International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Improving the Strength of Subgrade Soil Using Building Debris

Anish Sadhotra

M. Tech Scholar Galaxy Global Group of Institutions, Dinarpur (Ambala),India

ABSTRACT

Building debris is an important parameter from the construction and demolition waste which can prove hazardous to both public as well as environment. Therefore its recycling and reuse can prove beneficial and can offer an optimal solution. As we know that India is developing faster and the population goes on increasing tremendously, we need to provide buildings, make roads and improve other residential and building properties to overcome this urbanising and faster rate of population.

In the modern road construction soil is considered to be as an ideal material for the subgrade road construction. As we know that road connectivity is from region to region and from strong source to weak source were in weak source soil subgrade possess very low bearing capacity and poor strength. To overcome the tragedy of settlement in weak soil subgrade soil in its natural condition need to be evaluated on the basis of their performance and strength criteria. There are various techniques which can be employed to overcome this weakness and to give better and satisfactory results for well performance of soil subgrade. The technique can be employed by adding certain additives to this poor soil so that the engineering properties of soil get modified. The technique which is adopted in my dissertation work will be optimal use of building debris for the strengthening of soil subgrade. This not only reduces the threat to environment and humans but also modifies the soil properties to a certain extent hence giving a balance to the environment. Since there are various studies which come in from time to time for the evaluation of soil subgrade at or near optimum moisture contents. The need of this study is to treat very weak subgrade soils having moisture contents more or less than optimum moisture contents. To cope up with the critical loading condition in pavement or foundation various test will be conducted like Atterbergs limits, compression tests, UCS, CBR tests. The need of this proposed research is Treatment of very weak soil with demolished cementitious fine powder as a stabiliser. In this investigation, C&D Waste has been utilized as a stabilizer to improve the properties of locally accessible cohesionless soil.

After doing various literature survey and experimental studies, it was seen that with increase in the percentage of C&D Waste Liquid limit decreases. With increase in the percentage of C&D Waste Plastic limit decreases. With increase in the percentage of C&D Waste Shrinkage limit increases initially and then decreases. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtainedfrom virgin soil were 0.161 and 1.96 g/cc respectively. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtainedfrom soil mixed with 0.8% of C&D Waste were 0.144 and 1.97 g/cc respectively.The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 1.6% of C&D Waste were 0.135 and 1.99 g/cc respectively.The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 2.4% of C&D Waste were 0.124 and 2.015 g/cc respectively.The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 3.2% of C&D Waste were 0.121 and 2.216 g/cc respectively.The maximum Unconfined Compressive strength is achieved equal to 2.435 at the percentage of 1.6 % of C&D Waste. The optimum content of the C&D Waste in the soil is 2.4 %

Introduction

Building debris is an important parameter from the construction and demolition waste which can prove hazardous to both public as well as environment. Therefore its recycling and reuse can prove beneficial and can offer an optimal solution. As we know that India is developing faster and the population goes on increasing tremendously, we need to provide buildings, make roads and improve other residential and building properties to overcome this urbanising and faster rate of population.

In the modern road construction soil is considered to be as an ideal material for the subgrade road construction. As we know that road connectivity is from region to region and from strong source to weak source were in weak source soil subgrade possess very low bearing capacity and poor strength. To overcome the tragedy of settlement in weak soil subgrade soil in its natural condition need to be evaluated on the basis of their performance and strength criteria. There are various techniques which can be employed to overcome this weakness and to give better and satisfactory results for well performance of soil subgrade. The technique can be employed by adding certain additives to this poor soil so that the engineering properties of soil get modified. The technique which is adopted in my dissertation work will be optimal use of building debris for the strengthening of soil subgrade. This not only reduces the threat to environment and humans but also modifies the soil properties to a certain extent hence giving a balance to the environment.

Building debris like bricks in its crushed and powdered form can be used in its powdered form as an additive to soil subgrade. The cementitious debris also proves an important parameter which can be used well within the soil to improve its engineering properties. The debris can be brought from construction and demolition sites and is broken down into 20-25 mm diameter and are then further pulverized down with the help of a pulverising machine. Various screens are employed to enable the pulverisation Upto a desired level of fineness. This pulverized demolished material is then mixed with proper proportions with the soil subgrade to check the feasibility and sustainability. Certain quantity of cement is then added to this soil subgrade for the enhancement of engineering properties.

The properties of soil are the significant angles which must be remember before executing a development plan. Properties like the bearing limit, dampness content, nature and sort of soil and so forth decides the chance and solidness of the forthcoming task .The dirt having high dampness substance won't have the option to give the solidness as wanted by engineers and neither does a dirt with low bearing limit have the option to continue load on itself. Not just the dampness substance and bearing limit yet the evaluation of the soil is additionally one among the central point which decides the solidness of the dirt. The dirt could be very much reviewed which has lesser no. of voids and consequently attractive and consistently reviewed which has more noteworthy no. of voids and consequently ought to be stayed away from or blended in with various evaluation of soils to improve its properties.

