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DOI: 10.48047/IJIEMR/V11/ISSUE 12/21

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Volume 11, ISSUE 12, Pages: 135-145

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A Laboratory Study on Effect of Random Inclusion of Jute Fiber on Strength Behavior of Brick Powder Treated Black Cotton Soil for Pavement Subgrade

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Abstract—Development of asphalt subgrades for streets and railroads on dark cotton soil (BC soil) is very hazardous on geo-specialized grounds in light of the fact that such soil is helpless to differential settlements, poor shear quality and high compressibility. Substance adjustment is one of the most seasoned strategies for adjustment of hazardous soil. Lately, it has been examined that expansion of filaments will improve the malleability conduct of the dirt there by diminishing the advancement of break during shrinkage. Extensive examination has been completed on the adjustment of extensive soils utilizing different added substances, for example, lime, bond, flyash, brick powder modern waste items and so on., and furthermore with irregular consideration of strands, for example, coir, sisal, polyester filaments and so on. Arbitrarily situated elastic considerations joined into soil to improve its heap misshapening conduct by communicating with the dirt particles precisely through surface contact and Effect of Random Inclusion of Jute Fibers on Strength Behavior of Brick Powder Treated Black Cotton Soil. This venture depicts the compaction and quality conduct of brick powder treated dark cotton soil (BC soil) strengthened with Jute filaments. The different level of Brick powder as 2%, 4%, 6% and 8% was utilized to discover the ideal estimation of Brick Powder. Jute fiber has been haphazardly included into the Brick Powder treated soil at four unique rates of fiber content, for example 0.5%, 1% 1.5%, and 2% (by weight of soil). The tests which were done are Atterberg's Limits, Modified compaction test, California bearing proportion test, unconfined pressure test and tri-hub test. The test outcome shows that quality properties of ideal blend of BC soil-Brick Powder examples fortified with Jute strands is apparently superior to anything untreated BC soil. And furthermore the quality of the blended soil increments with increment in days. Also, Cyclic Plate Load tests were done for the ideal rate got from the above test outcomes and the outcomes were dissected for the appropriateness of subgrade under specific loads in a model test tanks under research facility conditions. It was seen that the by including the various rates of Brick Powder, the ideal esteem accomplished at the careful level of 4%. Past the variety of any esteem is minimal. In the wake of including the various rates of Jute fiber to the Brick Powder balanced out sweeping soil the ideal estimation of the two blends were 1% Jute fiber.

***Keywords*— Expansive soil, Jute fiber, Brick powder, UCS, shear strength parameters and CBR.**

I. INTRODUCTION

For any land-based structure, the establishment is significant and must be solid to help the whole structure. Arranged by the establishment to be solid, the dirt around it assumes an exceptionally basic job. Along these lines, to work with soil we need legitimate learning about their properties and components which influence their conduct. The procedure of soil adjustment accomplishes the required properties in a dirt required for the development work. From the earliest starting point of the development work, the need of improving soil properties has gone to the light. Old human advancement of the Chinese, Romans and Incas used different strategies to improve the dirt quality and so on., a portion of the techniques were effective to the point that their structures streets still exist. In India, the cutting edge time of soil adjustment started in mid 1970's, with a general lack of oil and totals, it wound up important for the specialists to see intends to improve soil other than supplanting the poor soil at the structure site. Soil adjustment was utilized yet because of the utilization of out of date strategies and furthermore because of nonappearance of appropriate method, soil adjustment lost support. As of late, with the expansion in the interest for framework, crude materials and fuel, soil adjustment has begun to take another shape. With the accessibility of better research, materials and gear, it rising as well known and savvy strategy for soil improvement.

Here, in this present examination Brick powder and jute fiber have been utilized for adjustment of Black cotton soil. Itemized research facility tests were completed to find out the advantages regarding designing properties.

II. MATERIALS USED

Soil Sample

The dirt example utilized for testing has been gathered from THUMMALAPALLI town of East Godavari area of Andhra Pradesh. The dirt example utilized for the testing reason has been taken from profundity of about 1.0 to 1.5m subterranean dimension.

Figure 1 Soil Sample

Properties of Soil Sample:
This soil is classified according to I.S classification as inorganic clay of **High Compressibility (CH).**

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Table1:Properties of Expansive soil

S.NO	Laboratory Test	Symbol	Results	Relevant IS Codes
1	Differential Free Swell	DFS	**110%**	IS 2720 Part XI
2	Liquid Limit	WL	**79%**	IS 2720 Part V
3	Plastic Limit	WP	**38%**	IS 2720 Part V
4	Plasticity Index	PI	**41%**	IS 2720 Part V
5	Specific gravity	G	**2.52**	IS 2720 Part III
Grain size analysis				
1	Soil Classification		**CH**	IS 2720 Part IV
Compaction parameters (Modified Proctor test)				
1	Optimum Moisture content	OMC	**21.42%**	IS 2720 Part VIII
2	Maximum Dry Density	MDD	**15.99 KN/m3**	IS 2720 Part VIII
3	California Bearing Ratio (Soaked)	CBR	**1.76**	IS 2720 Part XVI
4	**California Bearing Ratio (Un Soaked)**	CBR	**2.6**	IS 2720 Part XVI
5	Unconfined Compressive Strength	UCS	**350KN/m^2**	IS 2720 Part X
Tri-axial test				
1	Cohesion		0.56kg/cm^2	
2	Angle of shearing resistance		2deg	IS2720S-11
Cyclic plate load test				
1	Settlement mm		3.3	**IS-5249**
2	Load kN		62	

