Improvement of Load Penetration Resistance by Reinforcing Unpaved Road Models

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ABSTRACT

Successful use of geosynthetics is ensured in an exceedingly given geotechnical application, because it isn't solely compatible however effective in rising the soil properties once suitably placed.The natural geotextiles are often used as extractor, reinforcement and emptying layer for caliche-topped road sections. There square measure many studies conducted supported the applying of various materials for rising the bearing capability of weak soil. No model studies according within the literature on sealed road models wherever as few studies were according on caliche-topped road models. during this study the performance of plain-woven and nonwoven fibre geotextiles in caliche-topped and sealed road models were dole out by experimentation by utilizing the California Bearing magnitude relation (CBR) testing arrangement.

Hence the load penetration behaviours and CMBR values were determined and therefore the results were compared. This takes a look at reports the useful impact of 2 kinds of fibre geotextiles (one plain-woven fibre geotextile and one non-plain-woven fibre geotextile) on the load penetration behaviour and California bearing magnitude relation (CBR) of subgrade soil in caliche-topped and sealed road models. This study indicates that the CMBR improvement spare to eliminate the requirement for a powerful base course in each caliche-topped and sealed road models. this is often achieved through the employment of those fibre geotextiles. plain-woven fibre geotextiles square measure found to perform far better compared to non-plain-woven.

Keywords: Geosynthetics, Coir geotextile,CBR,Unpaved Road, Woven and Non-woven Geosynthetics, Cyclic Plate Load Test

1.INTRODUCTION

The options of expansive soil behaviour that are critically reviewed area unit soil structure, swelling potential (intrinsic expansiveness), swelling pressure, volumetric(swelling and shrinking) strains, shear strength, cyclic swelling strain and also the associated effects of applied external load. The definitions and strategies of determinant these options area unit

thought of and their shortcomings area unit noted. additionally, the various heave prediction strategies and soil models, revealed over the last fifty years area unit reviewed. The degree of empiricism or rationality of the models and strategies area unit highlighted.

Expansive or swelling soils area unit soils that, thanks to their mineralogical composition, expertise massive volume changes or volumetrically strains once subjected to wet changes. They swell on wetting and shrink on drying severally. (Bolt, 1955; Jennings and Knight, 1957). These soils area unit unremarkably mentioned in literature as active soils, swelling soils or volumetrically active soils. during this thesis, they're known as expansive soils (Gromko, 1974; Gens and Alicia Alonso, 1992). the power of the soil mineral to sorb and absorb water is its intrinsic property, which ends from its mineral composition. Schreiner (1987) known as it intrinsic expansiveness.

2.LITERATURE REVIEW

R. M. Tailor et al., (DEC 2011) geotextile as reinforcement in versatile pavement for swelling subgrade.Pilot initial field observations throughout execution traffic have established practicableness of use of geotextile reinforcement in pavement to regulate performance. The observations when two monsoons can solely ensure its capability to switch cushion of 600 to a thousand millimeter for expansive subgrades (IRC:37-2001). Future studies are assessing minimum durability of cloth and additional embedment over traffic zone.

K.S.Gill, et al., (2012), has conducted series of California bearing quantitative relation (CBR) and swell tests to judge the helpful effects of inserting one layer of reinforcement horizontally at variable depths from the highest surface of the subgrade soil. The position of the reinforcing layer is optimized for 2 differing kinds of reinforcement specifically, geogrid and jute geotextile. Results disclosed that insertion of one layer of reinforcement at intervals the expansive soil subgrade controls the swelling considerably. the proportion reduction in swell potential but depends on its depth of embedment and also the variety of reinforcement used. The cosmic microwave background worth of the soil will increase well once one layer of reinforcement is placed horizontally at intervals the soil. The extent of improvement depends on the sort of reinforcement and also the embedment quantitative relation. The jute geotextile offers an improved reinforcing potency as compared to the geogrid and might be used for low value road comes in rural areas. however, sturdiness study is needed for long run application of the jute geotextile.

KundanMeshram et al., (Oct 2013)Application of fibre Geotextile in Rural Roads Construction on before Christ Soil Subgrade.Results Revelled that one. there's a necessity for rising the engineering characteristics of before Christ soil for building. 2. Incorporation of CGT between sub-grade and sub-base layer is an rising technology. It not solely stops flowing of water however additionally brings reduction in thickness. The ingress of flowing water into the sub-grade is stopped by introducing the geotextile layer or membrane at the interface of Granular Sub-base layer (GSB) and sub-grade that retains the intrusion of sub-grade soil into the interstices of granular sub-base layer, and this allows correct operate of GSB as evacuation layer. 3. it's reducing intensity of stress on subgrade

Rishi Srivastava et al., (July 2016) conducted on result of plain-woven Polyester Geotextile on the Strength of Black Cotton Soil.dry density worth is increasing with reduction in optimum wet content with maximum worth of one.84g/cc at 16 pf OMC for 100mm depth from the

highest of mould, because of bigger soil to soil interaction provided by geotextile,because the house that was earlier occupied by air particles area unit currently replaced with soil particle having bigger density. The cosmic microwave background worth of soil will increase by three.43% and 6 June 1944 for geotextile placed at H/5 and 2H/5 depths from high of specimen. cosmic microwave background worth of soil decreases for 75mm (3H/5) and a 100millimetre (4H/5) depth of geotextile placement from high, that is even below the cosmic microwave background worth of unreinforced soil. the advance in soil properties is seen in higher layers, this might ensue to a lot of resistance offered by geotextiles to penetration and there's improvement in load-penetration behaviour. the foremost optimum position of geotextile placement is at 2H/5 (50mm) depth from high of compacted specimen wherever most improvement in cosmic microwave background worth was seen. the utilization of geotextile in soft subgrade causes reduction in thickness demand of pavement, will increase the service life and reduces the frequency of maintenance needed, leading to economical pavement style

3.MATERIALS USED

3.1 Origin of Expansive Soil

Expansive soils area unit largely found within the arid and semi-arid regions and it covers terribly massive space of the planet. It covers nearly two hundredth of the land in Bharat and includes nearly the whole Deccan upland, Western Madhya Pradesh, components of Gujarat, Andhra Pradesh, state, Karnataka, and geographic region. The swelling soils area unit unremarkably proverbial by the name of Black Cotton Soils. For swelling to occur, these soils should be at first unsaturated at some water content. If the unsaturated soil gains water content, it swells. On the opposite hand, if a decrease in water content happens the soil shrinks. The presence of montmorillonite soil in these soils imparts them high swell–shrink potentials.

3.2Nature of Expansive Soil

Swelling in soils is sub-categorized into 2 distinctive varieties, namely:

Elastic rebound within the compressed soil mass because of reduction in compressive force.Imbibing of water leading to enlargement of water-sensitive soils. Swelling soils area unit, the soils that exhibit latter variety of swelling, wherever the soil minerals with mostly inflating lattice area unit gift. one in every of the elemental characteristics of soil is that they show very little cohesion and strength once wet, however they become exhausting once empty of water. However, all of them don't swell because of wetting action. Decrease in final bearing capability at saturation, and enormous differential settlement because of this happens. Thus, soils exhibit foundation issues.

