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Investigational studies on beneficial effect of geosynthetic reinforcement at an interface of two layered system

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ABSTRACT

The phenomenon of inclusion of geosynthetic reinforcement on California bearing ratio values of two-layered systems along with various[H/4,2H/4,3H/4,5H/4,H/4&2H/4,H/4&3H/4,2H/4&5H/4] thickness configuration and different geosynthetic(geogrid&geotextile)was studied in the laboratory. The thickness of expansive clayey subgrade pavement over a two-layer system of various thickness configuration was computation for unreinforced and reinforced soil layer system. In this investigation thickness configuration of expansive clay soil has been observed. Expansive soils originate in several components of the planet such kind of soil usually comprises of active clay minerals. Geotechnical engineers face several issues while planning groundwork owing to clayey soil due to poor bearing capacity and excessive settlement. Expansive soils are sometimes wet when they are in saturation and these soils rephrase their rigid as they become dry. Expansive clayey are accompanied by less compressive strength and more excessive settlement. This decrease of strength due to moisture results in severe damages to building foundations and roads other vital structures. The utility and efficacy of geosynthetics as a replacement for the subgrade course for pavements, as a cost-effective approach. Various experiments were conducted on expansive soil with an increase of strength geosynthetics at diverse heights. The foremost aim of this research is to investigate the utilization of Geosynthetics in soil reinforcement applications and to raise the effects of geosynthetic on the strength property of unsaturated soil by carried out the compressive test on the soil samples. The outcomes attained are compared for two treated soil and untreated soil. Without reinforcement the CBR value of clay soil was 2.90. The CBR value is tested by palcing geogrid and geotextile at various heights and it was identified that one layer geogrid palced at H/4 and two layer geotextle was palced at H/4 &2H/4 the distance from the top the CBR test was shows greater values of 2.38 & 2.03 times more than the soil alone.

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1. Introduction

The soil is a complicated, varied, and random material that has been open to the modification of the universe with no management. The characteristics of soil amendment not only from one place to another [2]. Additionally, at the site with the depth and with an amendment within the drainage, environmental conditions under which it exists. At the beginning of any foundation work, it is necessary to enhance the soil strength and returned to the earliest times. Antiquated civic found the Chinese, Romans, and the Incas were utilized several treatments to boost up the strengthening of soil. Some of those techniques are still in operation and exist in structures and roads. In comparing to alternative construction material like steel and concrete, is not economically possible to move from one location to another [3,4]. The engineers are sometimes to build a structure at the land site choose for understanding apart from the properties of the soil sample condi-

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tions. Therefore, it's progressively vibrant for the civil engineer to know all the properties [index&eengineering] of the soil could amend or choice that maybe an idea for the development of the supposed design of the structure at the specific location [12]. If the soil is not suitable for the conditions are found at the construction place, that soil is bypassed and suggests to lay deep foundations, replace the poor soil with suitable materials or soil having the high bearing capacity and it can be treated by using soil stabilization and soil reinforcement techniques to enhance the soil properties [9].

Therefore, to make it out of the chosen site, to collect the correct data concerning their (Engineering &Index) properties and component that affect their performance. So at the beginning of the development of any construction work, the need for improving the engineering properties has been low and the soil reinforcement or soil stabilization helps to reach the requisite characteristics of the very soil necessary for the development work [10]. For any type of construction project, an inspection of the site can take place earlier, and then to study the subsoil properties and its feasibilities are economically beneficial before commencing the work. Based on that data location of the project can be prepared [13].

1.1. Feature concerning soil interconnected to expansive soil

Clay soil is one among chief soil deposits of Asian countries. They show a high range of damages in the form of swelling and shrinkage once exposed to changes in wetness complacent and dry which are found to be most challenging from engineering thought. The rate of montmorillonite is high in black cotton soil which leads to expansiveness and crack occurs in soil without any warning which is hazardous for construction owed to its excessive swelling and shrinkage belongings, the expansive (Soft clays) has been considered by the foundation engineers. The expansive soil is absurd escaping of water once dry, but the soil in the wet condition it's poor of its nature.