Brick powder:
Brick dust is lavish material which on dumping not only occupy land but also it has environmental problems which is hazardous to livings. This waste is generated in brick kilns, brick masonry construction sites and during transportation. By recycling brick dust the problem could be solved up to some extent.

Figure2: Brick powder

Jute Fiber
Jute is one of the most reasonable regular strands, and second just to cotton in the sum delivered and assortment of employments. Jute filaments are made principally out of the plant materials cellulose and lignin. It falls into the bast fiber class (fiber gathered from bast, the phloem of the plant, in some cases called the "skin") alongside kenaf, mechanical hemp, flax (material), ramie, and so on. The modern term for jute fiber is crude jute. The strands are grayish to brown, and 1–4 meters (3–13 feet) in length. Jute is likewise called the brilliant fiber for its shading and high money esteem.

Figure3: Jute Fiber

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Properties of Jute Fiber:

Jute fiber is produced from plants in the genus *Corchorus*, family *Malvaceae*. Jute is a lignocellulosic fiber that is partially a textile fiber and partially wood. It falls into the bast fiber category (fiber collected from bast or skin of the plant). The chemical composition of jute fiber includes cellulose (64.4%), hemicellulose (12%), pectin (0.2%), lignin (11.8%), water soluble (1.1%), wax (0.5%), and water (10%). Jute fiber consists of several cells. These cells are formed out of crystalline microfibrils based on cellulose, which are connected to a complete layer by amorphous lignin and hemicellulose. Multiples of such cellulose and lignin/hemicellulose layers in one primary and three secondary cell walls stick together to form a multiple layer composite. These cell walls differ in their composition (ratio between cellulose and lignin/hemicellulose) and in the orientation of the cellulose microfibrils

Table 3Physical Properties of Jute Fiber

S.No.	Properties	Units	Values
1.	Length	mm	25
2.	Diameter	mm	2.0
3.	Specific Gravity	-	2.3
4.	Water Absorption	%	60-85%
5.	Density	KN/m^3	13.00
6.	Tensile strength	Mpa	340

III. DISCUSSION AND RESULTS

In this part, a nitty gritty exchange on the outcomes acquired from different lab tests is displayed. This section shows the consequences of the tests directed on soil by expansion of differing level of molasses and changing level of jute fiber. The tests were led so as to decide the accompanying properties.

- Index properties and order the dirt as per Indian Standards
- Proctor compaction (MDD&OMC) attributes of the dirt.
- California Bearing Ratio (CBR) attributes of the dirt.
- Variation of compaction esteems (MDD&OMC) with differing in level of BRICK POWDER Content.
- Variation of California Bearing Ratio (CBR) with differing in level of BRICK POWDER content.
- Variation of UCS with shifting in level of BRICK POWDER content.
- Variation of compaction esteems (MDD&OMC) with Optimum level of BRICK POWDER content alongside differing in level of BAMBOO Fiber content.
- Variation of California Bearing Ratio (CBR) with Optimum level of BRICK POWDER content alongside differing in level of BAMBOO Fiber content.
- Variation of UCS with Optimum level of BRICK POWDER content alongside changing in level of JUTE Fiber content
- Variation of Ultimate Cyclic Pressure and Settlement for Untreated Expansive soil subgrade with Model Flexible asphalt.
- Variation of Ultimate Cyclic Pressure and Settlement for Expansive soil subgrade treated with ideal rates of BRICK POWDER and JUTE FIBER for Model Flexible asphalt.

Differential Free Swell Index

Standard procedures recommended in the respective I.S. Codes of practice [IS:2720 (Part-5)-1985; IS:2720 (Part-6)-1972], were followed while finding the DFS viz.