These days an enormous number of various kinds of waste are produced in this advanced life. Different kinds of squanders like mechanical waste, horticultural waste, clinic squander, private squanders and tires are turning into a genuine danger to nature. It turns out to be more extreme on the off chance that they are non-biodegradable materials. The structural architects have utilized many waste materials to settle frail mud and sandy soils. Squander glass, rice husk debris, marble dust, fly debris, stone residue, bagasse debris, emergency clinic squander, destroyed tires has been utilized in various building rehearses in a strategy called soil adjustment. These waste items carriages a genuine natural issue in the event that it isn't arranged appropriately. So as to spare the cost and decrease natural contamination this kind of reused squander material can be utilized. Soil adjustment is characterized as a designing methodology used to improve the building properties of the dirt, just as to diminish the deformities in soil, for example, settlement, development and compressibility. Numerous scientists utilized various kinds of squanders in soil adjustment. Sweeping soil can be utilized for development by treating it as adjustment utilizing modern squanders, Flyash, Rice husk debris (RHA), Phosphor gypsum, Quarry dust, Granulated impact heater slag and so forth with or without a folio like concrete, bitumen, lime, calcium chloride and so on. Numerous specialists found that fiber strengthened soils are likely composite materials in improving the basic conduct of balanced out and regular soils. Extensive soils with fly debris purchased a huge decrease in growing weight of the dirt. Elastic was utilized with concrete to diminish the growing weight of dirt soil. California bearing proportion and the unconfined compressive quality were expanded in dirt soil with the expansion of Jute fiber. The bearing limit, dry thickness, and unconfined shear quality of silty mud soil was expanded when aluminium build up and reused black-top was included. All the analysts have discovered shifted accomplishment in improving the designing properties of broad soil. One of the provoking squanders to nature is glass squander and is considered on the head of the strong waste rundown. The volume of worldwide glass creation was assessed to be near 130 million tons in 2005. In Australia, around 850,000 tons of glasses are utilized every year, while just 350,000 tons (40%) were recuperated for reusing. Thusly, an enormous number of glass squander is covered in landfills. Regularly glass takes 450 years to biodegradation. Subsequently, it turns out to be more essential to reuse as soil adjustment. The physical properties of the squashed glass are that they uncover high penetrability, little strain solidness, high pulverizing opposition and these properties could improve its utilization in geotechnical building works for soil adjustment, bank developments and so forth. An examination was completed on eco-accommodating asphalt squares made of waste glass, fly debris and residue and found that compressive quality and flexural quality of the asphalt square is expanded by 37% and half individually. The expansion of waste glass brought about the expansion of Dry Density and CBR esteems and the decrease of versatility list, Optimum Moisture Content. An on-going exploration found that the utilization of pop lime glass powder squander with mud significantly affects the quality of the dirt. Another exploration showed that utilizing glass powder with earth soil up to 8.5% expanded the unconfined compressive quality, attachment and point of inner grating. The CBR esteem increments to a normal 10% when 20% squashed glass blended in with 80 % clayey material. Squashed waste glass and waste plastic was stirred up to 12% with two sorts of soil and found that CBR (was expanded to 5%) and grinding point was expanded as expanding in added substances while, Plasticity file and union were diminished. The frictional quality of the fine-grained soils impressively improved with the expansion of squashed glass and suggested that this idea could be utilized to improve the building properties. An exploration demonstrated that the blend comprises of 80% mud material and 20% squashed waste glass can be utilized in subgrade and bank of read asphalts development.

This study consists of selection of construction and demolished site at Jewel Chowk Jammu. The C&D waste was brought from the site and examined in the laboratory. Same Material was pulverized Upto a certain degree of fines as discussed in the previous sections. A planed site has been chosen by me from on-going ring road construction project in Jammu for carrying out the proposed dissertation work. Soil samples were prepared with varying percentage of C&D waste and also of the Virgin soil, after that tests were carried out. The test results obtained were noted down and after that test results were plotted and conclusions were drawn from that. The various tests which were conducted are listed below:-

- Liquid limit test.
- Plastic limit test.
- Plasticity Index
- C.B.R. test.
- Standard Proctor Test
- Unconfined Compressive Strength Test

Liquid Limit Test

Liquid Limit Test was conducted on virgin soil as well as on soil samples mixed with varying percentages of C&D Waste. Test procedure is already discussed in the previous section. The liquid limit of virgin soil as well as of soil samples mixed with varying percentages of C&D Waste is tabulated in Table 5.1 and shown in Fig 5.1

Table 5.1 Liquid Limit Results

S. No	Mix	Liquid Limit (%)
1	Soil	58.7
2	Soil + 0.8 % C&D waste	54.8
3	Soil + 1.6 % C&D waste	49.6
4	Soil + 2.4 % C&D waste	45.1
5	Soil + 3.2 % C&D waste	41.3

Plastic Limit Test

Plastic Limit Test was conducted on virgin soil as well as on soil samples mixed with varying percentages of C&D Waste. Test procedure is already discussed in the previous section. The plastic limit of virgin soil as well as of soil samples mixed with varying percentages of C&D Waste is tabulated in Table 5.2 and shown in Fig 5.2

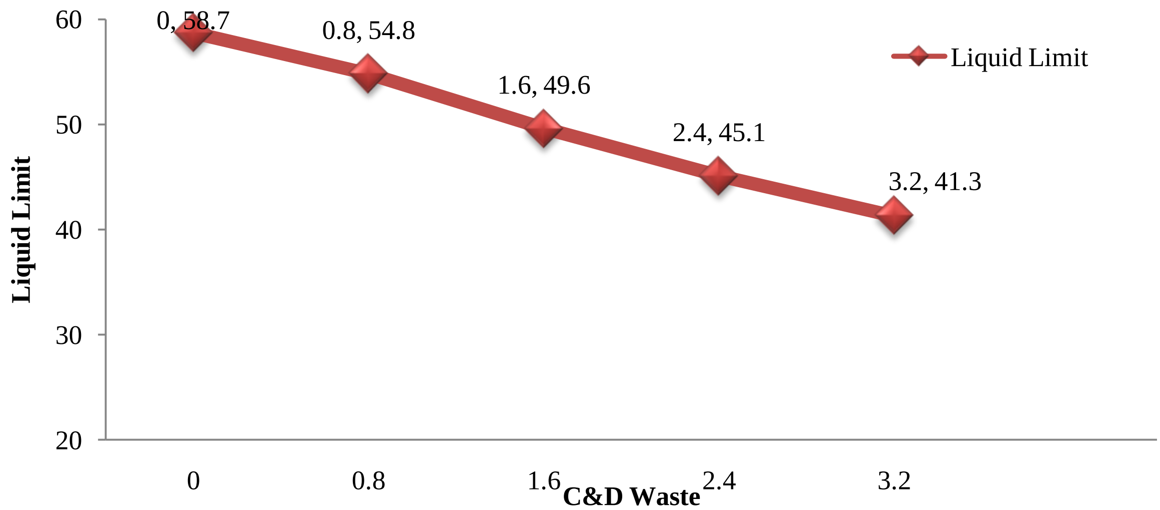

Fig 5.1: Liquid limit of soil with Different percentages of C&D Waste

Table 5.2 Plastic Limit Results

S. No	Mix	Plastic Limit (%)
1	Soil	45.6
2	Soil + 0.8 % C&D waste	37.6
3	Soil + 1.6 % C&D waste	31.4
4	Soil + 2.4 % C&D waste	29.7
5	Soil + 3.2 % C&D waste	26.5