3.3 Soil geology

On the premise of their crystalline arrangement, soil minerals is categorised into 3 general teams, namely:

- Kaolinite cluster
- Montmorillonite cluster
- Illite cluster

3.3.1 Mineral cluster

A soil mineral that encompasses a chemical composition Al2Si2O5(OH)4 is termed mineral. this kind of soil mineral encompasses a superimposed salt, with linkage to at least one

octahedral sheet of corundom through element atoms. China soil or kaoline is that the name given to rocks that area unit made during this mineral. A thickness of 7Å is exhibited by the stacked layers of kaolinite; as a result of this, kaoline cluster of minerals area unit seen to be the foremost stable, that is additionally thanks to the very fact that water cannot enter between the sheets to inflate that building block**.**

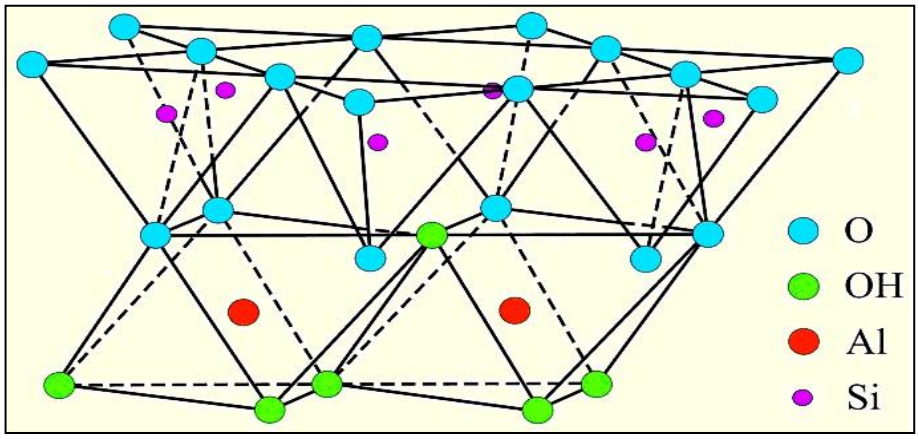

Fig 1.1: Atomic Structure of Kaolinite

3.3.2 Montmorillonite Group

Montmorillonite cluster Two silicon oxide tetrahedral sheets combined with a central corundom octahedral sheet comprise the structural arrangement of Montmorillonite. The bond between crystal links is weak here. Thus, the soil containing higher share of Montmorillonite minerals demonstrate high shrinkage and swelling characteristics, looking on the character of exchange-able cations gift. The common layer of a Montmorillonite unit is made by one in every of the hydroxyl group layers of the octahedral sheet and therefore the tips of the tetrahedrons from every oxide sheet. Atoms that square measure common to each oxide and mineral layers ne'er participate within the method of swelling. throughout weak bond between the crystal forms, water will penetrate, breaking the structures to 10Å structural units.

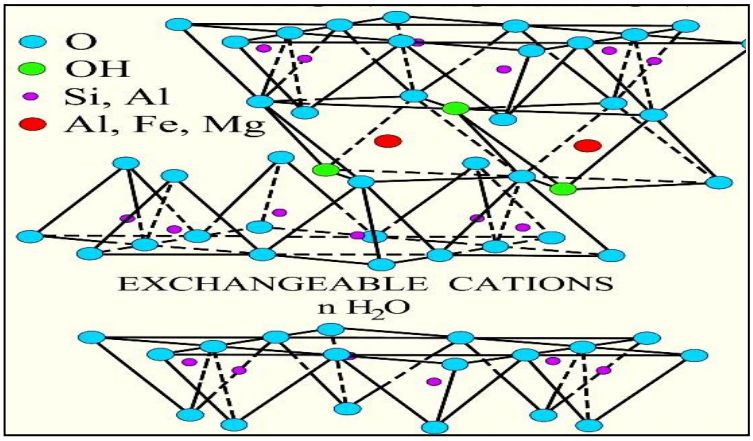

Fig 1.2:Atomic Structure of Montmorillonite

3.3.3Illite Group

As so much as structural arrangement cares, Illite minerals fall between Montmorillonite and mineral cluster. As just in case of Montmorillonite unit structure, 2 oxide tetrahedral sheets combined with a central aluminum oxide octahedral sheet comprise the

structural arrangement of Illite. The spacing between the elementary silica-gibbsite-silica sheets depends for the most part upon the provision of water to occupy the house. due to this reason, Montmorillonite is believed to own associate increasing lattice. However, in presence of excess water, Illite will separate into individual layers of 10mm thick.

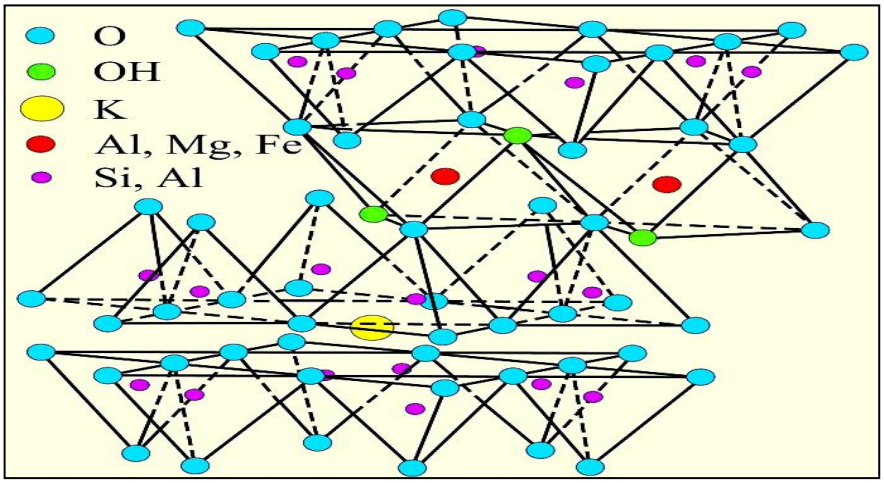

Fig 1.3:Atomic Structure of Illite

3.4 Types of Fibers

Fibers may be classified into a pair of varieties, fiber and fiber. Some normally used fibers square measure coconut fiber, sisal fiber jute fiber, amphibole fiber, metallic fiber etc,

3.4.1 Artificial Fiber: the varied kinds of artificial fibers square measure polypropene, Nylon, plastic, glass amphibole etc., those square measure most popular than the natural fibers as a result of their higher strength and resistance. polypropene fiber square measure proof against acidic, alcalescent and chemicals. These fibers square measure high lastingness, resistance to ocean water and high freezing point i.e., 1650C. Polyamide has inherent defect of obtaining stricken by the ultraviolet rays from sun however because the fiber square measure embedded they're not affected. Associate in Nursing expertise fiber, no chemical changes has been detected. artificial fibers additionally show a good biological resistance. polypropene fibers square measure vulnerable to hearth and sun light-weight that much cannot reach within the soil.

3.4.2 Coconut coir Fiber

Use of waste product and fiber for up soil property is advantageous as a result of their low-cost, domestically obtainable and eco-friendly. fiber could be a natural perishable material profusely obtainable in some elements of south and coastal regions of India. the employment of natural materials like jute, cotton, coir, sisal etc. as reinforcing materials in soil started within the early nineties. Fibers like polypropene have glorious chemical resistance, denseness, high freezing point and moderate price. of these builds it a very important fiber in construction applications. Fiber structure of polypropene consists of crystalline and non-crystalline regions.Fibers square measure of 2 types: natural fibers and artificial fibers. each the kinds square measure used for applied science functions. Natural fibers won't cause environmental issues square measure low-cost compared to artificial fibers, for end of the day these natural fibers can bear biodegradation, exception is for fiber fibers. On the opposite hand artificial fibers square measure pricey despite the fact that there will serve for long run they

cause environmental issues. but the lifetime of natural fibers like fiber may be checked by coating with some admixture on the fiber surface

3.5 Copper slag

Copper slag could be a by-product created throughout the extraction of copper from copper ore victimization smelting and processing method. As refineries draw metal out of copper ore, they turn out an oversized volume of metallic dirt, soot and rock that together compose slag that may be used for a stunning range of applications within the building and industrial fields.

4 METHODLOGY

4.1 Tests employed in this Investigation varied laboratory experiments have conducted on soil sample treated with totally different proportions of admixtures and additionally on untreated soil sample during this investigation square measure explained below as per the IS code of apply.

