Experimental Study on Lateritic Soil Stabilization with Waste Engine Oil and Lime

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Abstract: The world wide concern for cleanup, protection and enhancement of the environment has development of a sub discipline within the field of geotechnical engineering; namely Geoenvironmental, which is concerned with the application of geotechnical engineering to environmental control. It is within this area that the concepts of stabilization, solidification, reuse and recycling wastes in geotechnical engineering works are popularly encountered. The cost of the construction materials has rapidly increased and hence stabilization of soil using admixtures becomes Cost effective and eco-friendly blocks. Thus waste engine oil and natural lime considerably promise to reduce the cost of construction or alternative material that would be suitable for construction activities and also reduces the disposal problem and hence reduces contamination of soil and water.

Keywords: Geoenvironmental, Waste Engine Oil, Natural Lime, Laterite Soil Stabilization.

1. Introduction

A developing country like India which has a large geographical area and population, demands vast infrastructure i.e. network of roads and buildings. Everywhere land is being utilized for various structures from ordinary house to sky scrapers, bridges to airports and from rural roads to expressways. Almost all the civil engineering structures are located on various soil strata. Soil can be defined as a material consisting of rock particles, sand, silt, and clay. It is formed by the gradual disintegration or decomposition of rocks due to natural processes that includes disintegration of rock due to stresses arising from expansion or contraction with temperature changes. Weathering and decomposition from chemical changes that occur when water, oxygen and carbon dioxide gradually combine with minerals within the rock formation, thus it is breaking down to sand, silt and clay. Transportation of soil materials by wind, water and ice forms different soil formations such as those found in river deltas, sand dunes and glacial deposits. Temperature, rainfall and drainage play important roles in the formation of soils as in the different climatic regions. Under different drainage regimes, different soils will be formed from the same original rock formation.

Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives. The different types of methods used for soil stabilization are: Soil stabilization using cement, Soil stabilization using lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of

stabilization that is stabilization of soil by using Geo textiles and Geo synthetic.

2. Literature Review

Samuel Akinlabi Ola [1977], The paper reviews lime stabilization of lateritic soils and shows that all Nigerian lateritic soils from A-1-a soil to A-7-6 soil used in the investigation, improved their engineering characteristics substantially by the addition of lime.

M D Anisur Rahman [1986], Lateritic soil was stabilized with various percentages of rice husk ash (RHA), lime and cement. Atterberg limits, standard Proctor compaction, unconfined compression and California bearing ratio tests were carried out on lateritic soil with various percentages.

Akinwumi, I. I. [2014], Experimental investigation was carried out to determine the effects of contaminating a lateritic clay soil with waste engine oil on its geotechnical engineering properties. Varying percentages (0%, 2%, 4%, 6%, 8% and 10%) of waste engine oil were mixed with the soil, as a simulation of its contamination.

A. A. Amadi and A. Okeiyi [2017], A laboratory study was undertaken to evaluate and compare the stabilization effectiveness of different percentages (0, 2.5, 5, 7.5, 10%) of quick and hydrated lime when applied separately to locally available lateritic soil, a major soil group in the tropical and subtropical regions.

3. Objectives

- To investigate the usage of waste engine oil and lime mix material along with lateritic soil as construction material
- To produce cost effective blocks for building construction
- To explore the effective utilization of waste materials like waste engine oil and lateritic quarry waste.
- Attempt to improve the properties of sub grade soil for pavement construction.

4. Materials And Methodology

A. Lateritic Soil

Laterite is a soil and rock type rich in iron and aluminium, and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterites are of rusty-red coloration, because of high iron oxide content. They develop by intensive and prolonged weathering of the underlying parent rock.

B. Lime

Lime is one of the basic building materials used mainly as lime mortar in construction. Properties of building lime, advantages, and uses in construction. The broad category of lime is non-hydraulic and hydraulic lime. The non-hydraulic lime is called as quick lime, fat lime or white lime or as lump lime. Hydraulic lime sets under water and non-hydraulic lime do not set under water. Quick Lime is a form of lime is manufactured by the burning of stone that has calcium carbonate within it. The burning temperature varies, say 900 degree Celsius and above for several hours. This process is called as calcination.

C. Sea shell

Shells of oysters and other shellfish are mainly calcium carbonate, but the shell tends to be contaminated with sand and organic material and is usually too coarse to be effective in soil. A seashell or sea shell, also known simply as a shell, is a hard, protective outer layer created by an animal that lives in the sea. The shell is part of the body of the animal. Empty seashells are often found washed up on beaches by beachcombers. The shells are empty because the animal has died and the soft parts have been eaten by another animal or have decomposed.

D. Egg shell

An eggshell is the outer covering of a hard-shelled egg and of some forms of eggs with soft outer coats. Eggshell waste is fundamentally composed of calcium carbonate, and has the potential to be used as raw material in the production of lime.




5. Results And Discussions

Study of Geotechnical Properties of Lateritic Soil:

Tests Conducted On The Lateritic Soil

TABLE.1 BIS Codes are used for various test conducted

Test	**IS Code**
Water content test	IS 2720:2
Specific gravity test	IS 2720(Part3)-(1980)
Grain size analysis	IS 2720-4(1985)
Atterberg's limit test	IS 2720-5(1985)
Compaction test	IS 2720-7(1980)

Specific gravity test IS-2720-Part-3/section-1-1980 (Reaffirmed- 2002)

Trial No.	**1**	**2**	**3**
Empty weight of density bottle (W1)	570	570	570
Weight of density bottle+soil (W2)	854	860	872
Weight of density bottle+soil+water (W3)	1584	1592	1585
Weight of density bottle+water (W4)	1404	1410	1408
Specific gravity of lateritic soil	2.730	2.68	2.516

Result: The specific gravity of soil= 2.62

Dry sieve analysis IS: 2720 (Part 4) – 1985 (Reaffirmed-2006)

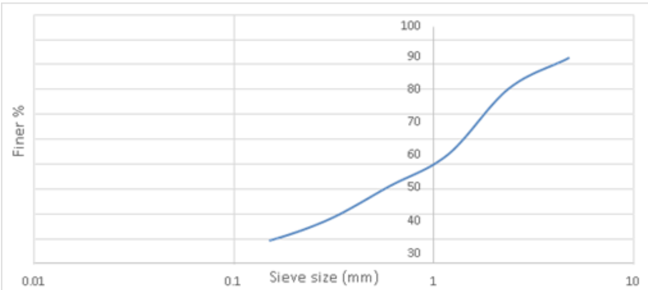

Fig.1 Graphical representation of sieve size vs. finer %

Result: Uniformity coeffecient, Cu=7.78

Co efficient of curvature, Cc=2.66

Wet sieve analysis IS: 2720 (Part 4) – 1985 (Reaffirmed-2015)

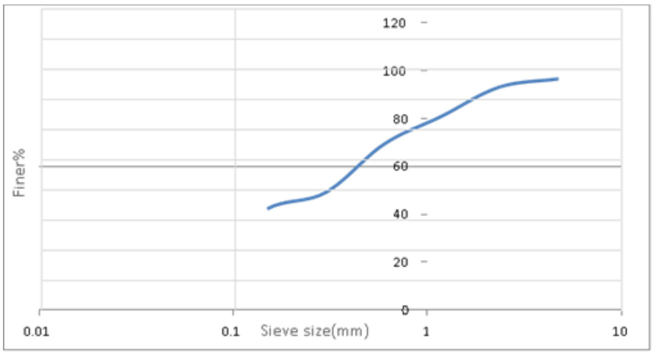

Fig.2 Graphical representation of sieve size vs. finer %

Result: Weight of dry soil taken for sieve analysis=1Kg

Weight of soil retained in sieves after wet analysis (excluding pan value)=0.967Kg

Weight of soil in pan =1-0.967=0.033 kg

Water content test: IS2720:2

Table.2 Water content tabular column

Trial No	**1**	**2**	**3**
Empty weight of container (W1)	68	66	67
Weight of container+ wet soil (W2)	143	147	149
Weight of container+ dry soil (W3)	133	136	138
Weight of water (W2-W3)	10	11	11
Weight of dry soil (W3-W1)	65	70	53
Water content (w%)	15.38	15.71	15.49

Result: Water content of soil=15.526%

Liquid limit test IS: 2720 (Part 5) –1985(Reaffirmed-2006)

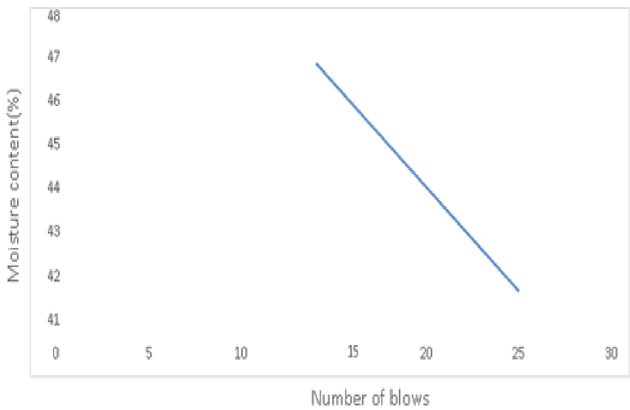

Fig.3 Graphical representation of Number of blows Vs moisture content %

Result: Liquid limit= 40%

Plastic limit test IS: 2720 (Part 5) – 1985(Reaffirmed-2006)

Table.3 Plastic limit test tabular column

Trial No	**1**	**2**
Container number	24	27
Empty weight of container (W1)	51	48.5
Weight of container+ wet soil (W2)	60.5	59
Weight of container+ dry soil (W3)	58	56.5
Weight of water (W2-W3)	2.5	2.5
Weight of dry soil (W3-W1) gram	7	8

Water content (w)%	35 .71	31.2 5

Result: Plastic limit= 33.48%

Standard proctor compaction: IS 2720-Part VII-1980(Reaffirmed- 2011)

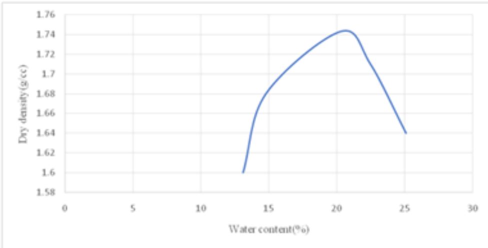

Fig.4 Graphical representation of Water content (%) Vs Dry density(g/cc)

Result: Maximum dry density= 1.71g/cc

Optimum moisture content= 22.47%

Study On Properties Of Waste Engineoil

Specific gravity test IS-2720-Part-3/section-1-1980 (Reaffirmed- 2002)

Table.4 Specific gravity test tabular column

Trial No	**1**	**2**	**3**
Empty weight of density bottle (W1)	5 70	5 70	5 70
Weight of density bottle + water(W2)	1 461	1 463	1 460
Weight of density bottle + oil (W3)	8 91	8 93	8 95
Weight of density bottle + water + oil (W4)	1 435	1 439	1 446
Specific gravity	0. 926	0 .93	0. 95

Result: The specific gravity of oil= 0.935

Flash and fire point test for waste engine oil

Table.5 Flash and fire point test tabular column

Test Material	**Number of observation**			**Avera ge value**
Flash Point	97	96	98	97
Fire Point	10 9	110	113	111

Result: Flash point of used engine oil is 97°C

Fire point of used engine oil is 111°C

Torsion Viscometer test on waste engine oil

Table.6 Torsion viscometer test tabular column

Red	Te	Siz	Cir	Densi	M

wood Seconds	mpera ture Oil in T°C	e of the cylinde r	cular scal e readin g	tyof soil Kg/m³	ass of the oil m/g
330	30	20	294	980	49
240	35	20	310	970	48. 5
190	40	20	320	960	48

Result: Viscosity of the used engine oil =60.69*(10^{-3})N sec/m²

Stabilization of Lateritic Soil with Various Proportion of Waste Engine Oil: Lime

Standard Proctor Test for Lateritic Soil with Waste Engine Oil: Lime (2:3)

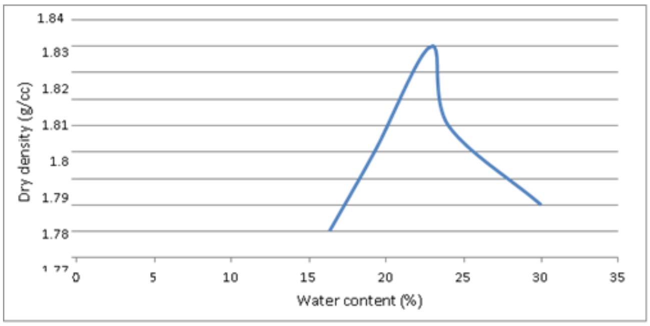

Fig.5 Graphical representation of Water content (%) Vs Dry density (g/cc)

Result: Maximum dry density= 1.83g/cc

Optimum moisture content= 22.857%

Standard Proctor Test for Lateritic Soil with Waste Engine Oil: Lime (3:4)

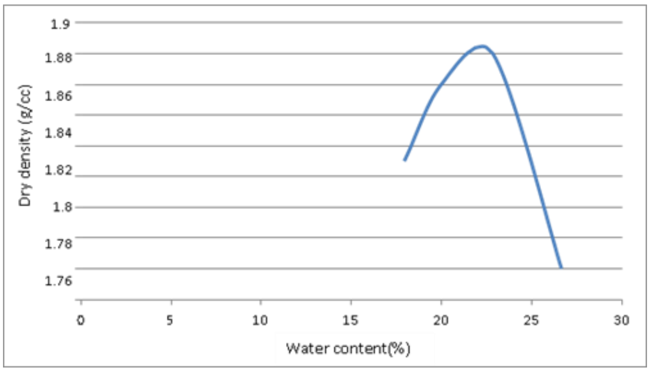

Fig.6 Graphical representation of Water content (%) Vs Dry density (g/cc)

Result: Maximum dry density= 1.88g/cc

Optimum moisture content=22.88 %

Standard Proctor Test for Lateritic Soil with Waste Engine Oil: Lime (4:5)

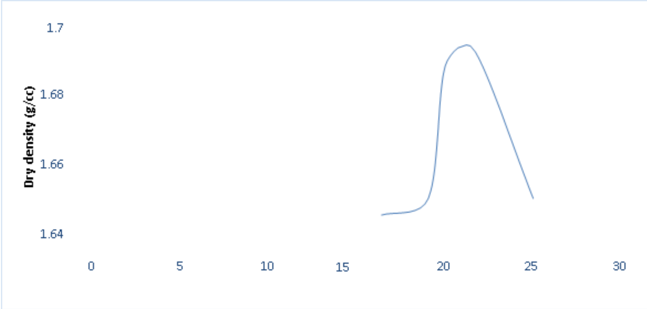

Fig.7 Graphical representation of Water content (%) Vs Dry density (g/cc)

Result: Maximum dry density= 1.68 gm/cc

Optimum moisture content= 21.62%

CBR Test for lateritic Soil with Waste Engine Oil : Lime (2:3)

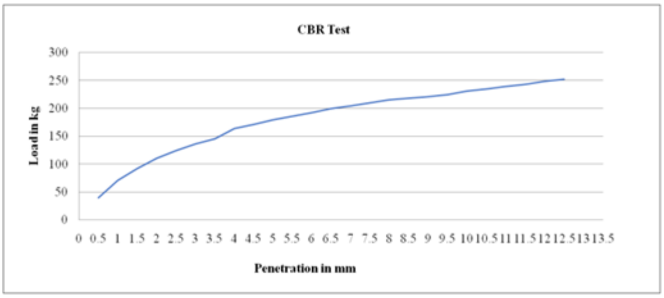

Fig.8 Graphical representation of Penetration (mm) vs load (Kg)