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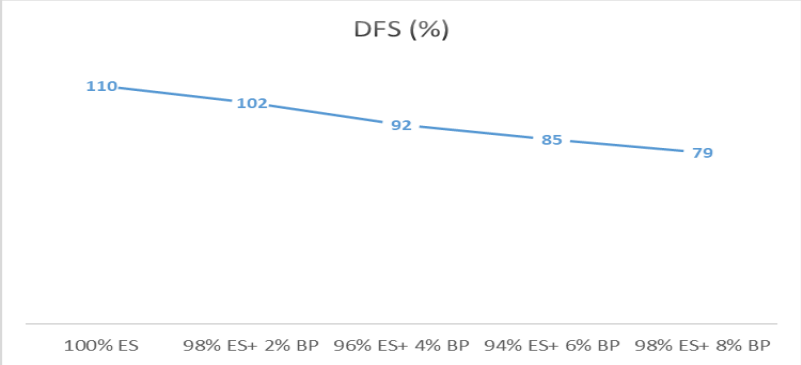
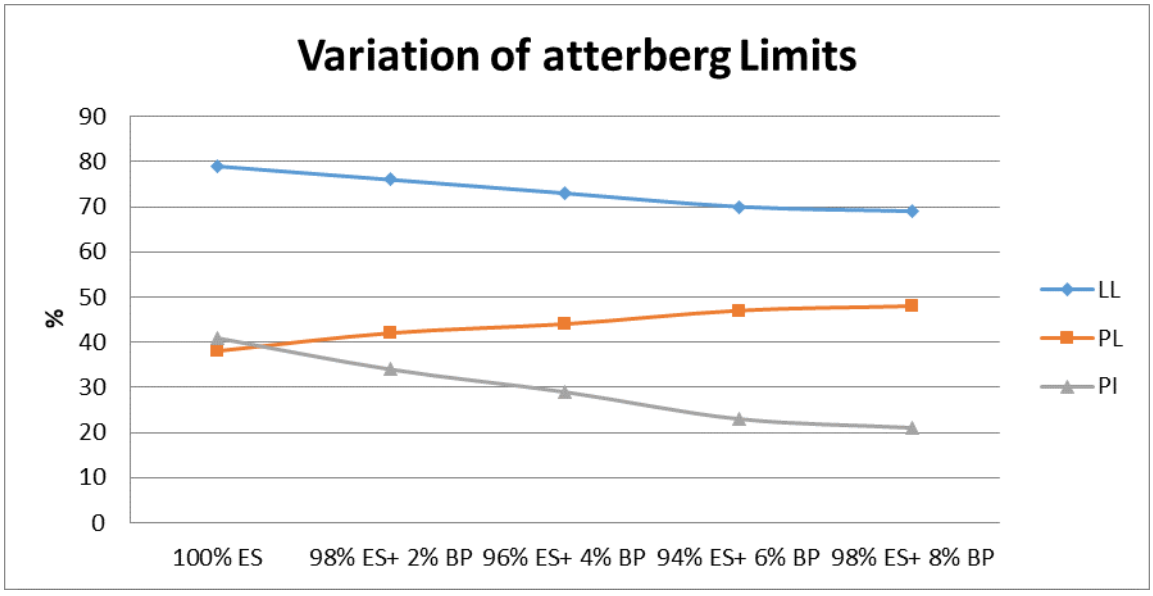


Graph 1 Variation of DFS of ES with different % of Brick powder

Index Properties

Standard methods prescribed in the individual I.S. Codes of training [IS:2720 (Part-5)- 1985; IS:2720 (Part-6)- 1972], were pursued while finding the Index properties viz. Fluid Limit and Plastic Limit of the examples attempted in this examination. The consequences of Liquid Limit tests on far reaching soil treated with various rates of Brick powder can be seen that with increment in level of Brick powder the fluid furthest reaches of soil continues diminishing from 79% to 68% when Brick Powder is expanded from 0 to 8% as appeared in fig. 5.1. The consequences of plastic Limit tests on far reaching soil treated with various rates of Brick powder can be seen that with increment in level of Brick Powder the plastic furthest reaches of soil continues expanding from 38% to 52% when Brick powder is expanded from 0to 8% as appeared in fig 5.2.



Graph 2 Variation of atterberg Limits of ES with different % of Brick powder

Compaction Test Results

IS Modified Proctor compaction tests were directed according to Seems to be: 2720 (Part VIII). The Compaction test is completed for both Brick powder and Jute fiber. At first the far reaching soil Samples are blended with various rates of Brick Powder and later with ideal of Brick powdeer blended with soil and various rates of jute fiber. Diagram are drawn between water substance and dry thickness for every rate augmentation of Brick Powder and bamboo fiber to the far reaching soil, from these outcomes Optimum Moisture Content and Maximum Dry Density esteems are determined. The outcomes and diagram from these tests are introduced beneath:

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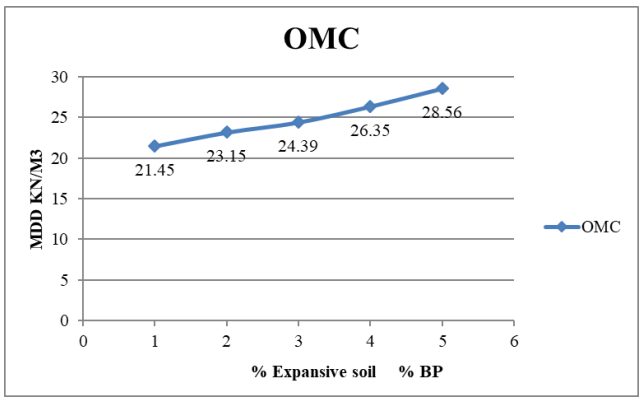
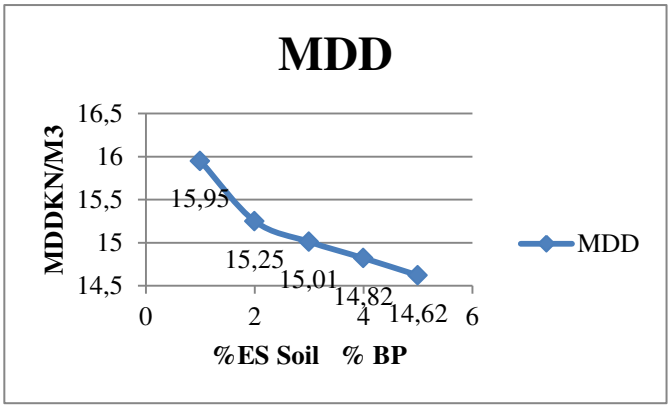
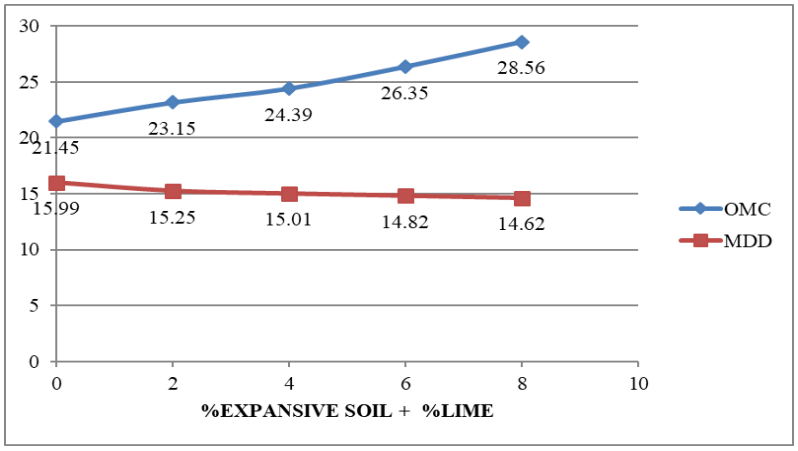




Graph 3 Variations of OMC for ES with different % of Brick powder

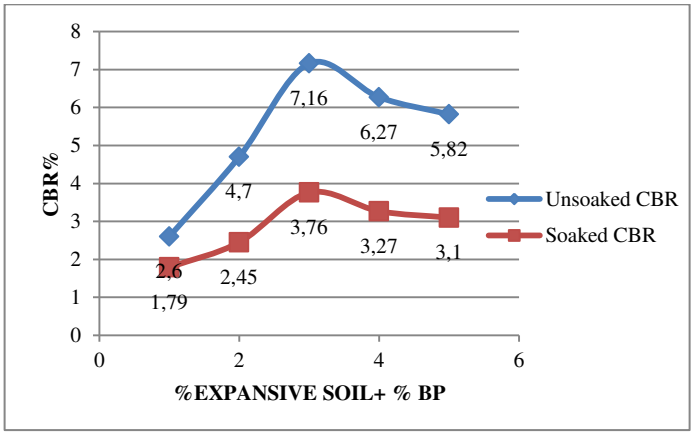
Graph 4 Variations of MDD for ES with different % of Brick powder



Graph 5 Variations of OMC and MDD for ES with different % of Brick powder

California Bearing Ratio (CBR) Test Results

The CBR tests were directed in the research center for all the sweeping soil tests treated with various rates of Brick powder and Jute Fiber according to I.S.Code(IS:2720(part-16)- 1979). The aftereffects of Soaked and Unsoaked CBR tests on far reaching soil treated with increment in level of Brick Powder and Bamboo Fiber continues expanding up to the ideal rates of added substances and the outcomes are exhibited in beneath:



Graph 6 Variation of Un-Soaked and Soaked CBR for % ES with different % of Brick powder