4.1.1 Relative density Test

At Specific gravity is that the magnitude relation of the mass of unit volume of soil at a explicit temperature to the mass of identical volume of gas-free water at a explicit temperature. the precise gravity of a soil is employed within the part relationship of air, water, and solids in a very given volume of the soil. relative density takes a look at was dispensed by Pycnometer as per IS: 2720 Part3 (1980).

4.1.2 Differential Free Swell test

The free swell of soil as per IS: 2720 half XL (1977). Free swell or differential free swell, additionally termed as free swell index, and is that the increase in volume of soil with none external constraint once subjected to submersion in water. Free Swell Index = [Vd-Vk]/Vkx100% Where, Vd = volume of soil specimen scan from the graduate containing water. Vk = volume of soil specimen scan from the graduate containing hydrocarbon.

4.1.3 Grain Size Analysis test

At The distribution of various grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution, and it's needed in classifying the soil. Grain size analysis tests square measure still a number of the foremost valuable guides to the engineering behaviours of soils within the context of geotechnical engineering. Coarse particle and fine particle size distributions were determined, during this study, in accordance with take a look at ways IS: 2720Part4 (1985) severally. This methodology is followed for size of particles over 75micrometres solely. measuring instrument analysis was dispensed for size of particles but 75micron. Dry sieve analysis is appropriate for cohesion less soils and if the soil contains a considerable number of fine particles, a wet sieve analysis is needed.

4.1.4 Atterberg Limits

Liquid limit and plastic limit are termed as Atterberg limits. Liquid Limit (LL) is outlined because the wet content at that soil begins to behave as a liquid material and begins to flow. Plastic Limit (PL) is outlined because the wet content at that soil begins to behave as a plastic material. Liquid limit and plastic limit tests were dispensed as per IS:2720 Part5 (1985). Liquid limit tests were conducted victimization 2 totally different equipment specifically Casagrande equipment and cone penetration equipment.

4.1.5 Casagrande methodology

Liquid limit of soil was firm with the assistance of normal equipment designed by Casagrande. concerning one hundred twenty g of the soil sample passing 425 micrometres IS Sieve shall be mixed totally with water within the evaporating dish or on the flat glass plate to create a homogenous paste. The paste placed within the brass cup of Casagrande equipment and also the groove is cut with the quality formation tool. The handle is turned at a rate concerning a pair of revolutions per second and also the numbers of blows square measure counted till very cheap of the groove on a distance of 10mm because of flow and not by sloppy. concerning ten g of soil from close to the closed groove is taken into the chamber to work out water content of the soil sample. This method is perennial at totally different water contents of the soil sample.

4.1.6 Liquid Limit

A flow curve shall be planned on a semi power graph representing water content on the arithmetic scale and also the range of drops on the graduated table. The flow curve could be a line drawn as nearly as potential through the four or a lot of planned points. The wet content resembling 25 drops as scan from the curve shall be rounded off to the closest number and reportable because the liquid limit of the soil.

4.1.7 Plastic Limit test

At Plastic limit of Clay is decided from soil that is passing through the 425-micrometre sieve,which is mixed with water till the soil mass becomes plastic enough to be simply remoulded. A ball is made with concerning 8 g of paste and rolled between figures up to 3mm diameter and the sample is once more remoulded into a ball. This method of rolling and remoulding is perennial till the thread starts simply crumbling at a diameter of 3mm.The crumbling threads are unbroken for water content determination. The take a look at is perennial 2 or thrice and also the average water content square measure taken that is treated because the plastic limit test.

4.1.8 Compaction test

Standard proctor compaction tests were conducted as per IS: 2720 half 7(1980) on varied mixes ready on basis of dry weight. The mould of normal volume adequate 1000cc is employed. The mould is crammed up with the fabric to be compacted by 25 blows in 3 layers. customary hammer of 2.45 weight unit weight falling from a height of 30cm is employed for compaction. test is perennial at totally different water contents. Dry density is calculated the least bit water contents thus on acquire the compaction curve between wet content and dry measure weight. The water content resembling most dry density achieved is taken because the optimum wet content

4.1.9 Calif. Bearing magnitude relation test

The cosmic microwave background radiation takes a look at could be a penetration take a look at which provides a live of the load spreading ability of the pavement. this is often solely even within the case of versatile pavements. The cosmic microwave background radiation tests were performed as per IS: 2720 half 16. to arrange the samples for cosmic microwave background radiation, take a look at, totally different mixes chosen were compacted statically in customary moulds at optimum wet content and most dry density. The dimension of the soil sample for cosmic microwave background radiation takes a look at is taken as 150mm diameter and a hundred 25 metric linear unit height. Surcharge weight of 25 N was used

throughout the testing. A metal penetration plunger of diameter fifty metric linear unit and one hundred metric linear unit long was accustomed penetrate the samples at the speed of one.25 mm/minute victimization computerised cosmic microwave background radiation testing machine. Soaked cosmic microwave background radiation tests were conducted when 96 hours soaking. For soaking samples were placed in a very tank maintaining constant water level throughout the amount.

4.2 Cyclic Plate Load test

Plate Load take a look at could be a field or laboratory take a look at for deciding the last word load carrying capability of soil and also the most settlement below an applied load. the scale of model flexible pavement is of 20cm untreated or treated expansive soil sub grade, 5cm of gravel cushion as sub base and WBM-III as base course for conducting laboratory cyclic plate load test. The plate load takes a look at essentially consists of loading a plate placed at the muse level and recording the settlements resembling every load increment. The load applied is step by step accumulated until the plate starts to sink at a fast rate. the entire price of load on the plate in such a stage divided by the realm of the plate offers the worth of the last word bearing capability of soil. the last word bearing capability is split by appropriate issue of safety (which ranges from a pair of to three to reach the worth of safe load capability of soil

Fig 4.1Experimental Setup for Cyclic Plate Load Test

These tests were administered on flexible pavements systems in an exceedingly circular steel tank of diameter 60cm as shown in plate three.10. The loading was done through a circular metal plate of 10cm diameter arranged on the model flexible pavement system. The steel tank was placed on the pedestal of the compression testing machine. 2 dial gauges of least count zero.01mm were organized as shown in plate three.11 for getting the deformations. A 5 Ton capability hydraulic jack was placed on the loading. Cyclic load tests were allotted at OMC state love tire pressures of 500,560,630,700 and 1000kPa. every pressure increment was applied till there was no vital amendment in deformation between the consecutive cycles. The testing was additional continuing until the prevalence of failure of the model pavement to record the final word load for with or while not the geo-textile as reinforcement and extractor.

5 RESULT AND DICUSSIONS

Table 5.1 Soil Properties For this work, expansive black cotton soil was procured from Allavaram, close to Amalapuram, state. The black cotton soil was collected by

technique of disturbed sampling once removing the highest soil at a 1000 Millimetre depth and transported in sacks to the laboratory. very little quantity of the sample was sealed in polyethylene bag for deciding its natural wet content. The soil was air dried, powdery and sieved with 4.75 millimetre Indian as needed for laboratory check.Table 5.1 Properties of Soil

Table 5.1 soil mechanical properties

Sl.No	Property	Value
1	Specific Gravity (G)	2.64
2	**Atterberg's limits**Liquid Limit (%) Plastic Limit (%) Plasticity Index(%)	72 32.5 39.5
3	**Compaction properties** Optimum Moisture Content, O.M.C. (%) Maximum Dry Density, MDD (g/cc)	29.05 1.48
4	**Grain size distribution** Sand (%) Silt (%) Clay (%)	7 30
5	IS Classification	CH
6	Unconfined Compressive Strength (kg/cm^2)	1.48
7	California Bearing Ratio(%)	1.79
8	Differential Free Swell(%)	140

5.2 Copper Slag Properties

Copper slag could be a by-product created throughout the extraction of copper from copper ore victimisation smelting and processing method. As refineries draw metal out of copper ore, they manufacture an outsized volume of aluminous dirt, soot and rock that jointly form up dross that may be used for a stunning variety of business.