Chaosheng Tang et al. [1] expansive soils are mainly composed of hydraulic minerals, such as Montmorillonite, elite, and with significant swelling and shrinkage. Every day the damage due to expansive soil is becoming gradually a research crisis. The strength of the structure will automatically decrease as the soil expands. The main aim of the nature of expansive soil is to reduce shrinkage and swelling in nature. However, expansive soil with the little amount of water shows the same characteristics behavior such as expansion, crack, and over-consolidation. Cracks are mainly due to expansion and over-consolidation. Eeven drop of water containing the soil will shrink and results in the crack, alternatively drying, and wetting due to environmental change results in small cracks. According to N. K Ameta et al. [2] the crack is a very important factor of stability slopes of expansive soil. The unsaturated expansive soil with special engineering and mechanical properties; there is nearly hundred years of history about the expansive basic properties such as physical and mechanical, engineering application and the straight method from the play key role on the expansive soil intensity, deformation and seepage. (N. V. Gajera et al., 2015) has been observed on the stabilization analysis of low bearing capacity of the soil by exploitation groundnut ash. Ground nutshell contains about 25% protein and 45–50% soil. In this study, we have to know the way of apply the (GSA) groundnut ash to improve the engineering performance of BC soil. The (W.L&P.I) values of the soil very high i.e., 83.36% and 89.32%. By increasing the MDD of the soils with a decrease in the OMC. The unconfined compression test of these soil is increasing. The trend of improvement in the UCS is to be much with the curing of the soil and groundnut shell ash. The California bearing ratio value of 2.17% was attained at 10% groundnut ash [3].G.N SatyanarayanaI et al. [4] has worked on the effect of bamboo fibers and mill steel dust onthe capability characteristics of expansive clayey soil. Many techniques are accessible like providing reinforcement, soil stabilization. CBR value of soil considerably increases up to [1.2%] of bamboo fiber dosage.

The BC soil California bearing ratio penetration values are has been improved by using mill scale dust. In this work, the percentage of optimum moisture content and engineering properties have been improved. The engineering properties (L.L &P.L) of the soil has been fall due to the mill scale effect. When compared to other soil samples the maximum dry density has been shows better performance by using bamboo reinforcement. Based on the research studies baboo fiber reinforcement is useful for the stabilization of mill scale dust. The department of transportation and federal highway administration (US) consider the current methods and process to experience about the geotechnical problems in the design and construction of pavement subgrades and execution of current activities of the projects like construction, reconstruction, and habitation. The brief explanation about soil investigation and sub-surface exploration of place and construction of unbound pavement martial of subgrade and subbase. The geotechnical influence inputs are review by the demand in present and past in (AASHTO) as per design guidelines the mechanistic-empirical approach has been developed below [NCHRP 1-37A], as well as 3 levels of design quality input. The requirement of subgrade and subbase materials also along with the design features, selection, and suitable remedial measures for undesirable subgrades. The discussion about construction and its specifications, performance, monitoring and, measurements also consider [5]. V. Padmavathi et al. [6] Foundation in expansive soils it creates severe damages undergo alternative enlargement and shrinking upon change of state nature due to the wetness content changes seasonal fluctuations this movement soil induces hogging , which are more harming to the safety of the construction than the sagging nature. This type of severe damages would possibly in the wall of the structures as an impact. For soil and admixture only with quarry waste (stone dust), the optimal sequence is saved to be (soil + 3% quarry waste). The soaking condition of California bearing ratio test penetration reading of this combine is found (2.91), which is (1.57) times greater than the CBR reading of soil alone. The soaking condition CBR soil penetration reading of this accumulation was at 4.16, which is two times greater than the soil. The strength characteristics of clayey subgrade soil has been improved by adding of stone the percentage of optimum moisture 3%. N. Vijay Kumar et al. [7] has worked on the comparative study of reinforced soil using geogrid-1, geogrid-2 & geo-membrane [11–13]. S.A. Naeini et al., 2008; Mahmood et al., 2008; Prietto et al., 1999 randomly distributed fiber-reinforced soils have recently attracted increasing attention in geotechnical engineering. These investigations indicate that strength properties of fiber-reinforced soils consisting of randomly distributed fibers are a function of fiber content and fiber-surface friction along with the soil and fiber strength characteristics.

2. Materials used and its properties

SOIL – Expansive soil is used in the present study is procured from ToliChowk Military Hospital area (Telangana, India) disturbed but representative samples were collected from pits at a level of 1.5–2.5 m from below the ground level. The soil was obtained from the construction location and the sample was pulverized in the laboratory and conducted all experiments in St. Martins Engineering College Secunderabad. In this concern engineering properties of soil used in this investigation.

2.1. FTIr

In this paper an IR spectroscopy was used to identify minerals by their characteristics absorption spectra [17]. FTIR it is an analytical tool that measures the organic and inorganic composition clay minerals and their structure. The IR absorption spectra were recorded with a spectrometer M40 in region of 500···0.4000 cm^{-1} with a resolution of 0.4 cm^{-1} when measuring IR spectra by a spectrophotometer FTIR-8400S, a sample weight varied in the range of 0.1–0.5 mg.

The clay mineral samples as shown in Fig. 1 can accompaninment to kaolinite by IR absorption spectra.their IR spectra demonstrate fully -represented and well resolved Si—O—Si bands of the mineral latice around 1102 1033,1014,938,755,693,541 cm^{-1} and clealy seen asborption bands of OH streching. The main distictions of kaolinite group minerals is observed in OH streching absorption, particularly there are one and one narrow and intensive absorption peaks around 3500 and 3555 cm^{-1} which are characteristic of an ordered variety of kaolinite [14,15] (See Figs. 2 and 3).

2.2. Igeogrids IGX

TenCateIMira grid geogrids are plotted materials suitable for-Ishort and Ilong Iterm soil Ireinforcement applications. They consist of high modulus polyster fibers laid in a flat alignment that enableslextreme load -carrying Iefficiency (See Tables 1–3).

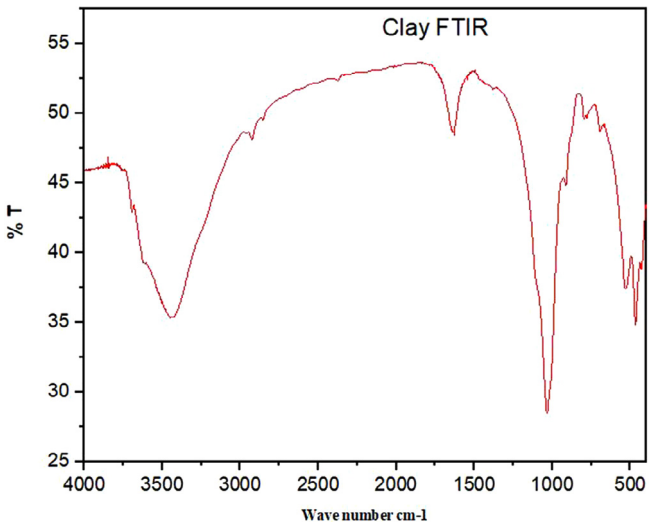

Fig. 1. IR Spectra of minerals in the region of 4000···400 cm^{-1}.

2.3. Geotextile IPolitely TS40 tencate Bidim®

Geo-textiles are inevitably secured continuous-filament nonwoven's factory-made from Ultra Violet-stabilized poly-propane. The mechanical properties of TenCate Bidim®P guarantee tremen-

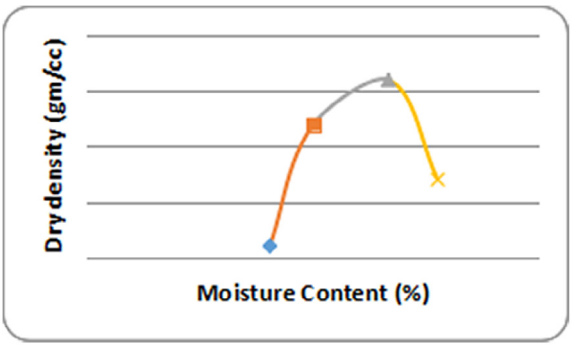

Fig. 3. Variation of OMC and MDD.

Table 1
Properties of expansive clay.

Engineering property	Value
Specific gravity	2.73
Gravel (%)	0
Silt	58%
Clay	42%
Liquid limit	58.80%
Plastic limit	27.90%
Plasticity index	30.9%
Soil classification	CH
OMC	15.52%
MDD	1.71 g/cc
Unconfined compression (KN/m^2)	98

Table 2
Geogrids reinforcement CBR values.