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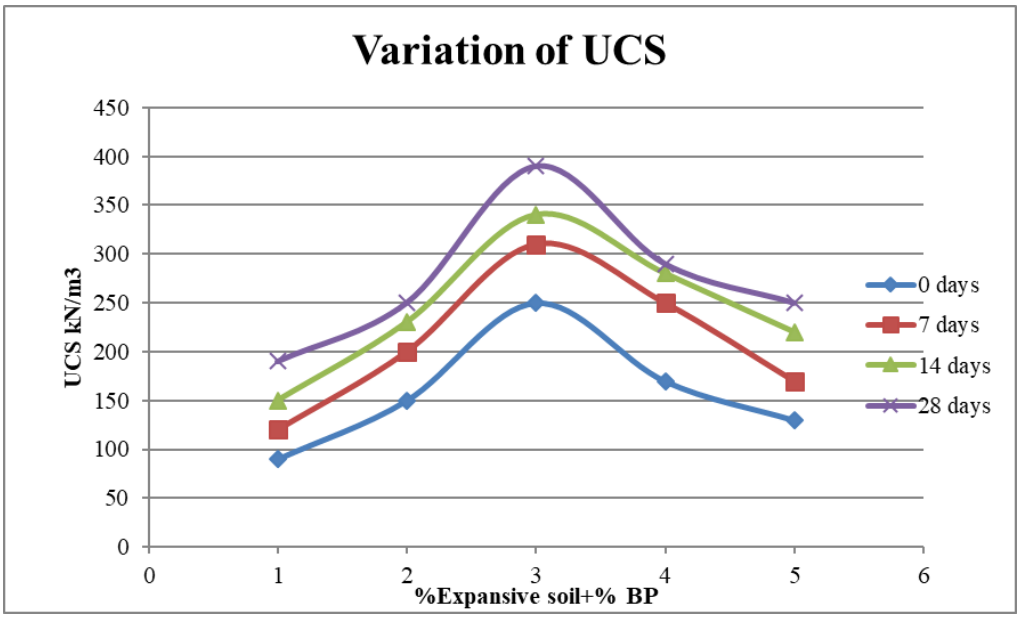
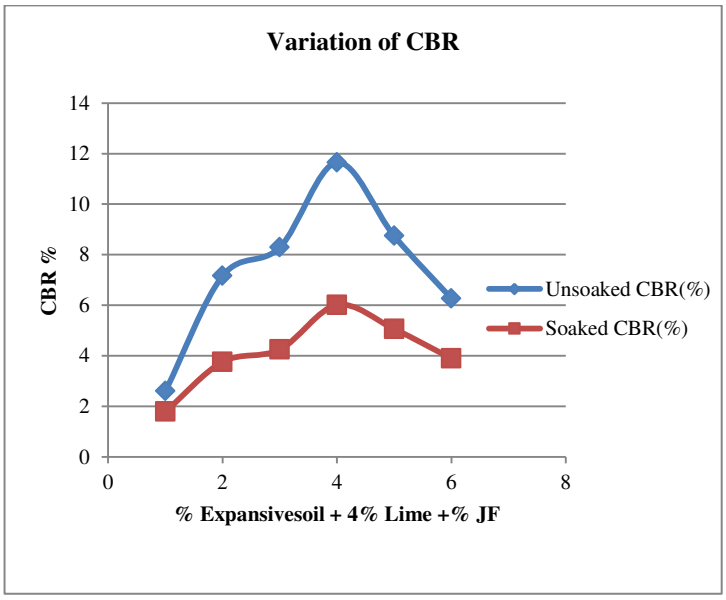
Unconfined Compressive Strength Test Result

The unconfined compressive quality testing machine is utilized to direct the tests as per IS 2720-section X. The test was led with various level of Brick Powder to the broad soil. The test outcome demonstrates that the UCS esteem continues expanding upto4% of Brick Powder. Distinctive relieving days for the dirt has been done (7, 14, and 28) days and the UCS esteems increments as days increments.



Graph 7 Variation of UCS for ES with different % of Brick powder



Graph 8 Variation of CBR (Un-Soaked&Soaked)of 4% Brick powder treated Expansive soil treated and inclusion with Different percentages of Jute Fiber