Table 5.2 Properties of Copper Slag

S.No	Property		Value
1	Specific Gravity		3.8
2	Grain Size Distribution (percent finer than)	4.75mm	100
		2.0mm	40
		0.6mm	42
		0.425mm	17
		0.21mm	4.5
		0.075mm	2.0

5.3 Properties of Coir Geotextile

Coir fiber made from natural fibers is progressively finding an area as erosion management. are often} in spite of the very fact that sturdy fibers like fiber that have a really high polymer content can be effectively created use of as a reinforcing material, provided they're given appropriate treatment. In recent days it's been investigated that addition of fibers can improve the plasticity behaviour of the soil there by reducing the event of crack throughout shrinkage.

Table 5.3 Physical and Chemical Properties of Coir Geotextile

Chemical Properties		**Physical Properties**	
Description	**Value**	**Description**	**Value**
Lignin	45.84%	Length in inches	6.8
Cellulose	43.44%	Density(g/cc)	1.40
Hemi-cellulose	00.25%	Tenacity (g/Tex)	10.00
Pectin‘s and related compound	03.00%	Breaking Elongation (%)	30
Water soluble	05.25%	Diameter in mm	0.1 to 1.5
Ash	02.22%	Rigidity of modulus	1.8924 dyne/cm^2
Swelling in water (diameter)	5%	---	---
Moisture at 65%RH	10.50%	---	---

