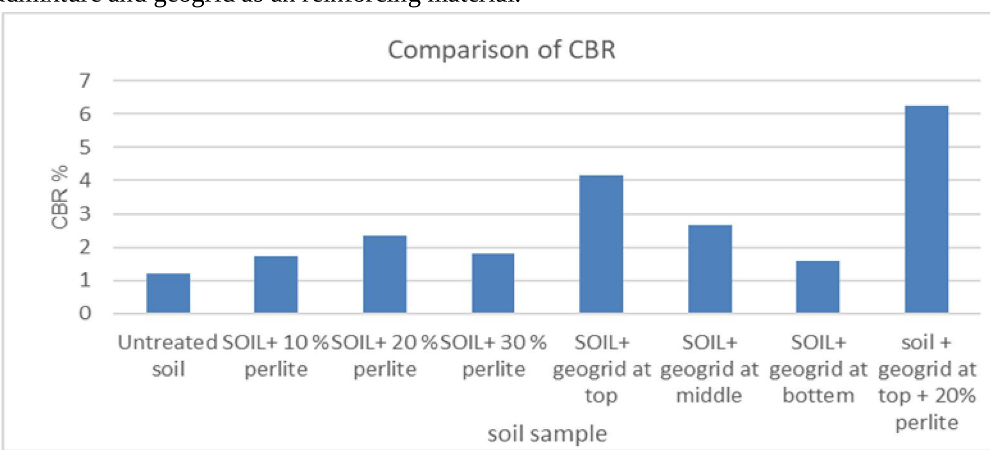


Fig. 7 : CBR Result

The CBR Value of the soil mixed with 20% perlite shows 94% increase in strength when compared with untreated soil. The dosage of perlite at 20% is considered as optimum due to strength gain phenomenon.

While soil treated with geogrid placed at (1/4) H from top of the soil sample, the CBR Value shows 247% increase in strength. This shows that inclusion of geogrid with soil increases strength of poor soil and yields a good CBR.

The soil stabilized using 20% of perlite with geogrid placed at (1/4) H from top of the soil sample shows 420% increase in strength when compared with untreated soil.

VI. DISCUSSIONS

Table.4 shows the variation of the maximum dry density and optimum moisture content for soil mixed with different percentage of perlite. The Standard Proctor Test Result shows that there is no marginal improvement in the dry density of soil, whereas, little increase in the optimum moisture content is observed due to water absorption capacity of perlite.

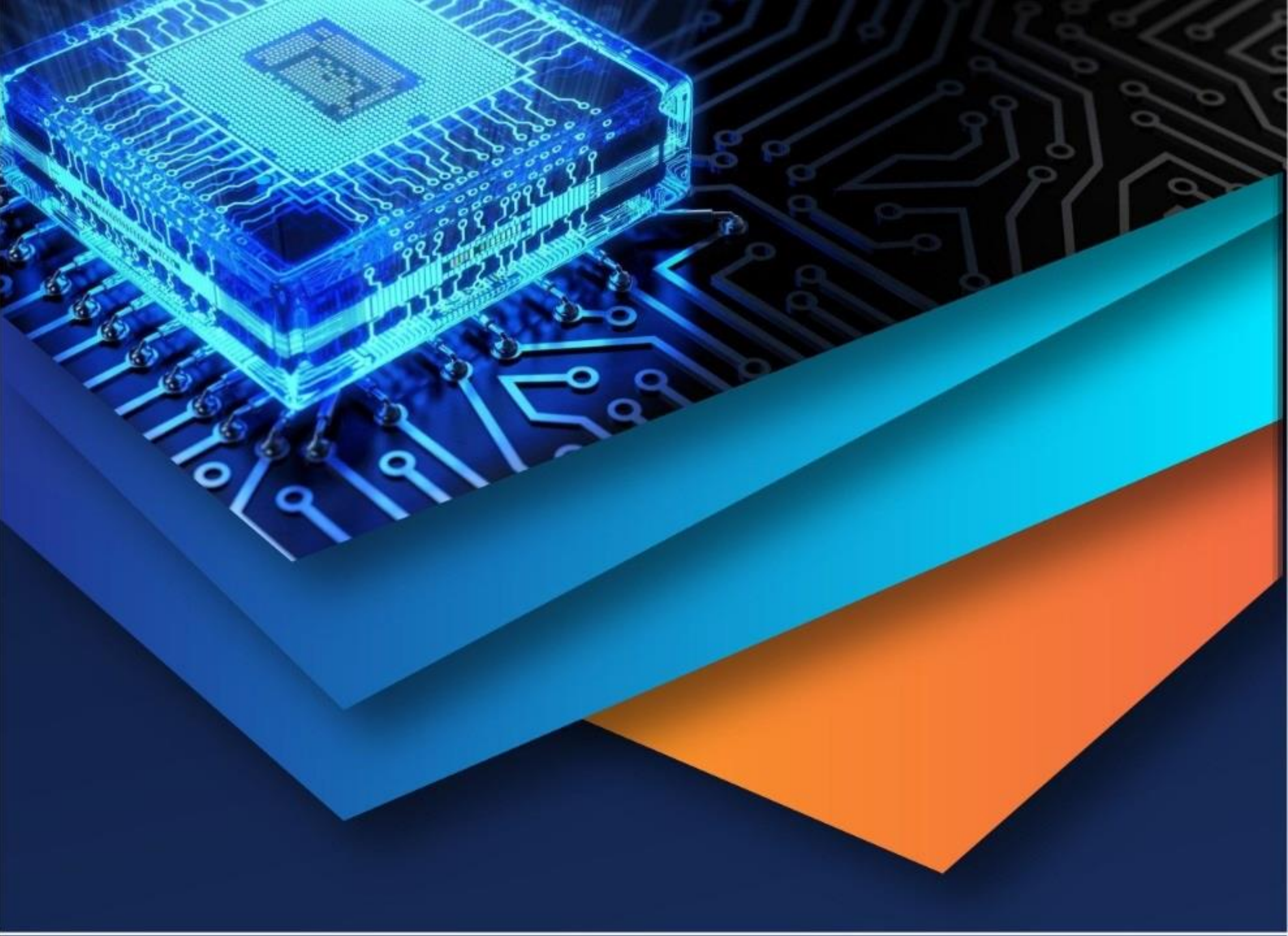
Addition of perlite increase the CBR value due to its water absorption capacity. Table 5 demonstrates the variation in efficiency of the soil for varying contents of perlite. Based on CBR values, it can be concluded that 20% perlite yields best results in unreinforced case. Table 6 illustrates the variation in reinforcement efficiency by varying the position of geogrid. Based on CBR values, it can be concluded that geogrid placed at the height of H/4 yields best results in reinforced case. Maximum CBR value was observed at 20% perlite and geogrid placed at H/4 distance which was already found as an optimum. The improvement of the CBR value is probably due to water absorption capacity of perlite and the interlocking capacity of geogrid. The vertical stress transferred to the geogrid layer causes a stress reduction. The geogrid, which acts as a thin slab, redistributes stress over a larger area. As a result, the load-deformation response increased, with less vertical deformation observed. The vertical deformation rate decreases with the presence of a geogrid layer in the stabilized laterite soil.