S. No	Position of geogrid [mm]	Penetration in [2.5 mm]	Penetration in [5 mm]
1	Without reinforcement	2.90	2.40
2	H/4	7.9	6.6
3	2H/4	7.3	6.40
4	3H/4	6.89	6.75
5	5H/4	4.90	4.30
6	H/4&2H/4	5.60	5.21
7	H/4&3H/4	4.90	4.60
8	2H/4&5H/4	3.90	3.27

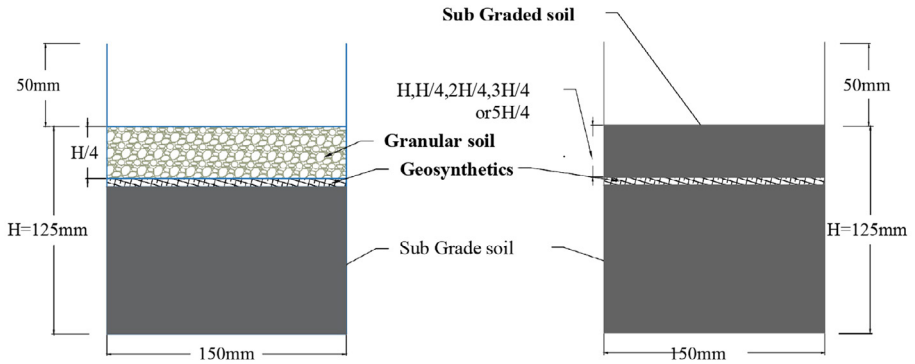

Fig. 2. Thickness Configuration of Different soil layers.

Table 3
Geotextile reinforcement CBR values.

S. No	Position of geogrid [mm]	Penetration in [2.5 mm]	Penetration in [5 mm]
1	Without reinforcement	2.90	2.40
2	H/4	5.80	5.30
3	2H/4	4.67	4.43
4	3H/4	4.23	4.10
5	5H/4	3.80	3.60
6	H/4&2H/4	5.90	5.70
7	H/4&3H/4	4.80	4.61
8	2H/4&5H/4	4.50	4.31

dous resistance to installation damages, excellent hydraulic properties, and outstanding long-term performance. These following applications. The strengthening of base course over a low bearing capacity pavement subgrades which offers good elongation and more tensile property.

2.4. Objectives of the study

A. In this present investigation is to study the effect of compaction energy on expansive clayey soil.
B. To evaluate the influence of Geosynthetics on CBR.
C. To investigate the strengthening of soil low bearing capacity.

Geosynthetics which made up of heterogeneity of products, primarily grouped under geo-textile, geo-grids, Geo-membranes, and Geo-composites have been constituting to be of massive use in the many infrastructures projects of India and worldwide. Apart from the usual civil engineering applications, it is being confirmed that even in geotechnical and environmental engineering approaches containing pollution, landfills, erosion controls, and geosynthetics are key roles. According to VenkatappaRao (1996) geosynthetics applications used in India for the design of pavement of the East-West and North-South corridors and golden quadrilateral of the NHDP projects being executed by the NHAI. Considering that the (VenkatappaRao 1996) has given a clear idea of the geosynthetics and its potential. The opening of the Indian market to the entry of foreign materials and technology and the realization of the people and government to the direct need for infrastructure and development without adaptation of new technology to make the structures cost-effective and enduring has brought for the other aspect for analysis between Indian civil engineers. This is a major improvement in the Indian environment helping in the soil and resources salvation. Stabilization of soft soils would accept the fibrous materials until a mass was formed that the adequate properties for the intended purpose because of the properly stabilizes nature of the now reinforced soil. Any Structure can't carry the insufficient reinforcement materials load. And also the draining of the soft soil up terminated the reinforcement soil. The degradation of fibrous material with time and governing back to the beginning improper condition. According to (Robert M. koener) the concept of the stabilization of expansive soils has advance until present on the day. The fiber material in reinforcing can be introduced by the South California Highway Department in 1926. A thin layer of the sand bed and a fabric material provides over an asphalt pavement. The Department has announced the results in this work in (1935) illustrate eight different in situ tests were conducted. Until the fabric deteriorated, the showed that the road was a good condition and these geosynthetics material decreases the cracking and rutting free from the normal road failures. Nowadays it is running of the separation and reinforcement functions of geosynthetics materials.