5.4 Compaction Test

5.4.1 OMC and MDD Values of Untreated Soil

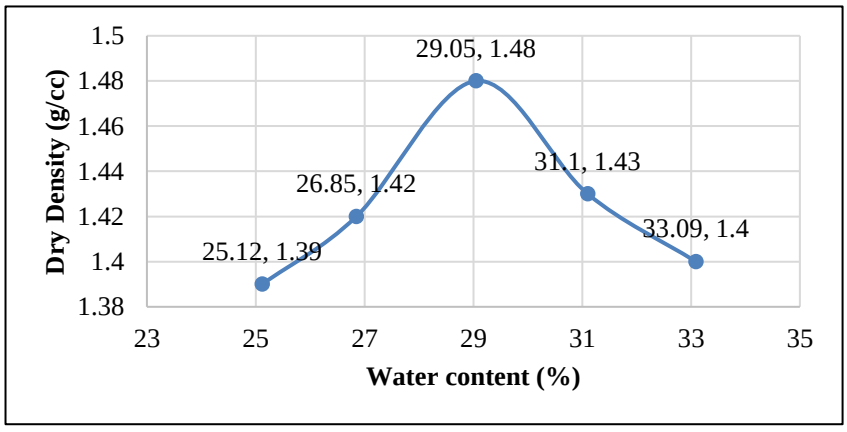

Fig 5.1 OMC and MDD Values of Untreated Soil

5.4.2 OMC and MDD Values of Expansive Soil Treated with 18% of Copper Slag

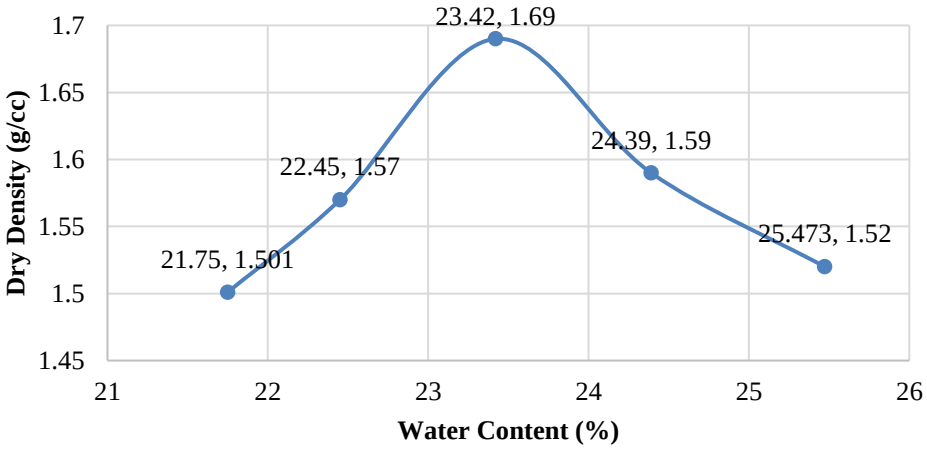

Fig 5.2 OMC and MDD Values of Expansive Soil Treated with 18% of Copper Slag

5.4.3 OMC and MDD Values of Expansive Soil Treated with 19% of Copper Slag

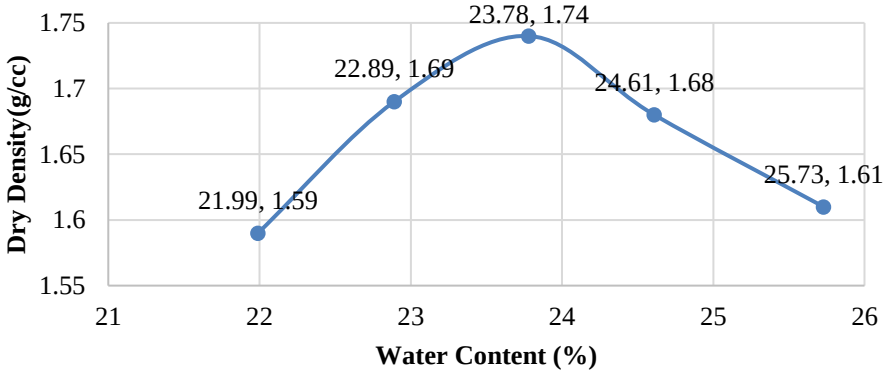

Fig 5.3 OMC and MDD Values of Expansive Soil Treated with 19% of Copper Slag

5.4.4 OMC and MDD Values of Expansive Soil Treated with 20% of Copper Slag

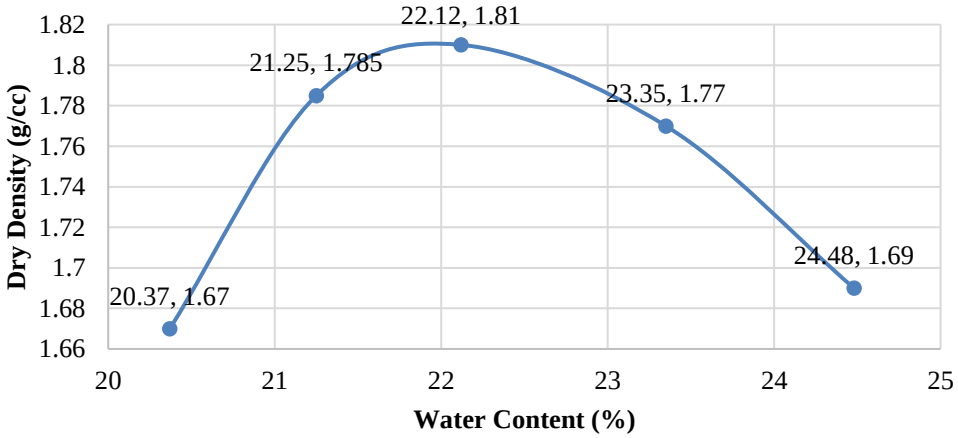

Fig 5.4OMC and MDD Values of Expansive Soil Treated with 20% of Copper Slag

5.4.5 OMC and MDD Values of Expansive Soil Treated with 21% of Copper Slag

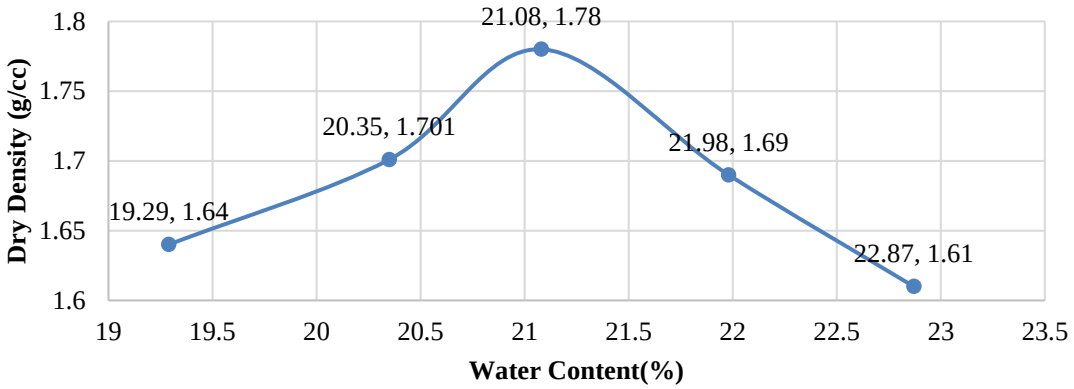

Fig 5.5 OMC and MDD Values of Expansive Soil Treated with 21% of Copper Slag

5.4.6 OMC and MDD Values of Expansive Soil Treated with 22% of Copper Slag

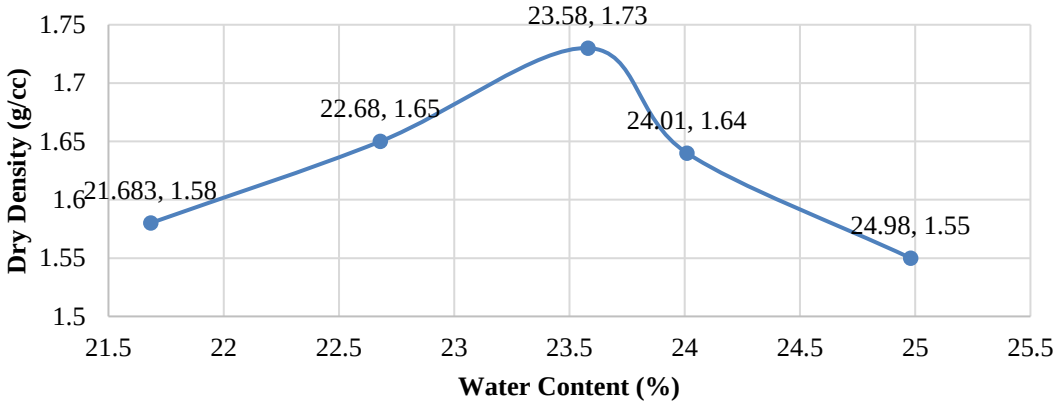

Fig 5.6OMC and MDD Values of Expansive Soil Treated with 22% of CopperSlag

5.4.7 Summary

Table 5.4 OMC and MDD Values of Expansive Soil treated with Various % of CopperSlag

SI.No	Mix Proportions	MDD (g/cc)	OMC (%)
1	Soil only	1.48	29.05
2	Soil + 18% of Copper Slag	1.69	23.74
3	Soil + 19% of Copper Slag	1.74	23.28
4	**Soil + 20% of Copper Slag**	**1.81**	**22.12**
5	Soil + 21% of Copper Slag	1.78	22.38
6	Soil + 22% of Copper Slag	1.73	23.58

- From the values, it is Noticed that the Maximum Dry Density of expansive soil increases up to the soil treated with 20% of copper slag. Beyond that value MDD will be decreases.

- From the values, it is observed that the Optimum Moisture Content of expansive soil decreases up to the soil treated with 20% of copper slag. Beyond that value OMC will be increases.

5.5 California Bearing Ratio Test

5.5.1 CBR Value for Untreated Soil in Unsoaked Condition

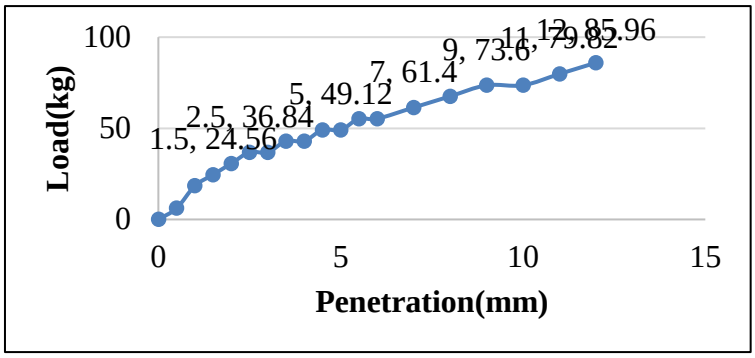

Fig 5.7CBR Value for Untreated Soil in Unsoaked Condition CBR Value = 2.68 %

5.5.2 CBR Value for Untreated Soil in Soaked Condition

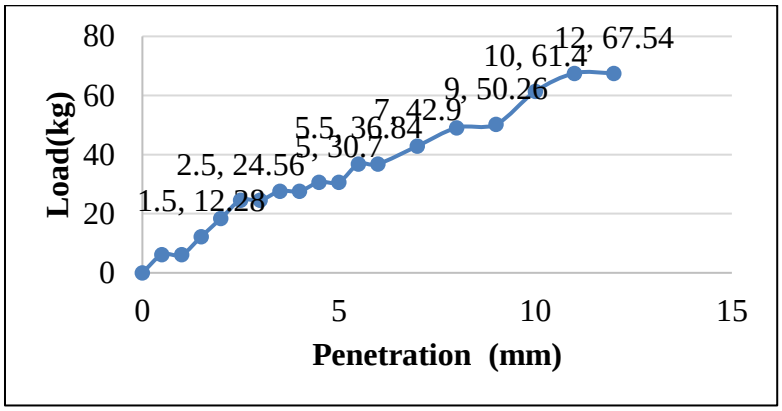

Fig 5.8 CBR Value for Untreated Soil in Soaked Condition CBR Value = 1.79%

5.5.3CBR Value for Soil Treated with 18% of Copper Slag in Soaked Condition

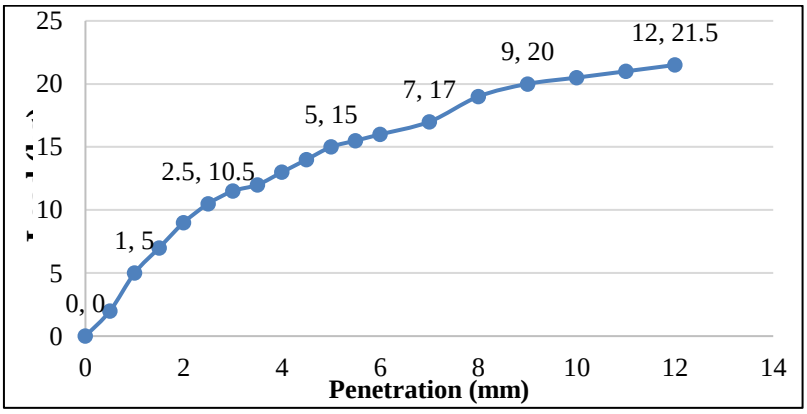

Fig 5.9CBR Value for Soil Treated with 18% of Copper Slag in Soaked Condition

CBR Value = 3.80%

5.5.4 CBR Value for Soil Treated with 19% of Copper Slag in Soaked Condition

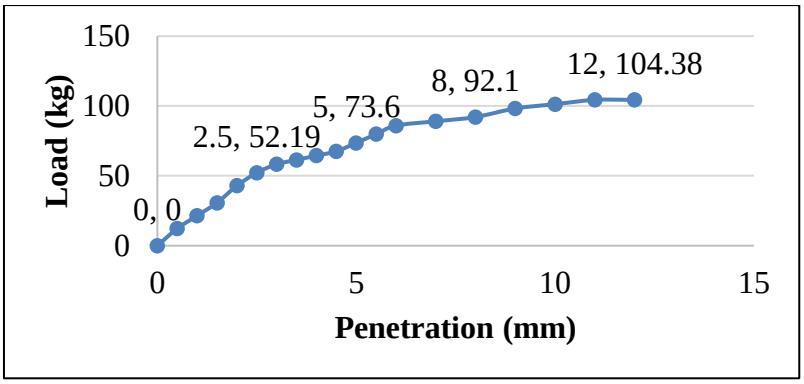

Fig 5.10 CBR Value for Soil treated with 19% of Copper Slag in Soaked Condition CBR Value = 4.03%