Shrinkage Limit Test

Shrinkage Limit Test was conducted on virgin soil as well as on soil samples mixed with varying percentages of C&D Waste. The shrinkage limit of virgin soil as well as of soil samples mixed with varying percentages of C&D Waste is tabulated in Table 5.3 and shown in Fig 5.3

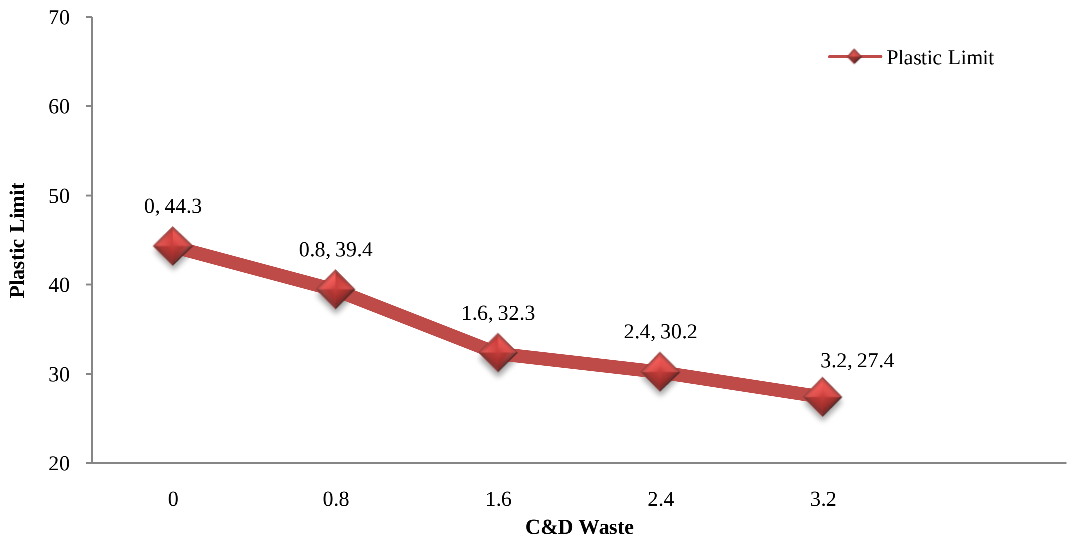

Fig 5.2: Plastic Limit of soil with Different percentages of C&D Waste

Table 5.3 Shrinkage Limit Results

S. No	Mix	Shrinkage Limit (%)
1	Soil	45.6
2	Soil + 0.8 % C&D waste	37.6
3	Soil + 1.6 % C&D waste	31.4
4	Soil + 2.4 % C&D waste	29.7
5	Soil + 3.2 % C&D waste	26.5

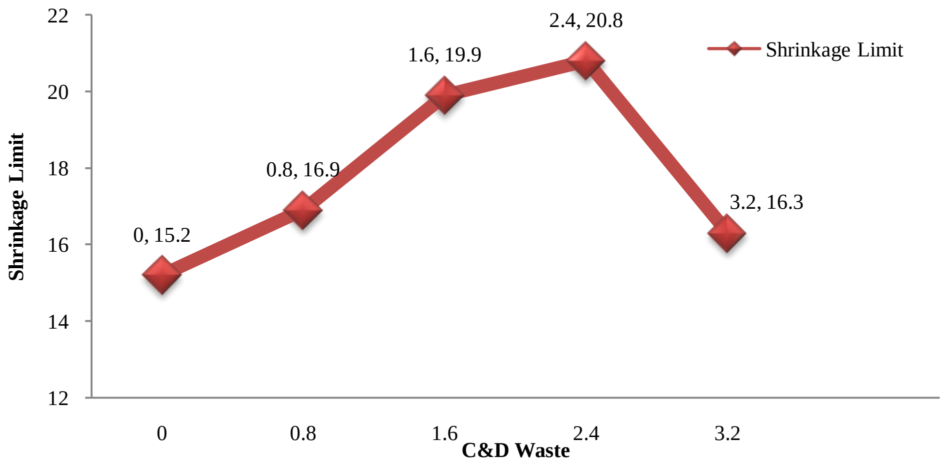

Fig 5.3: Shrinkage Limit of soil with Different percentages of C&D Waste

California Bearing Ratio Test Results

The California Bearing Ratio Test results of virgin soil as well as of soil samples mixed with varying percentages of C&D Waste are tabulated in Table 5.4 to Table 5.8 and shown in Figure 5.4 to Fig 4.8.

Table 5.4 CBR Test Results for Virgin Soil

S. No	Penetration (mm)	Load (kg)
1	0	0
2	0.5	14.754
3	1	23.304
4	1.5	29.604
5	2	37.704
6	2.5	43.554
7	4	55.254
8	5	62.004
9	7.5	80.454
10	10	93.054
11	12.5	106.154

Table 5.5 CBR Test Results for Soil Mixed With 0.8 % C&D Waste

S. No	Penetration (mm)	Load (kg)
1	0	0
2	0.5	14.754
3	1	27.804
4	1.5	32.304
5	2	37.254
6	2.5	53.004
7	4	60.654
8	5	71.904
9	7.5	99.804
10	10	118.254
11	12.5	141.254

Table 5.6 CBR Test Results for Soil Mixed With 1.6 % C&D Waste

S. No	Penetration (mm)	Load (kg)
1	0	0
2	0.5	10.254
3	1	25.104
4	1.5	28.254
5	2	39.504
6	2.5	49.854
7	4	61.554
8	5	70.554
9	7.5	96.654
10	10	116.454
11	12.5	134.054

Table 5.7 CBR Test Results for Soil Mixed With 2.4 % C&D Waste

S. No	Penetration (mm)	Load (kg)
1	0	0
2	0.5	26.904
3	1	34.554
4	1.5	40.854
5	2	49.404
6	2.5	55.254
7	4	72.354
8	5	81.804
9	7.5	99.804
10	10	113.754
11	12.5	119.654

Table 5.8 CBR Test Results for Soil Mixed With 3.2 % C&D Waste

S. No	Penetration (mm)	Load (kg)
1	0	0
2	0.5	21.504
3	1	35.454
4	1.5	42.654
5	2	49.854
6	2.5	57.054
7	4	68.304
8	5	80.454
9	7.5	92.154
10	10	104.354
11	12.5	117.354