3. Methodology

3.1. Specific gravity of soil

Engineering properties of soils show a significant function in the design and execution of any kind of structure, it is essential to find several properties (index and engineering) of soil. Specific gravity is one of the parameters to estimate the different properties of soil and also it is useful to measure the state of saturation and unit weight of moisture [9]. IS 2720 [Part III/Sec-I] [8]. The unit weights need in pressure, settlement, and stability problem on soil engineering. Letter 'G' is used to defined specific gravity. It is a source for deciding characteristics of the weight of the volume of the soil at a temperature/ chosen temperature to weight equals to the volume of water at that (TOC) temperature. It is explained as the volume of a unit mass of soil to the water

$$G_S \frac{[M_2 - M_1]}{[M_2 - M_1] - [M_3 - M_4]}$$

whereas Ms = mass of solids with V(volume)
M_w = mass of volume of water
This Sp. gravity of soil sample is determined after researching with the following facility using a jug with a thickness of 50.0 ml capacity along with a plug that has an opening in the center. The glass jar is thoroughly washed and is kept in the boiler at a temperature ranging from 10500Cto11000C. Take the lump of the soil and fill the bottle and take it as (M_1). Proceeds for example22.0 g of soil, oven-dry then and add the soil into the jar and note the heap of the jar and close it with a jar plug and record its mass as(M_2). Add water in the plug and notice the heap, close the plug, and notice the mass as (M_3). Remove the jar container and cleaned it completely with and record its mass as (M_4) repeat this procedure along with concerning 3.0 trials and place the assets.
For determination of Sp.gravity using the following relation

$$G = [Ms/Mw] = G_S \frac{[M_2 - M_1]}{[M_2 - M_1] - [M_3 - M_4]}$$

Whether M1 = mass of overtire vessel: M2 = mass of ewer + solids: M3 = mass of ewer + solids + H_2O:
M_4 = mass of ewer + H_2O.

3.2. Sedimentation analysis (Hydrometer Analysis)

The sieve analysis is adopted to find out the molecular size and dispensation of fine-grained soil which is less than 0.075 mm. The soil molecules size ranges from filters 0.075 mm to 0.1 mm. The measured Skelton investigation depends on the principles of Stokes law. For this typical analysis, the diameter of the molecules that are used in wet filter investigation was found that the molecules were smaller than 0.075 mm (Das et al.). Filter investigation or molecule dispensation can be defined as grading or separating the aggregates into molecules of different sizes (Julien, 1995). This technique is similar to that of wet filter study, according to IS code: 2720(Part-IV) – 1985, the mud moving through 75μ is taken as an unbroken micro woven machine for 24hrs. Take w.r.t 50.0gms of soil is an exceptionally round neck shape and add with w.r.t 200 ml (H_20) scattering expert is prepared by exasperate 4gms of malt mixerhexa-phosphate and 2gms of NA2CO3 in 100 ml of H_20 and mingle it entirely till the point when this completely mixed. This scattering expert and soil reply become a damage bump and it is made to mix for a moment with an automated strives. The full soil test is then replaced with graduated and H20 intercalary tilt and again mix it for a minute start the timer and take subsequent readings [16]. Jack and Cheng Liu et al. (2007), track the record at zero, 0.5, 2, 4, 9, 30, 60,120and 24*60 min for

examining and assessing the frame. The measured framework is embedded with regards to 20 s earlier inspect thus removed and unbroken inside the chamber. The quality zone unit uses the Stokes law. Based on sedimentation analysis the percentage of clay and silt is 42 and 58.

3.3. Liquid limit [W_L]

According to Swedish circle author, Atterberg's (1911) proposed a method for measuring the fluidity behavior of soil in liquid extremely. The extreme ranges of the soils are collected with Casagrande liquid apparatus persistence will a controlling equipment and investigation is carried out according to [8,10] IS: 2720 (V)-1980. The operator and research are being guided have a metal holding device which might be erected and permissible to slip on a degenerated adaptable base by whirring the handle. The glass is erected one cm. Take with regards to 120.0 gm of soil passing 425μ utensil is completely blended along with water to form it into a correlation paste. Few quantity of paste is set inside the device and leveled up thoroughly to a point of 10.0 mm. A network of a span of 11.0 mm approximately and 8 mm consequently will cross the case on an equally central part of the cone. The rip equipment must be reliable enough to control standards to the glass at the purpose behind the contact. The handle revolves at a specific speed of 2 cycles systematically and the degree of the blows is critical to close the trench mark of sample and not by the stage between the soil in the cone and the glass.