5.5.5 CBR Value for Soil treated with 20% of Copper Slag in Soaked Condition

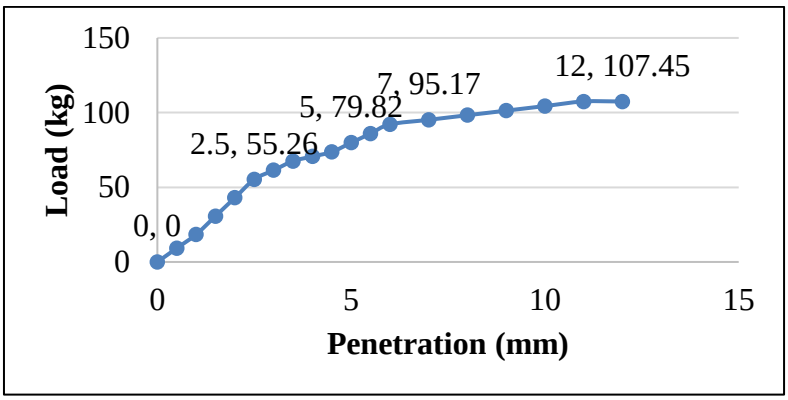

Fig 5.11 CBR Value for Soil treated with 20% of Copper Slag in Soaked Condition CBR Value = 4.48%

5.5.6 CBR Value for Soil treated with 21% of Copper Slag in Soaked Condition

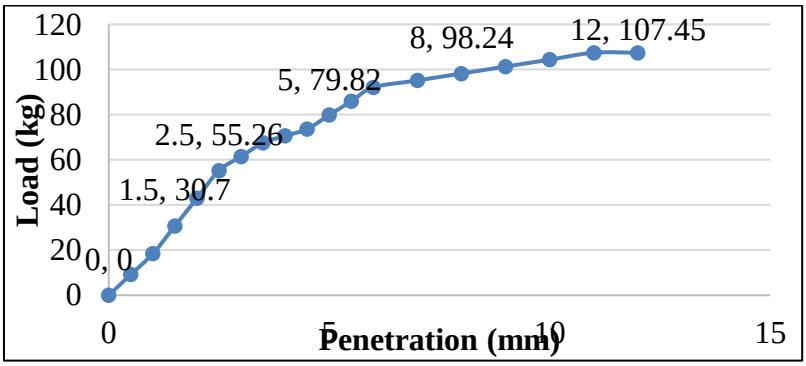

Fig 5.12 CBR Value for Soil treated with 21% of Copper Slag in Soaked Condition CBR Value = 4.25%

5.5.7CBR Value for Soil treated with 22% of Copper Slag in Soaked Condition

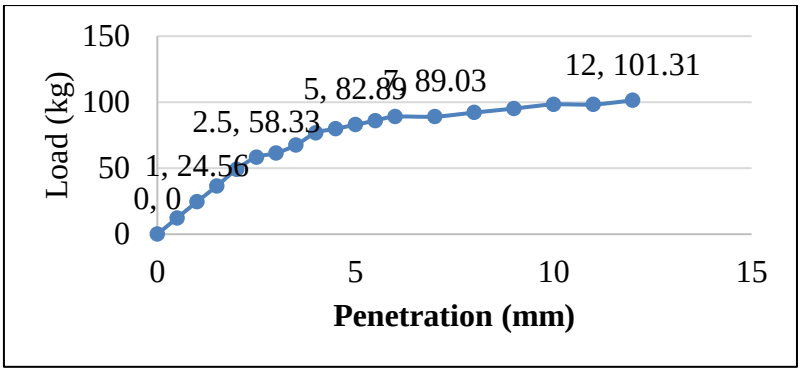

Fig 5.13 CBR Value for Soil treated with 22% of Copper Slag in Soaked Condition

CBR Value = 3.80%

5.5.8 CBR Value for Soil and Sub-base in Soaked Condition

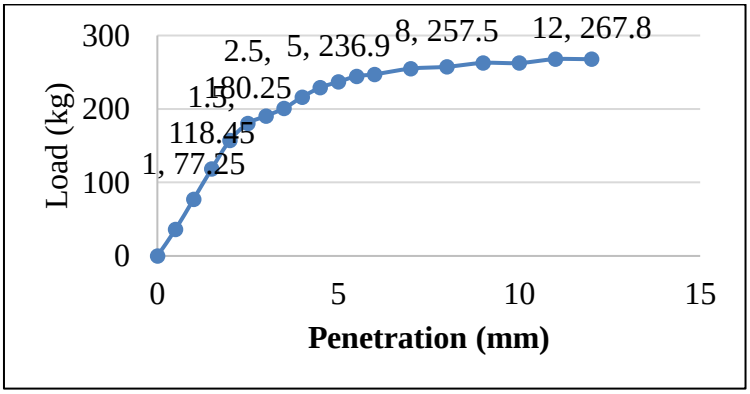

Fig 5.14 CBR Value for Soil and Sub-base in Soaked ConditionCBR Value = 4.70 %

5.5.9CBR Value of Treated Expansive Soil +20% CSwith Nonwoven Geotextile Placed at Middle of Subbase in Soaked Condition

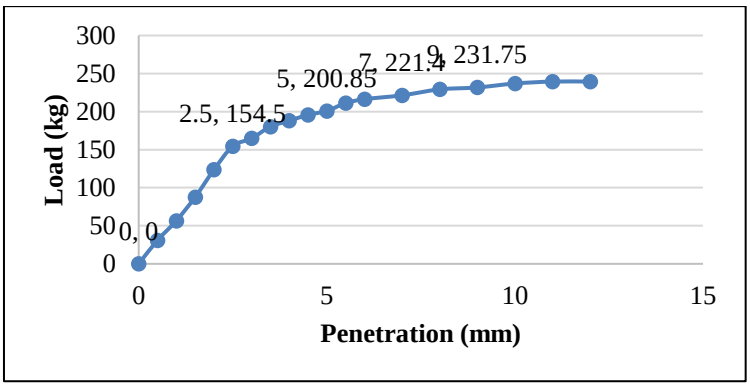

Fig 5.15CBR Value of Treated Expansive Soil+20% CS with Non woven Geotextile Placed at Middle of Sub-base in Soaked Condition CBR Value = 11.27%

5.5.10 CBR Value of Treated Expansive Soil+20% CS with Woven Geotextile Placed at Middle of Sub Base in Soaked Condition

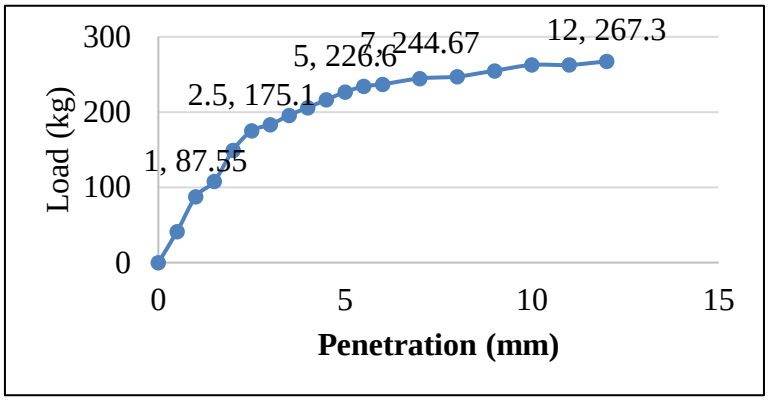

Fig 5.16CBR Value of Treated Expansive Soil+20% CS with Woven Geotextile Placed at Middle of Sub base in Soaked Condition CBR Value = 12.78%