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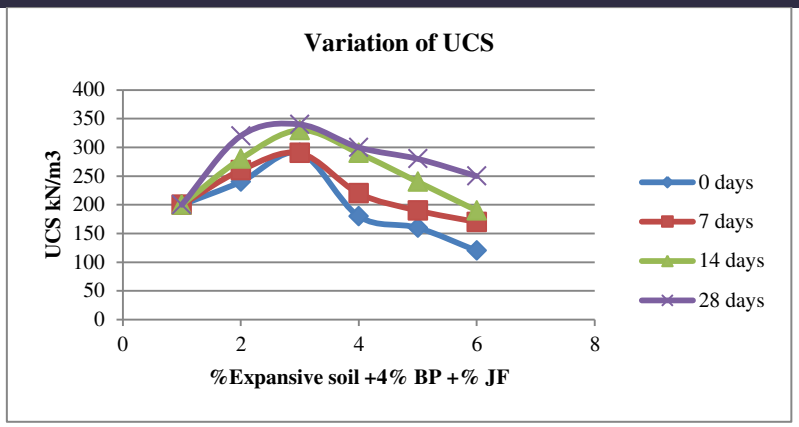
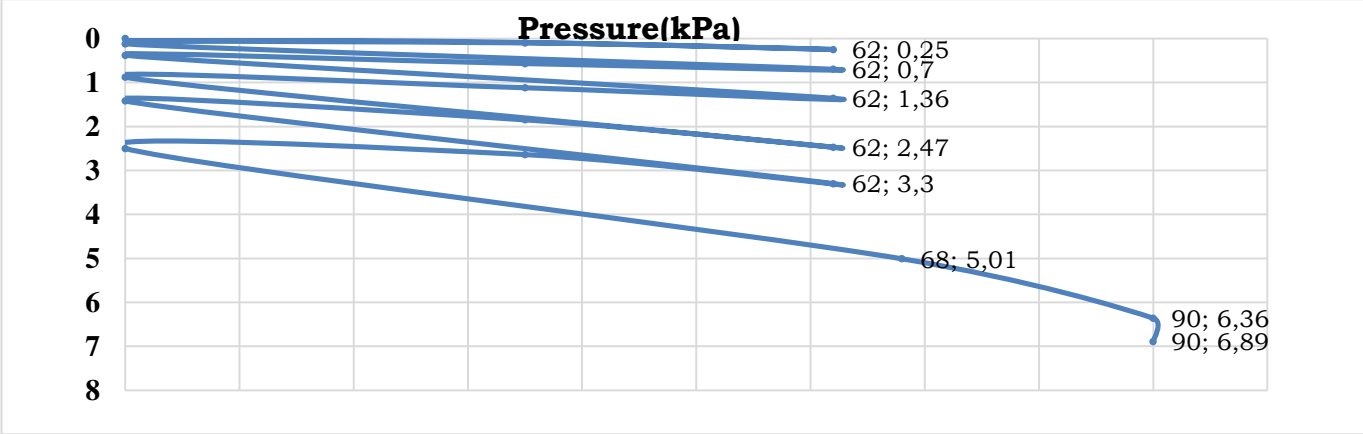
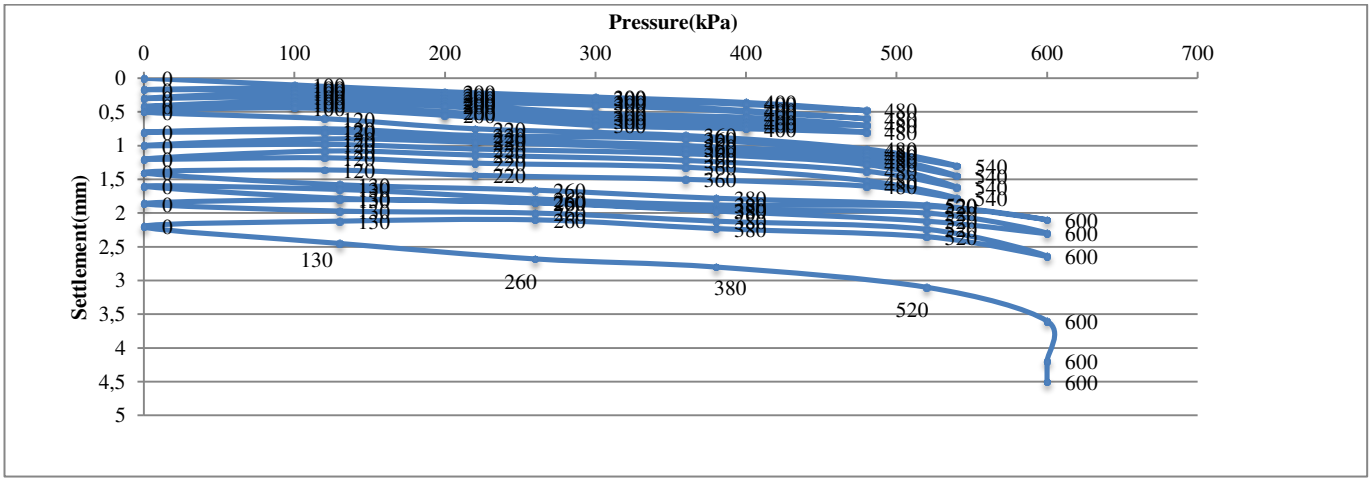


Cyclic plate load test

Cyclic plate burden tests were completed on untreated and treated Expansive soil asphalts in independent model tanks a woven Geotextile was utilized as fortification and separator between and subbase& base course under cyclic weights 500kPa, 560kPa, 630kPa, 700kPa, 1000kPa. The tests were directed until the disappointment of the Expansive soil model adaptable asphalts at OMC conditions.



Graph 14 Laboratory Cyclic Plate Load Test Results of Untreated Expansive Soil at OMC



Graph 15 Laboratory Cyclic Plate Load Test Results of Untreated Expansive soil for Model Flexible Pavement Subgrade at OMC

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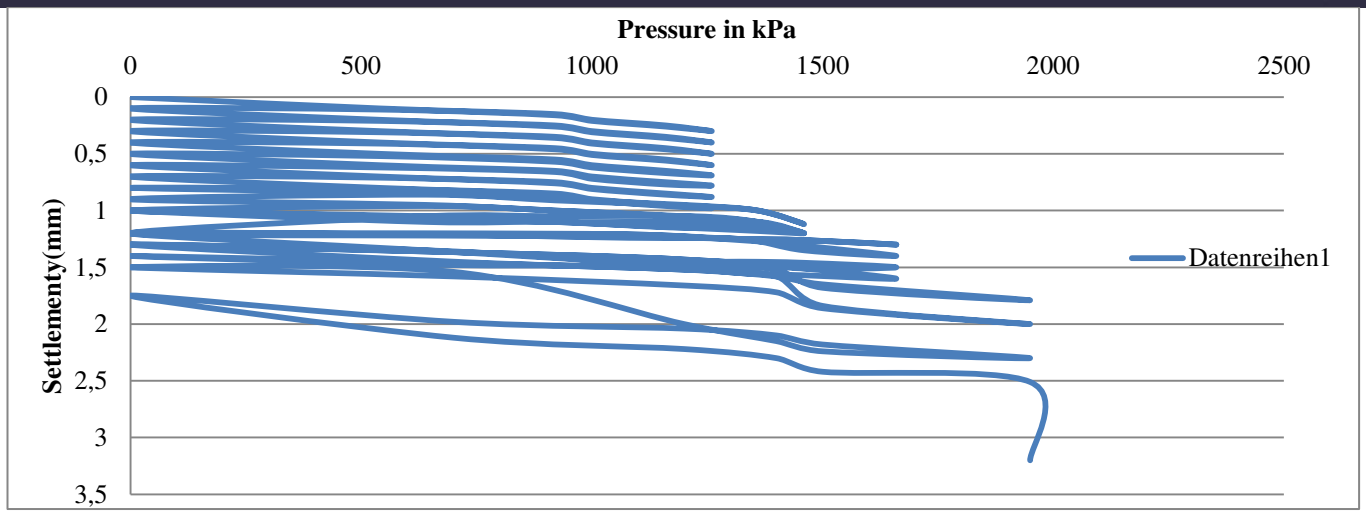
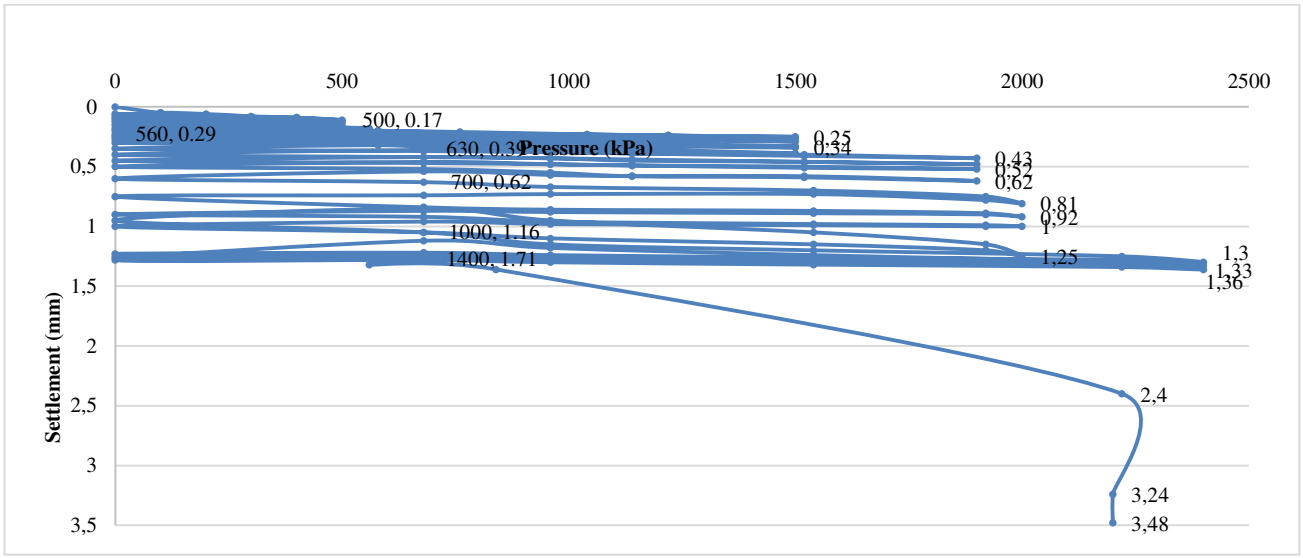


Graph.16 Laboratory Cyclic Plate Load Test Results of 4% Brick powder blended Exapansive soil + 1% Jute Fibre for Model Flexible Pavement Subgrade at OMC



Graph 17 Laboratory Cyclic Plate Load Test Results of 4% Brick powder Blended Expansive soil + 1% Jute Fibre+ Single Geotextile as Reinforecement and Seperator for Treated Expansive soil for Model Flexible Pavement Subgrade at OMC

IV. CONCLUSIONS

Based on *results* presented in this paper, following conclusions are drawn.