3.4. Thread test [PL]

The thread test is used to find moisture content at which soil is in plastic state as per IS code:2720-part 1985 (part-V) [10]. Thread test is observed by rolled out a sample thread of the object of soil along with a flat level and a non-porous surface. According to ASTM standards (4318). When the soil has moisture content where the soil sample behaves is plastic and the property of soil sample which comes thread will retain shape downward to a precise little diameter. The soil sample can be removed and the test is again repeated. As the water content falls due to physical change (evaporation), the soil sample (thread) will start to break apart a large diameter. The thread test of soil is the moisture content at the behaves plastically to be a thread will be without a crumbling 3.0 mm diameter.

3.5. California bearing RartioTest

The CBR experiment is used to evaluate the property of the subgrades and base courses below the newly construction of carriageway. As per IS code: 2720(part-XVI)-1979. The graph drawn between X-axis is load and Y-axis is penetration value at which California bearing ratio is designed. The corresponding value at which California bearing ratio is designed purpose, the corrected loading value is taken from the load penetration curve and the California bearing test is measured as follows

$$\text{CBR} = (\text{Corrected unit test load}/\ \text{Unit standard load}) \times 100$$

Mostly, California bearing ratio values of both soaking and unsoaking conditions samples are determined. The California bearing ratio values are generally measured for penetration 2.50 mm and 5.0 mm. Generally, The California bearing ratio penetration values at 2.5 mm greater than 5.0 mm penetration and this type of cases, only single-time is considered as the California bearing ration reading for designing purpose. If the corresponding California bearing ratio value to a penetration at 5.0 mm exceed for 2.50 mm, then the experiment will be conducted again. If the same outcome move, the bearing ratio similar to 5.0 mm penetration's reading are considered for design proposal. Provide the design charts for defining the suitable thickness of pavement necessary for substance with a given design charts, for different axle loads and design traffic (msa). The pavement thickness charts can be followed by many countries like (India, England) and proposed by the road and research laboratory. The C.B.R. values are usually calculated for penetration of 2.5 mm and 5 mm. Generally the C.B.R. value at 2.5 mm will be greater that at 5 mm and in such a case/ the former shall be taken as C.B.R. for design purpose. If C.B.R. for 5 mm exceeds that for 2.5 mm, the test should be repeated. If identical results follow, the C.B.R. corresponding to 5 mm penetration should be taken for design.

3.6. Strength behavior of geosynthetics reinforced subgrade

The activity of the road depends upon the strength of the filling material and subgrade at a lower place. Construction of a road over soft subgrade material is a primary content affecting the expenditure and schedule of the projects in a particular area where the soft clayey subgrade is common. Laboratory CBR tests were performed with and without geosynthetics at the interface of the two-layered soil system in according with (IS:2720(Part XXXII)-1979).The following schematic representation of the thickness configuration of soil layers [H,2H/4,3H/4,4H/4 and5H/4] for laboratory CBR tests without and with geosynthetics.

4. Experimental investigations

The outcomes of different tests are executed on various soil samples are demonstrated in this segment. The effects of Black Cotton soil on properties such as compaction features and California bearing ratio are studied for geosynthetic materials as shown in the below table.

The liquid limit 58.50%whilrmanyform of soil is given. Their fluid content is going to be presented in proportion. The value of various each tin number mentioned. the dry density is going to increase with the greater number of blows. The resultant liquid limit obtained from the

Liquid limit: 58.50%
Plastic limit: 29%
Plasticity index: 29.90%
IP: 0.73 [WL-20] = 28.10 from above A- line

4.1. X-ray diffraction (XRD) powder sample

X-ray diffraction (XRD) is a nondestructive technique is provides detailed information about the crystallographic, chemical composition, and physical properties of materials. In this present study carried out to observe the XRD analysis indicates that the diffraction peak for contains clinochlore observed direction angles, 2 degree (θ), equivalent to 200, 350 and 800. The X-ray diffraction analyses to show the extra peaks for muscovite.

4.2. ESEM scanning analysis

The microstructure of the soil specimens study by ESEM scanning (Fig. 5) scanning electron microscopy was conducted on three phases (7, 14.28) days cured period with the same water content. The sample microstructure was examined under the scanning electron microscopy (SEM). The maximum dry density and optimum moisture content of the soil were tested to be 1.71 g/cc and 15.52%, respectively, by modified proctor compaction test and specimens with single IWCs (initial water content 15%) and one dry density 1.71 g/cc (See Fig. 6).