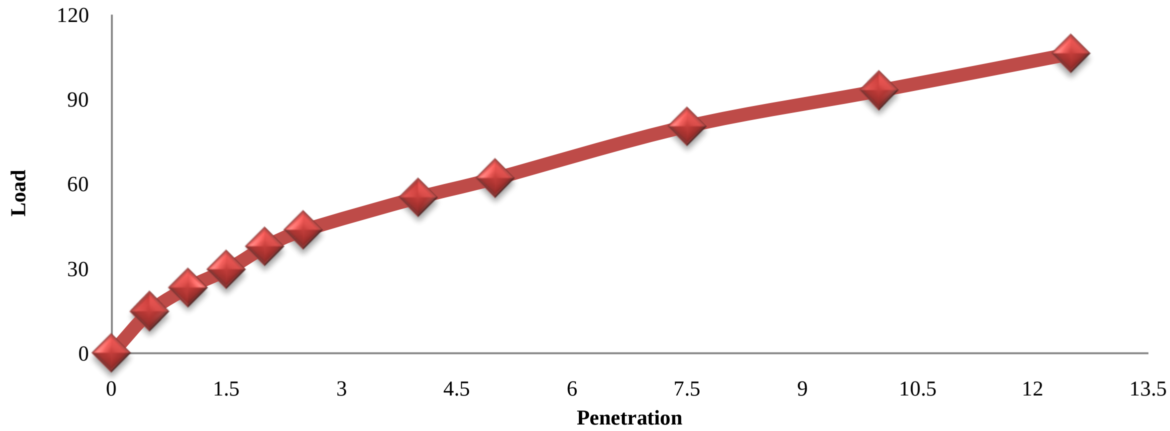

Fig 5.4 CBR Graph for Virgin Soil

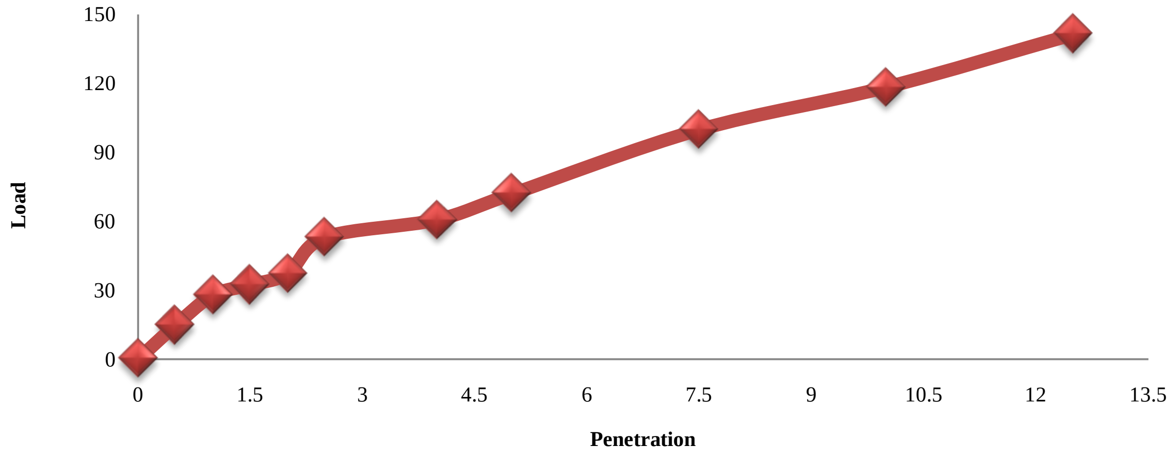

Fig 5.5 CBR Graph for Soil with 0.8 % C&D Waste

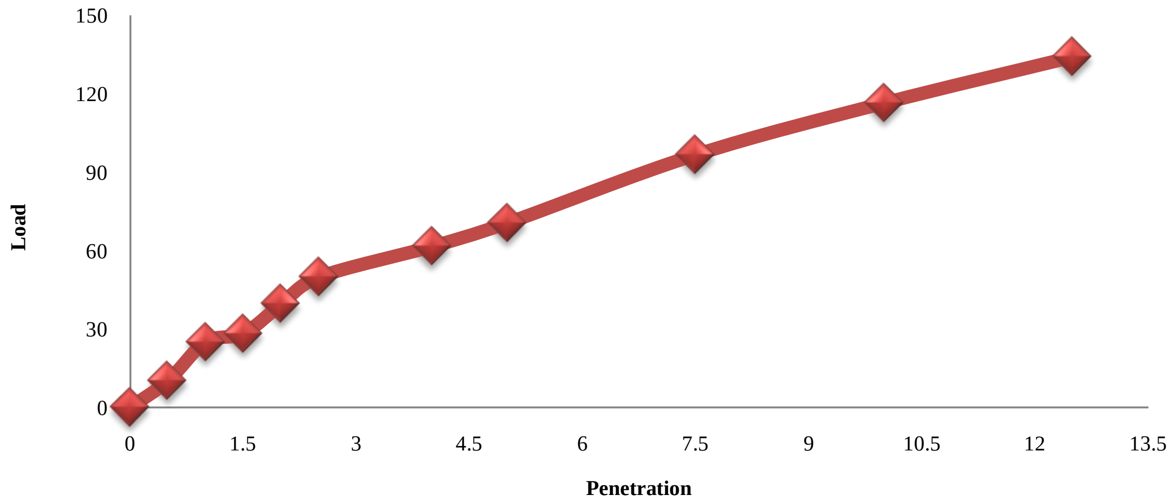

Fig 5.6 CBR Graph for Soil With 1.6 % C&D Waste

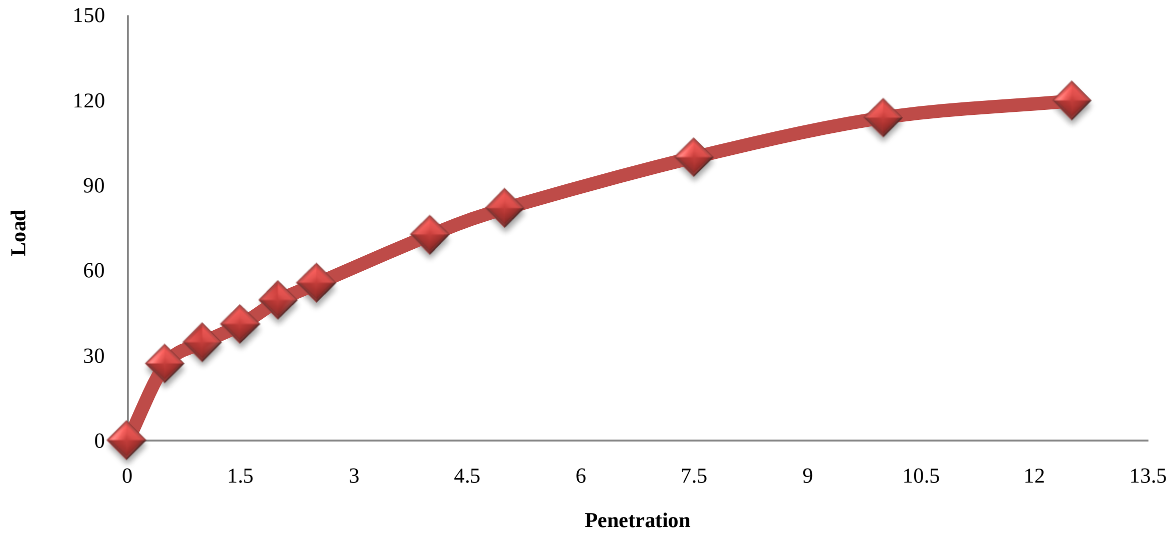

Fig 5.7 CBR Graph for Soil with 2.4 % C&D Waste

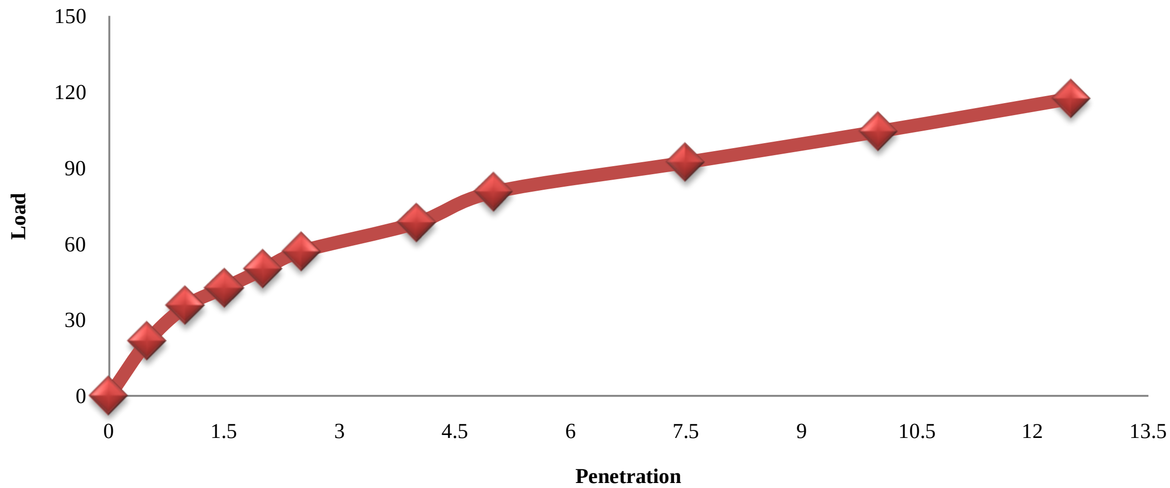

Fig 5.8 CBR Graph for Soil with 3.2 % C&D Waste

Optimum Moisture content and Dry Density

The maximum dry density and optimum moisture content of virgin soil as well as of soil samples mixed with varying percentages of C&D is tabulated in Table 5.9 to 5.14 and shown in Figure 5.9 to Figure 5.13.

Table 5.9 Water Content and Dry Density results of virgin soil

S. No	Water Content (%)	Dry Density (g/cc)
1	0.13	1.91
2	0.15	1.94
3	0.161	1.96
4	0.18	1.91
5	0.20	1.83

Table 5.10 Water Content and Dry Density of soil mixed with 0.8 % C&D Waste