Result: CBR at 2.5mm penetration = 9.056%

CBR at 5mm penetration = 8.735%

CBR Test for lateritic Soil with Waste Engine Oil : Lime (3:4)

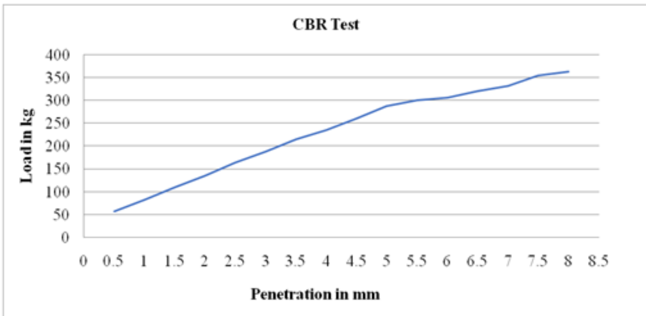

Fig.8 Graphical representation of Penetration (mm) vs load (Kg)

Result: CBR at 2.5mm penetration = 12.54%.

CBR at 5mm penetration = 13.98 %.

CBR Test for lateritic Soil with Waste Engine Oil: Lime (4:5)

Table.7 Torsion viscometer test tabular column

Lateritic soil		
DGR in mm	**PGR in division**	**Load in kg**
0.5	33	43.56
1	48	63.36

1.5	72	95.04
2	84	110.88
2.5	102	134.64
3	115	151.8
3.5	124	163.68
4	132	174.24
4.5	141	186.12
5	150	198
5.5	156	205.92
6	163	215.16
6.5	173	228.86
7	180	237.6
7.5	185	244.2
8	191	252.12

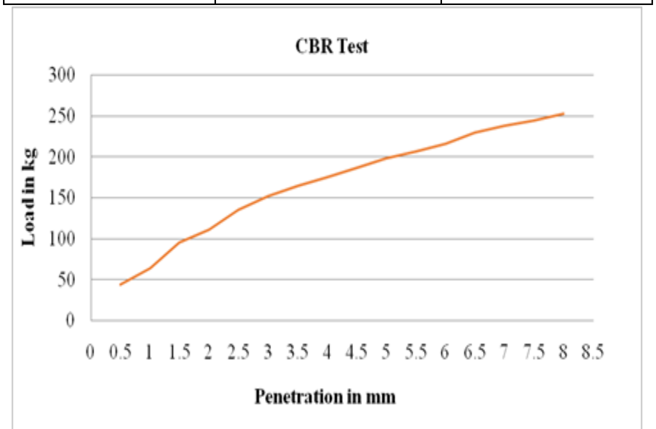

Fig.9 Graphical representation of Penetration (mm) vs load (Kg)

Result: CBR at 2.5mm penetration =9.827 %.

CBR at 5mm penetration = 8.63%.

Compressive Strength Test on Blocks

Table.8 Compressive strength of stabilized block

Size of block in Cm	Compressive strength in KN/M^2		
	3 DAYS	7DAYS	14 DAYS

6. Conclusion

- In compaction test maximum dry density of stabilized lateritic soil increased compared to convectional soil with the inclusion of waste engine oil and lime to the lateritic quarry waste for various proportions.
- Maximum dry density of stabilized lateritic soil for 3:4 ration of waste engine oil to the lime with soil was higher when compared with other proportions.
- The waste engine oil and Lime is mixed with lateritic soil the CBR value increased for various proportion. This makes the stabilized soil mixture suitable for construction of flexible pavement in sub base layer in accordance to IRC: 37-2012.
- Soil blocks prepared cannot withstand higher loads for a long duration, hence can be used for compound

wall construction.

- Plastering of wall is not required because of the smooth surface of the block prepared.
- Cost effective blocks are prepared with the help of waste engine oil and lateritic quarry waste which also helps in the disposal of toxic waste materials.

Effective utilization of waste engine oil, lateritic quarry waste and natural lime is achieved..

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