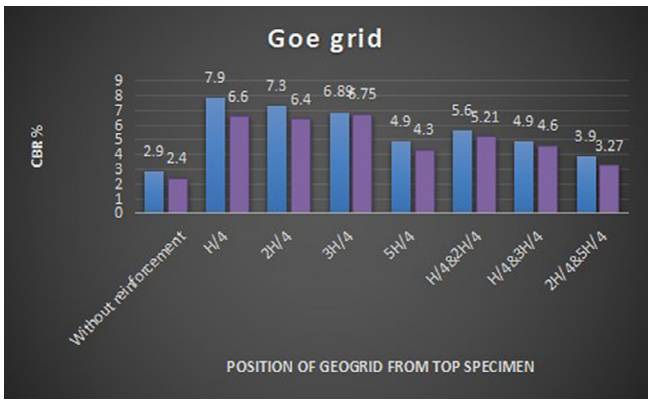

Fig. 4. Comparison of CBR values at different positions of geogrid.

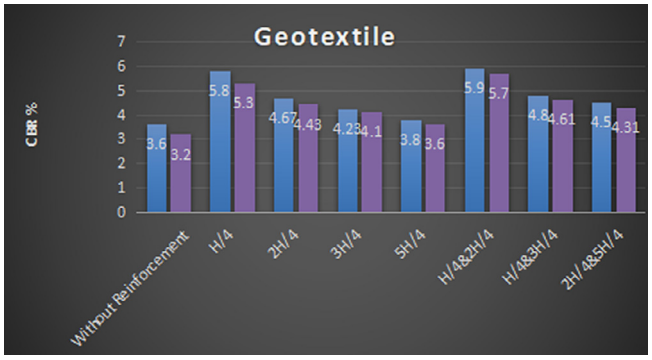

Fig. 5. Comparison of CBR values at different positions of geotextiles.

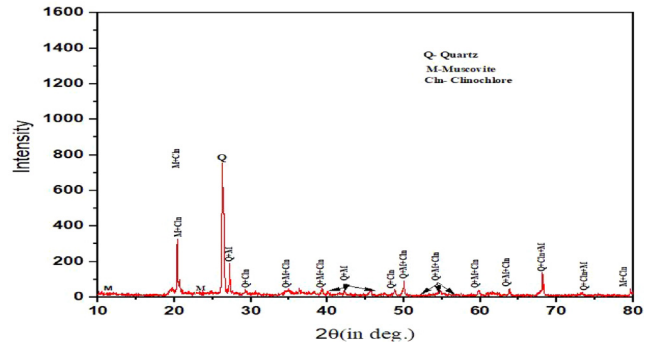

Fig. 6. X-ray diffraction pattern of the clay soil.

4.3. XRD results

Figs. 7–9 presents the X- ray diffraction powder samples taken from specimens cured to 7,14,28 days in curing tank. It can be found that the diffraction of samples with single IWCs and various curing ages exhibits little difference each other, especially for the characteristic peaks of primary minerals(Quartz and muscovite in the soil sample) which indicates that IWC has little effect on the crystabilized primary mineral composition of the soil-stabilizer mixture. The curing period of 7 days and 14 days, the strength value doesnot change significantly with the variation of IWC.

Throuh a curing period of 28 days, a parabolic relationship between UCS and IWC can be observed. The UCS and IWC reaching paek value at 15% IWC, which is equal to the optimum moisture content derived from the modified proctor compaction test.

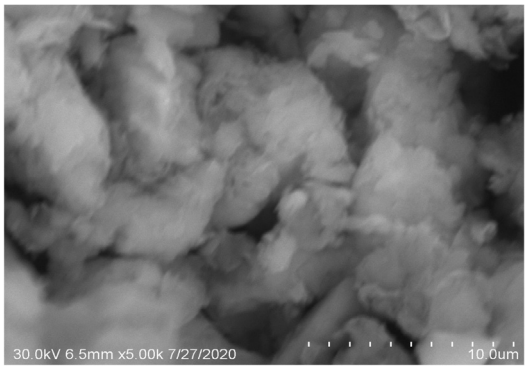

Fig. 7. Shows the SEM images microstructural aspects of clay soil cured for 7 days and initial water content effects on microstructure.