S. No	Water Content (%)	Dry Density (g/cc)
1	0.122	1.92
2	0.138	1.95
3	0.144	1.97
4	0.156	1.93
5	0.163	1.89

Table 5.11 Water Content and Dry Density of soil mixed with 1.6 % C&D Waste

S. No	Water Content (%)	Dry Density (g/cc)
1	0.11	1.95
2	0.12	1.98
3	0.135	1.99
4	0.15	1.94
5	0.17	1.89

Table 5.12 Water Content and Dry Density of soil mixed with 2.4 % C&D Waste

S. No	Water Content (%)	Dry Density (g/cc)
1	0.093	1.89
2	0.113	1.93
3	0.124	2.015
4	0.145	1.98
5	0.165	1.91

Table 5.13 Water Content and Dry Density of soil mixed with 3.2 % Silica Fume

S. No	Water Content (%)	Dry Density (g/cc)
1	0.108	2.132
2	0.118	2.221
3	0.121	2.216
4	0.134	2.014
5	0.156	1.982

Table 5.14 Water Content and Dry Density results of Soil

S. No	Soil Mix	OMC	MDD
1	Virgin Soil	0.161	1.96
2	0.8 % C&D Waste	0.144	1.97
3	1.6 % C&D Waste	0.135	1.99
4	2.4 % C&D Waste	0.124	2.015
5	3.2 % C&D Waste	0.121	2.216

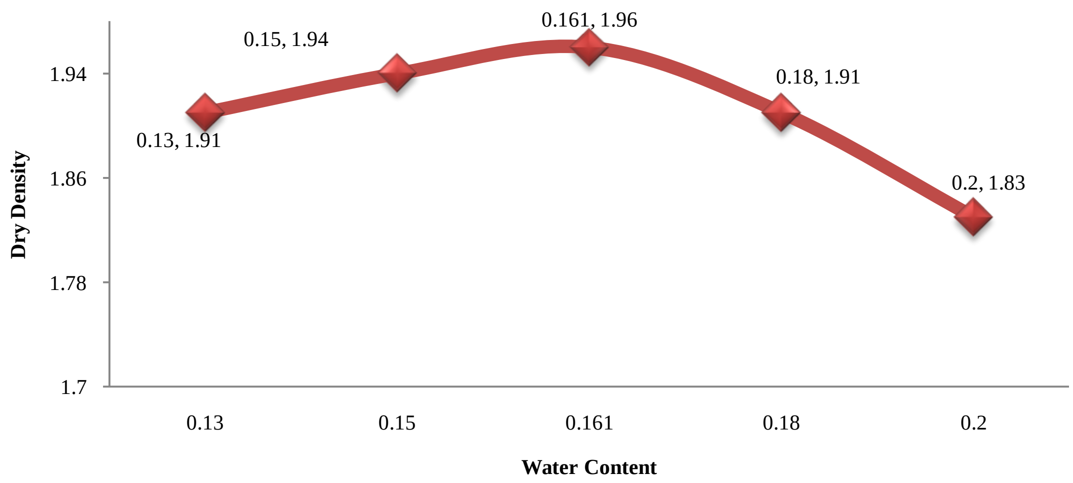

Fig 5.9 Water Content and Dry Density results of virgin soil

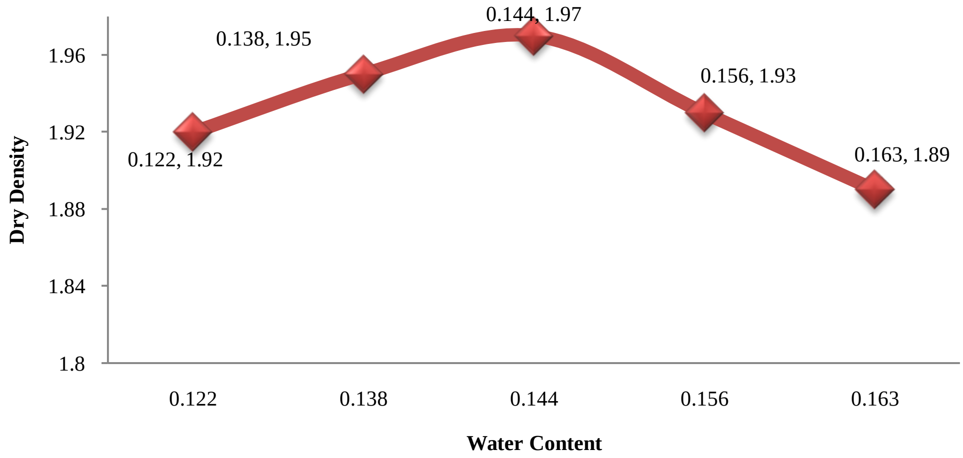

Fig 5.10 Water Content and Dry Density of soil mixed 0.8 % C&D Waste

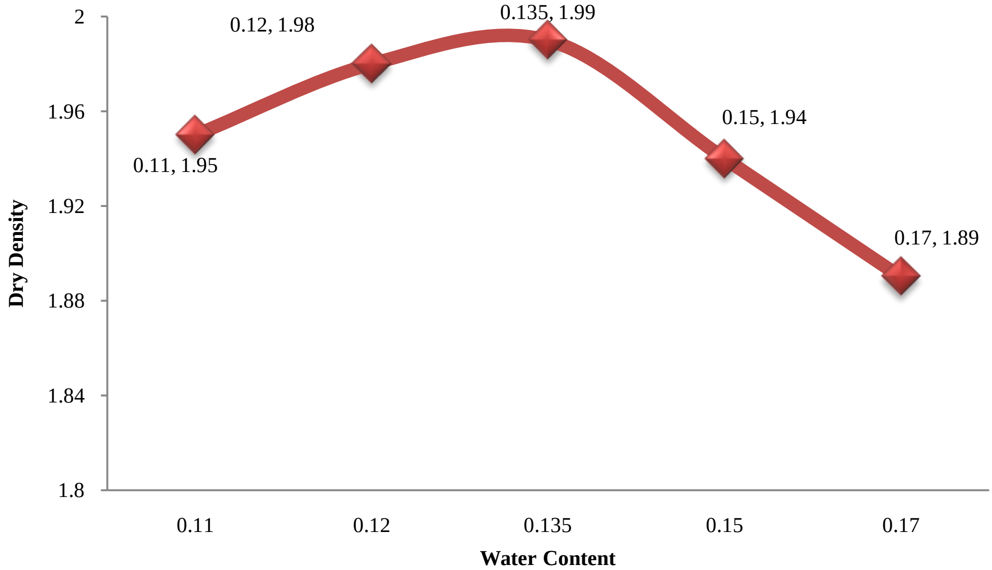

Fig 5.11 Water Content and Dry Density of soil mixed with 1.6 % C&D Waste

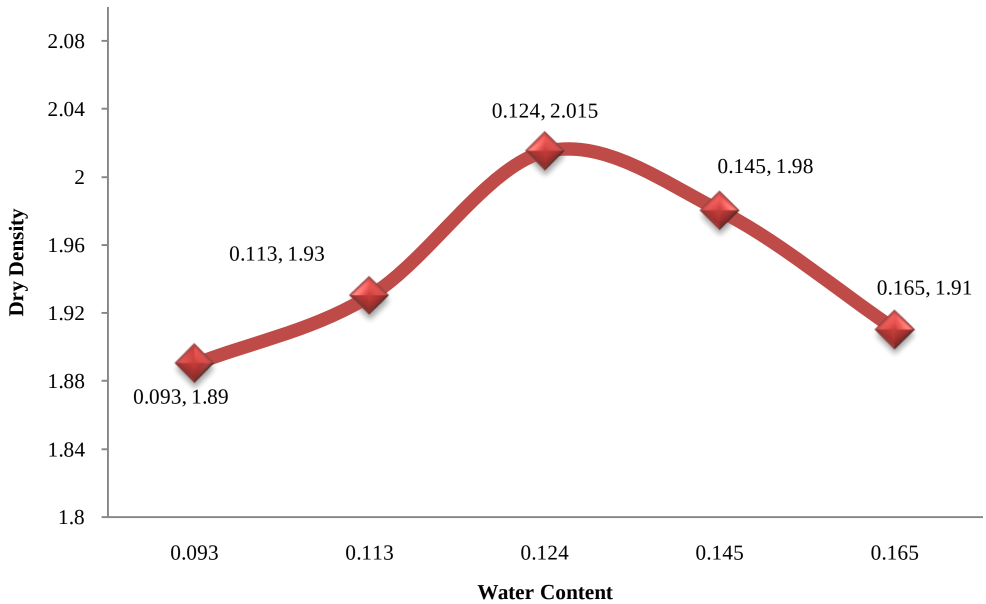

Fig 5.12 Water Content and Dry Density of soil mixed with 2.4 % C&D Waste

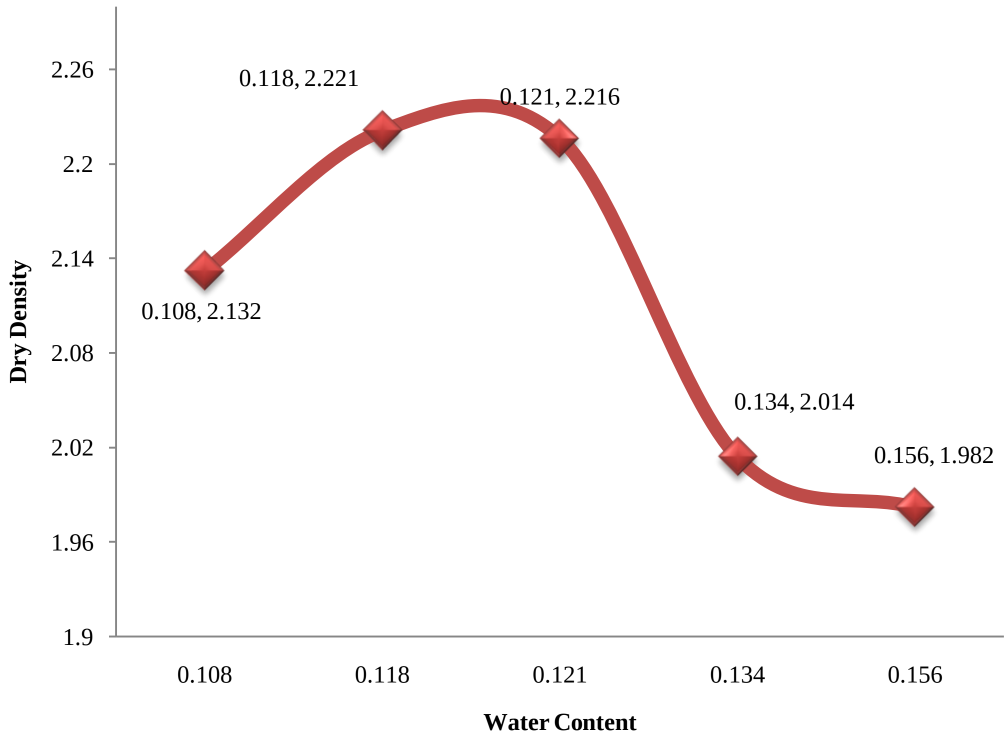

Fig 5.13 Water Content and Dry Density of soil mixed 3.2 % C&D Waste

Unconfined Compressive Strength Test Results

Unconfined Compressive Strength Test are carried out on soil admixed with C&D waste at various percentages ranging from 0 % to 3.2 % by weight of the soil in increment of 0.8%. The Unconfined Compressive Strength Test results of virgin soil as well as of soil samples mixed with varying percentages of C&D waste is tabulated in Table 5.15 and shown in Figure 5.14.

Table 5.15 Unconfined Compressive Strength Test Results

S. No	Mix	Unconfined Compressive Strength		
		0 Days	3 Days	7 Days
1	Soil	1.236	1.347	1.459
2	Soil + 0.8 % C&D Waste	1.884	1.994	2.013
3	Soil + 1.6 % C&D Waste	2.134	2.232	2.435
4	Soil + 2.4 % C&D Waste	1.934	2.01	2.109
5	Soil + 3.2 % C&D Waste	1.768	1.894	1.998

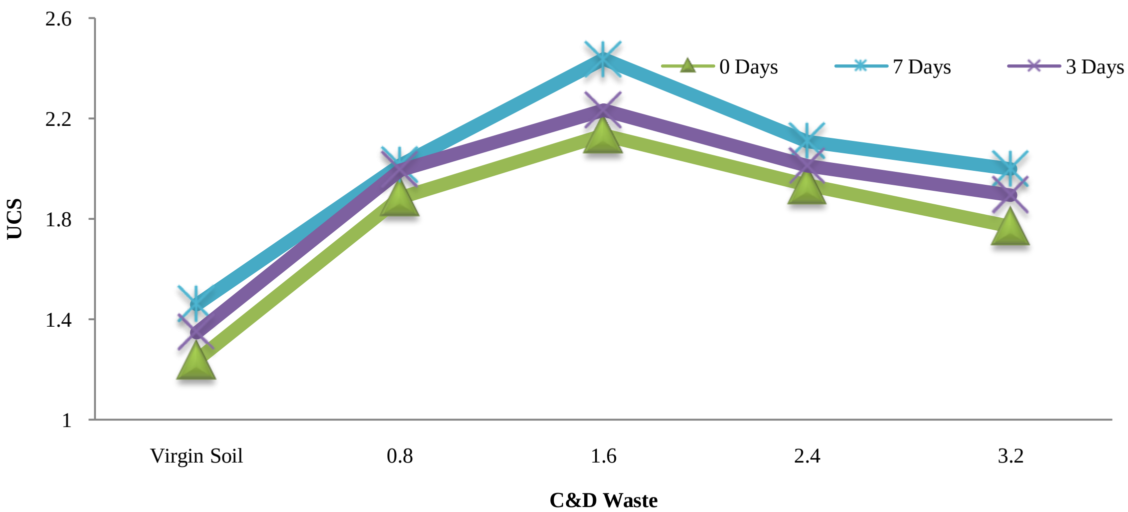

Fig 5.14: UCS of soil with Different percentages of C&D Waste

Conclusion

After doing various literature survey and experimental studies, following conclusions are drawn:

1. With increase in the percentage of C&D Waste Liquid limit decreases.
2. With increase in the percentage of C&D Waste Plastic limit decreases.
3. With increase in the percentage of C&D Waste Shrinkage limit increases initially and then decreases.
4. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from virgin soil were 0.161 and 1.96 g/cc respectively.
5. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 0.8% of C&D Waste were 0.144 and 1.97 g/cc respectively.
6. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 1.6% of C&D Waste were 0.135 and 1.99 g/cc respectively.
7. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 2.4% of C&D Waste were 0.124 and 2.015 g/cc respectively.
8. The Optimum Moisture Content (OMC) and Maximum Dry Density values obtained from soil mixed with 3.2% of C&D Waste were 0.121 and 2.216 g/cc respectively.
9. The maximum Unconfined Compressive strength is achieved equal to 2.435 at the percentage of 1.6 % of C&D Waste.
10. The optimum content of the C&D Waste in the soil is 2.4 %

REFRENCES

1. Bayomy, F. M., Al-Shaikh, A. M., and Abduljauwad, S. N. (1996). "Effect of geotextile on permanent deformation in salt-encrusted subgrade soils." Transportation Research Record: Journal of the Transportation Research Board, No. 1534, Transportation Research Board, Washington, D.C., pp. 40–49.
2. Perkins, S.W. (1999). "Geosynthetic reinforcement of flexible pavements: laboratory based pavement test sections." Report No. FHWA/MT-99/8106-1, Montana Department of Transportation, Helena, MT.
3. Perkins, S.W., and Ismeik, M. (1997). "A synthesis and evaluation of geosynthetic reinforced base layers in flexible pavements: part I," Geosynthetics International, Vol. 4, No. 6, pp. 549-604.
4. Webster, S. L., and Alford, S. J. (1978). "Investigation of construction concepts for pavements across soft ground." Technical Report S-78-6. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Miss.
5. Nithin S K Rajagopal A Veeraragavan "The use of natural geotextiles in reinforcing the unpaved roads" 2015
6. Dr.Bhavesh Joshi, Dr. R.P. Arora "Pavement design by geotextile" 2015 M. Tech scholar, CE, CTAE, Udaipur, India &Ast. Prof. CE, CTAE, Udaipur, India
7. Dr. K. Suresh, "Efficacy of CBR on Copper and Steel Slag In Expansive Soils", World Journal of Engineering Research and Technology, 2018, Vol. 4, Issue 5, 187-199.
8. Ravi Ekkabaram, "Enhancing the Clay Soil Characteristics using Copper Slag Stabilization", Volume 12 Number 26, Journal of Advances inchemistry.
9. Shubham Raj, "Suitability of stabilized copper slag and fly ash mix for road construction", World Journal of Engineering.
10. BambhaniyaMehulAshokbhai, "Utilization Of Copper Slag To Improve Geotechnical Properties Of Soil", International Research Journal of Engineering and Technology, Volume: 05 Issue: 07, July-2018.
11. R C Gupta, "An Experimental Study of Clayey Soil Stabilized By Copper Slag", Int. J. Struct. & Civil Engg. Res. 2012, Vol. 1, No. 1, November 2012.
12. P.Rajendra Kumar, "Laboratory Study of Black Cotton Soil Blended With Copper Slag and Fly-Ash", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 2, February 2017.
13. P. BharathGoud, "Stabilization of Black Cotton Soil with Copper Slag and Rice Husk Ash – An Environmental Approach", International Journal of Science and Research, Volume 7 Issue 5, May 2018.
14. JaberShahiri, "Utilization of Soil Stabilization with Cement and Copper Slag as Subgrade Materials in Road Embankment Construction", International Journal of Transportation Engineering, Vol.5/ No.1/ summer 2017.
15. M. Kavisri, "Experimental Study on Effects of Stabilization of Clayey Soil Using Copper Slag and GGBS", Rasayan J. Chem, Vol. 11 ,No. 1 ,111-117 ,January - March 2018.
16. Sivapriya S.V, "Utilization of Copper Slag as A Reinforcing Material", International Journal of Science Technology & Engineering, Volume 2 , Issue 12 ,June 2016.
17. Liang Cheng, "Bacteria induced cementation for soil stabilization", Proceedings of the 19th International Conference on Soil Mechanics and Geotechnical Engineering, Seoul 2017.
18. Ng Wei Soon, "Factors Affecting Improvement in Engineering Properties of Residual Soil through Microbial-Induced Calcite Precipitation".
19. N. Kamaraj, "Study on Improvement of Soil Behaviour by Bio-Stabilsation Method", Indian Journal of Science and Technology, Vol 9(33).
20. PawarShahaji P, "Assessments of Soil Properties by Using Bacterial Culture", International Journal of Innovations In Engineering Research And Technology, ISSN: 2394-3696, Volume 2, Issue 6, June-2015.
21. VolodymyrIvanov, "Applications of microorganisms to geotechnical engineering for bioclogging and biocementation of soil in situ", Rev Environ SciBiotechnol.
22. GujjulaKullayappa, "Experimental Study by of Soil Mixed with Guar Gum a Bio Enzyme", International Research Journal of Engineering and Technology, Volume: 05 Issue: 08, Aug 2018.
23. Murtala Umar, "Biological process of soil improvement in civil engineering: A review", Journal of Rock Mechanics and Geotechnical Engineering.
24. Manuel Delgado-Baquerizo, "Relative importance of soil properties and microbial community for soil functionality: insights from a microbial swap experiment", British Ecological Society, Functional Ecology.
25. R. B. Wath, "Soil Improvement Using Microbial: A Review", Indian Geotechnical Conference IGC2016, 15-17 December 2016, IIT Madras, Chennai, India.
26. Sunil B. H., "Role of Soil Microbes and their Cell Components on Stabilization of Soil Organic Carbon", International Journal of Pure &

Applied Bioscience, DOI: http://dx.doi.org/10.18782/2320-7051.6906.

27. Aziz, M.A. and Ramaswamy,S.D.(1984) [26],- Studies on jute fabric upon Coir Grid Matting for Subgrade Strengthening, Revue Generale das Routes Et Das Aerodrome, No. 614,Paris, Pp. 56-58.