5.5.11 CBR of Treated Expansive Soil+20% CS with Nonwoven Geotextile at Interface of both Layers in Soaked Condition

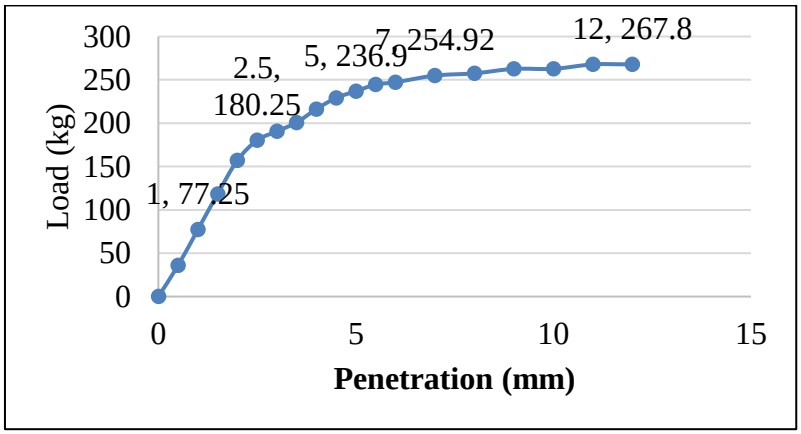

Fig 5.17CBR of Treated Expansive Soil+20% CS with Nonwoven Geotextile at Interface of both Layers in Soaked Condition CBR Value = 13.15 %

5.5.12CBR of Treated Expansive Soil+20% CS with Woven Geotextile at Interface of both Layers in Soaked Condition

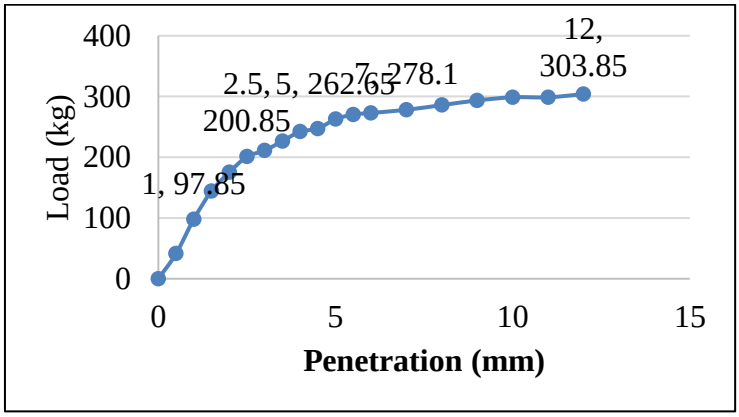

Fig 5.18CBR of Treated Expansive Soil+20% CS with Woven Geotextile at Interface of both Layers in Soaked Condition CBR Value = 14.66 %

5.5.13 Summary

Table 5.5 CBR Values of Copper Slag treated and Geotextile Reinforced Soil

S.No	Mix Proportion	CBR Value (%)
1	Soil in Unsoaked	2.68
2	Soil in Soaked	1.79
3	Soil + 18% of Copper Slag	3.80
4	Soil + 19% of Copper Slag	4.03
5	Soil + 20% of Copper Slag	4.48
6	Soil + 21% of Copper Slag	4.25
7	Soil + 22% of Copper Slag	3.80
8	Soil + Sub base	4.70
10	Soil +20% CS+ Nonwoven Geotextile placed at middle of the Sub base	11.27
11	Soil + 20% CS+Woven Geotextile placed at middle of the Sub base	12.78
12	Soil +20% CS+ Nonwoven Geotextile placed at Interface of the both the layers	13.15
13	Soil + 20% CS+Woven Geotextile placed at Interface of the both the layers	14.66

5.6 Cyclic Plate Load Test

Cyclic plate load tests square measure additional important for crucial the final word load carrying capability of the pavements. Cyclic plate load tests were conducted within the laboratory on untreated and treated Expansive clay subgrade versatile pavements exploitation model tanks.

A circular steel tank with diameter 60cm is employed as model tank during this study for making ready model versatile pavement with variable thickness of 20cm of untreated and treated Expansive clay as subgrade, 5cm of gravel combine water at O.M.C as sub base set on subgrade and WBM-III of thickness 5cm used as base course set on sub base. plain-woven geo-textile and Non-woven geotextiles square measure used as a reinforcement and setup between subgrade & sub base and sub base & base course for treated Expansive clay model versatile pavement to make tensile force to supply.

5.6.1 Laboratory Cyclic Plate Load Test Results of only Expansive Soil at OMC

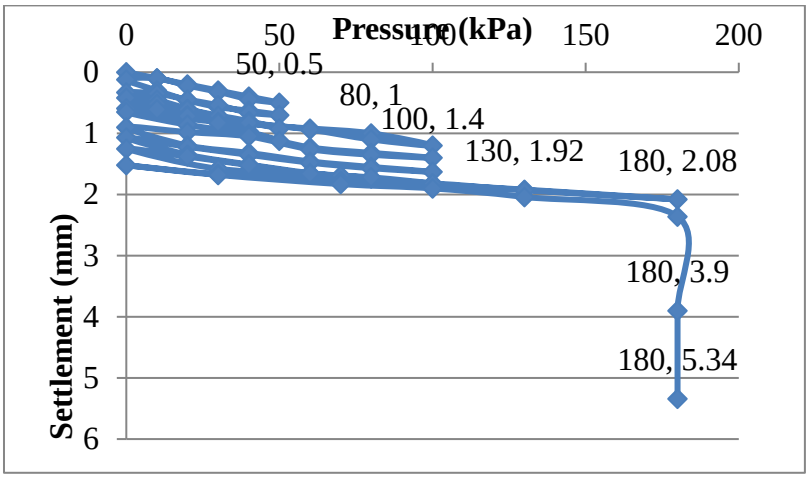

Fig 5.19 Cyclic Plate Load Test Results of Expansive Soil

5.6.2 Laboratory Cyclic Plate Load Test Results of Untreated Expansive Clay Model Flexible Pavement

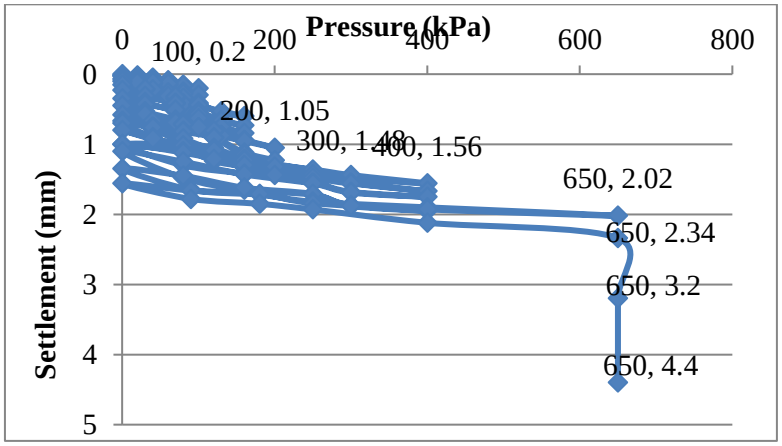

Fig 5.20 Cyclic Plate Load Test Results of Untreated Expansive Clay Model Flexible Pavement

5.6.3Laboratory Cyclic Plate Load Test Results of 20% Copper Slag Treated Expansive Soil subgrade model flexible Pavement at OMC