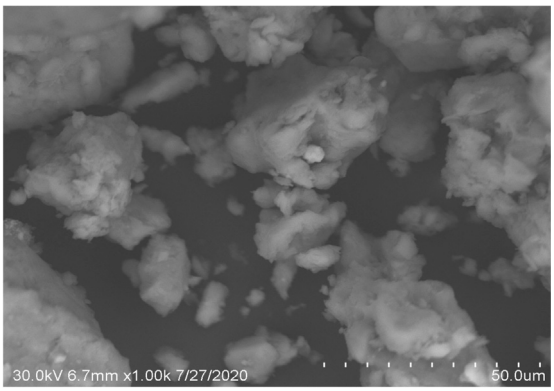

Fig. 8. Shows the SEM images microstructural aspects of clay soil cured for 14 days and initial water content effects on microstructure.

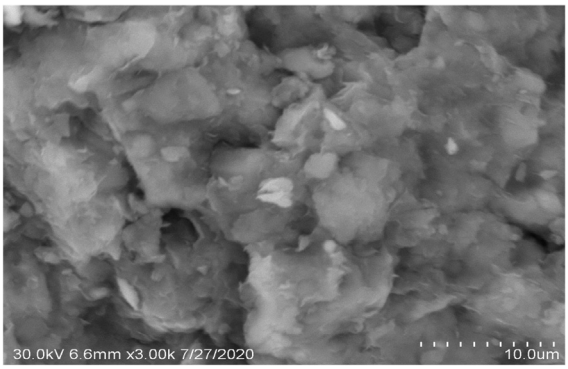

Fig. 9. Shows the SEM images microstructural aspects of clay soil cured for 28 days and initial water content effects on microstructure.

5. Results and discussions

The present study shows the strength of the clayey subgrade pavements has been increased significantly by the placing of the geosynthetics at various locations. From the Fig. 4. shows the without providing any reinforcement the CBR values of clay soil is 2.90% and by providing different reinforcements from Fig. 4 single layer system the geo-grid at a location of 3H/4 mm from the top of the soil the CBR values are enhanced by 6.89% and same way the application of two layer system the geotextile are placed at H/4 and 2H/4 mm CBR values also has been improved 5.90%.Based on the CBR results, the CBR values increased with the application of two

layer reinforcement, the maximum CBR values in clayey soils were approximately 2.37 and 2.03 times greater than those without reinforcement. From this observation the geogrid single layer system more suitable for subgrade clay soils and geotextile two layer system also useful for design of flexible pavements on clay soils.

6. Conclusion

The aim of this investigation was to measure the effectiveness of the one and two layer application of geosyntheics in bearing capacity of subgrade soil layers system. The proceeding conclusions were drawn based on the test results generally showed that with the utilization of geosynthetics in the interface of one and two layers systems, the resistance of soil samples against increasing surcharge appreciably.

Based on FTIR spectra process the clay soil consists of quartz, mica and muscovite, the according ASTM- D-854, AASHTO T100, BS 1377 the specific gravity of clay soil 2.73 (mica).

Based on X-ray diffraction powder analysis shows the extra peaks for muscovite.

From the test results the cured period of 28 days the microstructural study using SEM analysis shows that the chemical reaction and physical contacts developed in stabilized clay soil.

After curing period (28) of soil samples geosynthetics the for the analysis of microstructural study using SEM the sample conducting CBR test for one layers system (3H/4) for geogrid and double layer system (H/4 &2H/4) geotextile strength was improved and these layers economic beneficial to use geosynthetics in stabilization of clayey subgrades.

SEM and XRD studies confirm the formation of reaction products such as C-S-H and calcium hydroxide, which contributed to strength development in the stabilized soil.

Based on test CBR results, The CBR values increased with the application of one layer geogrid system, the maximum CBR values is 2.37 times more than than soil alone.

Based on test CBR results, The CBR values enhanced with the application of two layer geotextile system, the maximum CBR values is 2.03 times more than than soil alone.

CRediT authorship contribution statement

N. Vijay Kumar: Conceptualization, Data Curation, Resources. **S. S. Asadi:** Formal analysis, Investigation, Methodology. **M. Karthik kumar:** Project administration, Supervision. **M. Sujatha:** Validation, Visualization. **M.C. Venkatasubbiah:** Writing- original draft, Writing- Review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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