- Brick powder treated BC soil strengthened with 1% Jute fiber expands quality and lessens weak conduct of soil example, where as different rates of strands utilized demonstrates a minimal increment.
- This paper assessed impact of Jute fiber on quality and compaction attributes of brick powder treated dark cotton soil. A progression of tests were performed to think about impacts of brick powder on quality attributes of dark cotton soil.
- For a given Jute fiber rate substance in compaction tests, greatest dry thickness of balanced out soil diminished and ideal dampness substance expanded. most extreme dry thickness of Jute fiber fortified with 4%brick powder

treated soil diminished thickness esteem and OMC esteem.

- Expansion of different rates of brick powder to dark cotton soil gives expanded an incentive in unconfined compressive quality upto4% and expansion of brick powder with Jute fiber likewise gave increment in compressive quality upto1.0% Jute fiber.
- relieving time frame with expansion of brick powder and Jute fiber gave higher quality qualities. Consequently, 4% of brick powder substance and 1.0% of Jute fiber is considered as ideal rates for dark cotton soil.
- Expansion of different rates of brick powder to dark cotton soil gave expanded an incentive in CBR upto 4% as we can see in chart. At that point expansion of Jute fiber gave expanded estimation of CBR for 1.0 % Jute fiber.
- Mix of 4% brick powder and 1.0% Jute fiber gives more expanded an incentive than expansion of brick powder and Jute fiber. Subsequently, 4 of brick powder substance and 1.0% of Jute fiber can be considered as ideal rates for dark cotton soil to build CBR esteem.
- Expansion of brick powder has appeared in fluid point of confinement from 79% to 73% and improvement in plastic farthest point from 38% to 44% and versatility record decline from 41% to 29% when brick powder substance fluctuates from 0% to 8% with an addition of 2% blended in far reaching soil because of cation particles from brick powder which decreases volumetric changes.
- With expansion of differing level of Jute fiber with ideal estimation of brick powder, as far as possible esteem diminishes to 79% to 59%, plastic limit increments to 38% to 48
- Expansion of Brick powder to dark cotton soil results declines MDD valuefrom 15.99 KN/m3 to 15.11 KN/m3 while OMC increments from 21.42% to 24.30% at 4% of Brick powder.
- Compaction qualities of treated far reaching soil-brick powder blend at ideal 4% of Brick powder, OMC expanding from 24.39% to 31.40% and MDD diminishing from15.01 KN/m3 to 14.51KN/m3 with expansion of various rates of filaments ranges from 0.5 to 2 with an augmentation of 0.5% of Jute fiber.
- On looking at CBR esteems it is discovered that we showed signs of improvement CBR esteem when dirt is treated with both brick powder and Jute fiber than untreated soil.
- Expansion of brick powder to far reaching soil, Unsoaked CBR esteems increments from 2.6% to 7.16% up to 4% of brick powder and past esteem diminishes. Subsequently, ideal level of brick powder is 4%.
- Expansion of brick powder to far reaching soil, Soaked CBR esteems increments from 1.79% to 3.76% up to 4% of brick powder and past esteem diminishes. Henceforth, ideal level of brick powder is 4%.
- Unsoaked CBR esteem goes expanding from 7.16% to 11.65% up to addition of 1% fiber to brick powder treated soil, past it is diminished with further expansion fibber. Henceforth, ideal level of fiber is 1%.
- Doused CBR esteem goes expanding from 3.76% to 11.65% up to addition of 1% fiber to brick powder treated soil, past it is diminished with further expansion fibber. Henceforth, ideal level of fiber is 1%.
- From UCS test, it is acquired that unconfined compressive quality of far reaching soil is expanding with ideal of brick powder i.e.4% and expansion of Jute fiber up to 1% and past it is diminished.

- At 0 Days, Unconfined compressive quality esteem increments from 350KN/m2 of dark cotton soil to 780 KN/m2 at 4% of brick powder and came to 1110 KN/m2 at 1% Jute fiber with brick powder mixed soil. From it is reasoned that 1% Jute fiber is ideal.
- At 7 Days, Unconfined compressive quality esteem increments from 420KN/m2 of dark cotton soil to 910 KN/m2 at 4% of brick powder and came to 1370 KN/m2 at 1% Jute fiber with brick powder mixed soil. From it is presumed that 1% Jute fiber is ideal.
- At 14 Days, Unconfined compressive quality esteem increments from 480KN/m2 of dark cotton soil to 1020 KN/m2 at 4% of brick powder and came to 1560 KN/m2 at 1% Jute fiber with brick powder mixed soil. From it is reasoned that 1% Jute fiber is ideal.
- At 28 Days, Unconfined compressive quality esteem increments from 500KN/m2 of dark cotton soil to 1180 KN/m2 at 4% of brick powder and came to 1690 KN/m2 at 1% Jute fiber with brick powder mixed soil. From it is presumed that 1% Jute fiber is ideal.
- It is seen from research facility test after effects of cyclic plate burden test that a definitive weight of treated Expansive soil sub level adaptable asphalt has been expanded by 225% regarding untreated Expansive soil sub level adaptable asphalts.
- above perceptions give a lucidity that utilization of brick powder and strands in soil adjustment can improve quality attributes impressively.

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