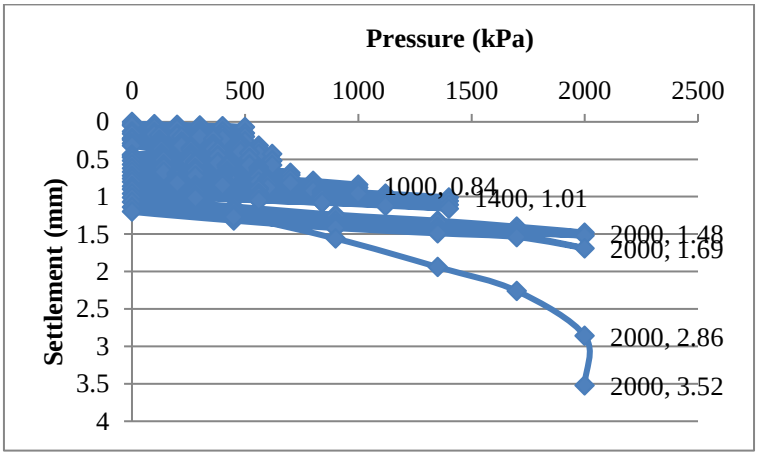

Fig 5.21 Cyclic Plate Load Test Results of 20% Copper Slag Treated Expansive Soil Subgrade Model Flexible Pavement at OMC

5.6.4Laboratory Cyclic Plate Load Test Results of 20% Copper Slag+ Single Woven Geotextile as Reinforcement and Separator for Treated Expansive Clay Flexible Pavement at OMC

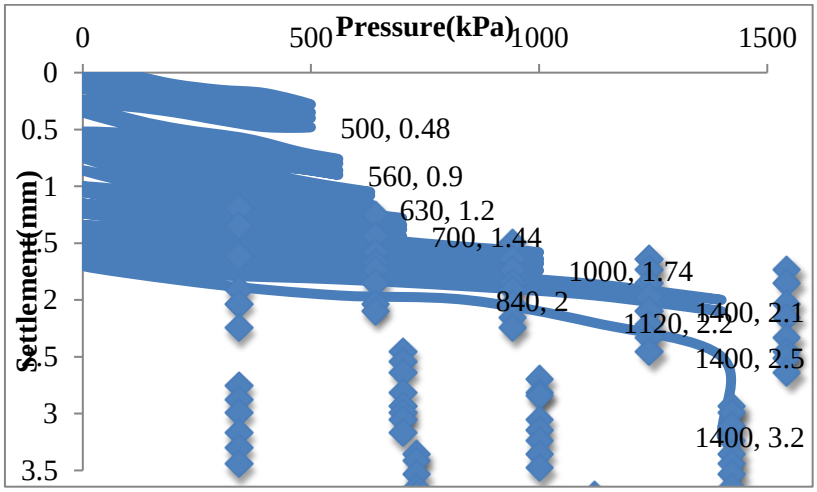

Fig 5.22 Cyclic Plate Load Test Results of 20% Copper Slag+ Single Woven Geotextile as Reinforcement and Separator for Treated Expansive Clay Flexible Pavement at OMC

4.6.5Laboratory Cyclic Plate Load Test Results of 20% Copper Slag + Double Woven Geotextile as Reinforcement and Separator for Treated Expansive Clay Flexible Pavement at OMC

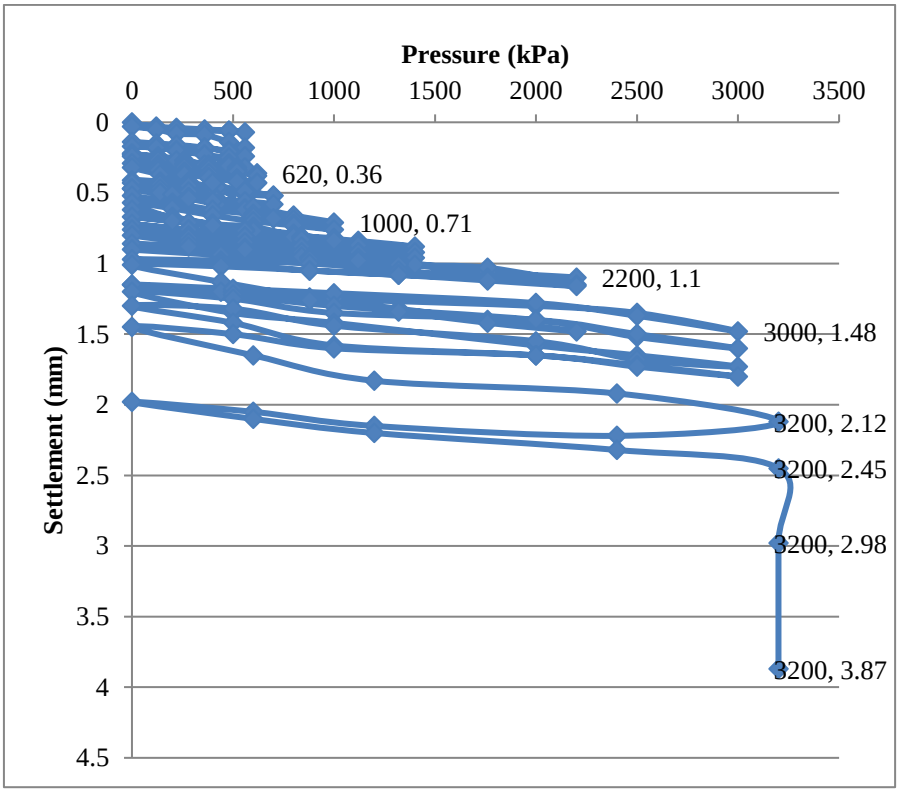

Fig 5.23 Cyclic Plate Load Test Results of 20% Copper Slag + Double Woven Geotextile as Reinforcement and Separator for Treated Expansive Clay Flexible Pavement at OMC

Table 5.6 Laboratory Cyclic Plate Load Test Results of Treated and Untreated Expansive Clay for Flexible Pavements at OMC

S.No	Type of Subgrade	Sub-Base	Base course	Pressure (kPa)	Settlement (mm)
1	Expansive Clay	-----	-----	180	2.08
2	Untreated Expansive clay	Gravel	WBM-III	650	2.02
3	Expansive Clay+ 20% Copper Slag	Gravel	WBM-III	1200	2.0
4	Expansive Clay+ 20% Copper Slag Single Woven Geotextile as reinforcement & separator provided between Sub grade and Sub-Base	Gravel	WBM-III	2200	1.9
5	Expansive Clay+ 20% Copper Slag + Double Woven Geo-textile as reinforcement & separator provided between Sub Base and Base Course	Gravel	WBM-III	3200	1.6

6 CONCULSION

From the check results obtained from laboratory studies, the subsequent conclusions square measure created.

- From the values, it's noticed that the driest density of expansive soil will increase up to the soil treated with 200th of copper slag. on the far side that worth MDD are going to be decreases.
- From the values, it's determined that the optimum wet content of expansive soil decreases up to the soil treated with 200th of copper slag. on the far side that, worth OMC are going to be will increase.
- From the values, it's determined that the most CBR worth earned at soil treated with 200th of copper slag.
- By the tests conducted it had been determined that optimum advantages were obtained by putting the plain-woven fiber geo textile at interface of each layers.
- CBR worth for each layer conducted on untreated expansive soil is four.705 %.
- When treated with copper slag cosmic microwave background radiation worth is seven.50 %.
- CBR worth for bolstered treated expansive soil is 14.66 %.
- It is noticed from the laboratory check results of cyclic plate load check that the final word pressure of treated marine clay subgrade flexible pavement has been raised by

650 kPa to 3200 kPa with relation to untreated expansive clay subgrade flexible pavements.

- It is noticed from the laboratory check results of cyclic plate load check that the overall deformations of treated marine clay subgrade versatile pavement have been improved by 25th at OMC relation to untreated marine clay subgrade flexible pavements.

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