VII. CONCLUSIONS

In the current study, CBR values have been used to evaluate the strength behaviour of different combinations of perlite and effort has been made to enhance the strength of subgrade soil using geogrid reinforcement by varying the position. In addition, reinforcement efficiency has been used to evaluate the performance of subgrade soil with the inclusion of geogrid reinforcement. It is to be noted that the strength of the subgrade is significantly altered positively by the positioning of the geo-grid at varying depth. It was observed that the highest subgrade strength is achieved when it is placed at H/4 for a single layer although has a satisfactory result at H/2 and 3H/4 respectively. On the other hand, in the unreinforced case CBR values increase with increase in perlite content. The test result shows that there is no marginal improvement in the dry density of soil, whereas, little increase in the optimum moisture content is observed due to addition of perlite as an admixture. Maximum CBR value was observed at 20% perlite and geogrid which is placed at H/4 distance which was already found as an optimum. Overall, it can be summarized that there is a significant amount of improvement in the strength of subgrade soil stabilized with perlite and reinforced with geogrid material.

REFERENCES

[1] Umit Calik and Erol Sadoglu, “Engineering properties of expansive clayey soil stabilized with lime and perlite” Geomechanics and Engineering,(2014)
[2] Fatih Yilmaz , Duygu Fİdan, “Effect of wetting-drying cycles on volumetric stability of clayey soil stabilized with lime and perlite”, European Journal of Technique (2017).
[3] S. Muthu Lakshmi, S. Gayathri, K. Divya Susanna, M. Ammaiappan, M. Manoharan “An experimental study on soil strength enhancement using geosynthetics”, International Journal of Innovative Research Explorer (2018).
[4] Erol Şadoğlu , Ümit Çalik, “Permeability of high plasticity clayey soil stabilized with lime and perlite”, Journal of the Faculty of Engineering and Architecture of Gazi University (2020).
[5] Samson Yonas Aga, “Physical stabilization of expansive subgrade soil using locally produced geogrid material”, SN Applied Sciences (2021).
[6] Sateesh Pisini, Swetha Thammadi, Monish Nadan, Naadirah Edward, Shaniza Nisha, “Experimental study on strength behaviour of geogrid reinforced subgrade soil”, IOP Conf. Series: Earth and Environmental Science(2022).
[7] Tri Harianto, “Performance of sub-base layer with geogrid reinforcement and zeolite-waterglass stabilization” Civil Engineering Journal”, (E-ISSN: 2476-3055; ISSN: 2676-6957) Vol. 8, No. 02 (2022).
[8] Mukku Pavan Kalyan, SVRB Pavan Krishnause, “Use Of Geo- Grids In Flexible Pavement Design”, Journal of Engineering Sciences. Vol 13 Issue 08, (2022)
[9] David A C L 2018 Guide to Pavement Technology Part 4G: Geotextiles and Geogrids Sydney: Austroads Ltd
[10] Shukla S K 2016 An Introduction to Geosynthetic Engineering. Leiden: CRC Press/Balkema.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY