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Influence of Soaking On The California Bearing Ratio of Lateritic Soils, Ibadan- Oyo Highway, Southwestern Nigeria.

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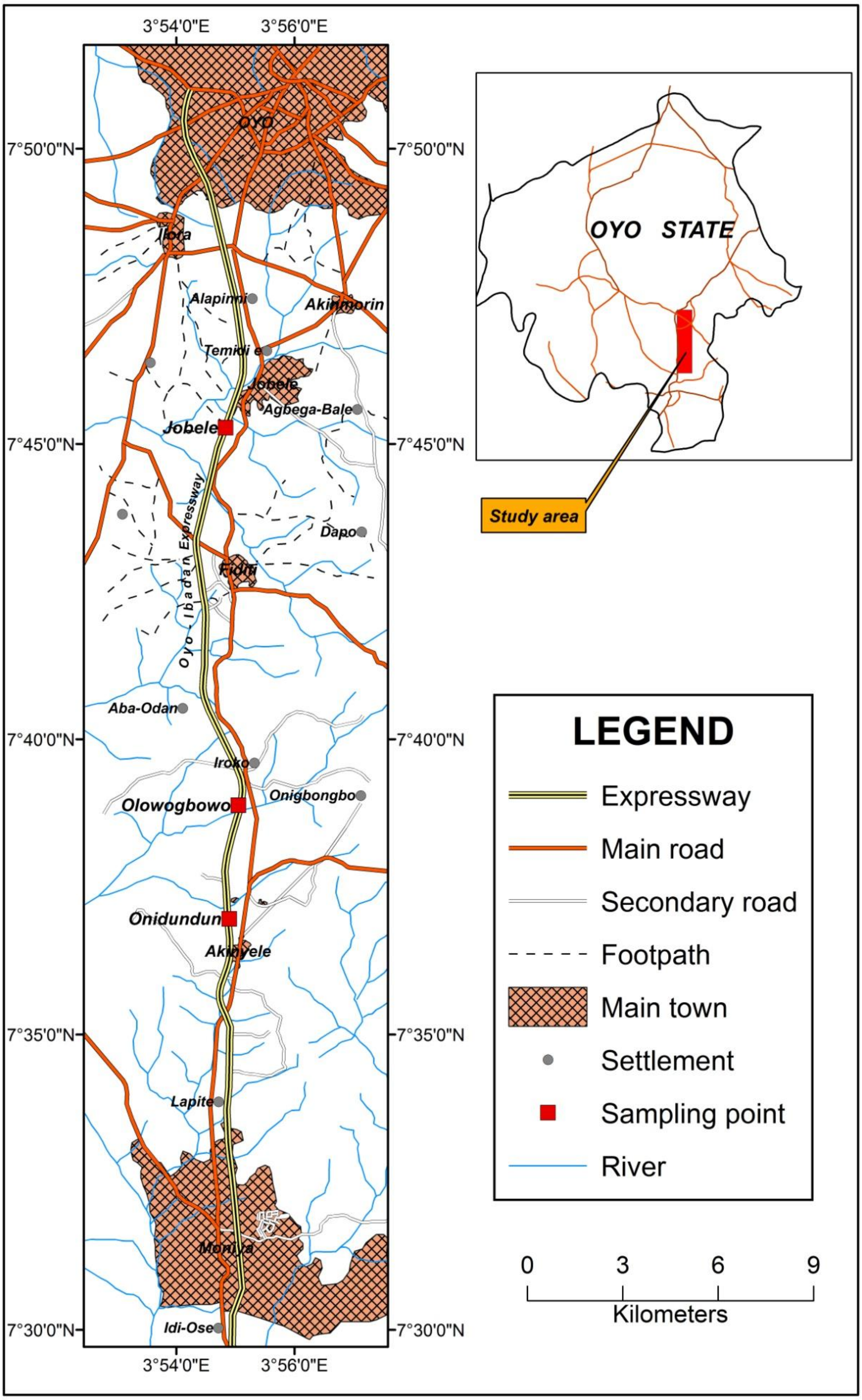
ABSTRACT: - Geotechnical properties of some sub base and sub-grade soils along Ibadan – Oyo highway, Southwestern Nigeria were investigated with a view of ascertaining the effect of water on the strength in terms of the California Bearing Ratio (CBR) on the soils. The results of the investigation showed significant decrease in the CBR of the sample after soaking. With small increases in the moisture content of the soaked samples, the percentages reduction in the CBR were very large. A slight increase in the moisture content can thus drastically reduce the CBR of the sub-base soil. Highway engineers should design adequate drainage system for highway pavement if the soils are to be used for construction. this is to prevent ingress of water to the sub-base soil.

Key Words: - Sub–Grade, Soaked, Highway, Geotechnical, Drainage.

I. INTRODUCTION

Failure of flexible highway pavement is a common feature in most parts of the tropical zones of the world. Such failure can occur in the form of pitting, rutting and waviness which was declared to be the most common form (Gidigasu, 1976). Since laterite soils are very important sub-base and sub-grade soils, their geotechnical properties should be investigated prior to their usage for construction purposes. This paper presents data on unsoaked and soaked CBR in order to determine the influence of soaking on the parameter. The studied area is within the tropical climatic region where there is distinct dry and wet season, which promotes the formation of lateritic soils. The heavy rainfall during the wet season may induce high percentage of moisture content, reduce the California Bearing Ratio and hence early failure of flexible pavement. The paper discusses the way to reducing the failure by a method of stabilization of a geotechnically weak lateritic soil by better one.



Map of Oyo-Ibadan Expressway showing study areas.

Study Area

Samples of soil studied were taking from two old borrow pits along Ibadan- Oyo highway Southwestern Nigeria. The area is within a tropical climate with distinct wet and dry seasons which favours the production of large quantity of lateritic soil which is abundantly present in the area.

Study Method

The investigation involved initial visits to the site, with a view to locate suitable areas of study. Two located areas were mapped out at 10 m by 40 m. Bulk soil samples were collected at 10m intervals at a depth of about 1 m and taken to the laboratory for analysis. Basic engineering tests, such as grain size analysis, consistency limits: Moisture content test: test procedure: (BS 1377: 1975 TEST 1 (A), ASTMD 2216), Liquid limit test (BS 1377 PART 2, 1990 Clause 4; ASTM D 423; AASHTO T 89**),** stabilization and California Bearing Ratio, were carried out The procedures followed were those given in BS 1377:1975 (British Standard Institute 1975). CBR tests were carried out on compacted unsoaked and soaked samples for 48 hours in order to simulate the conditions to which the sub-grade soils are exposed when there is ingress of water below the pavement, using The California Bearing Ratio test **(**BS 1377-4:1990 CLAUSE 7, ASTM D 1883**)** Compactions were carried out in a standard mould of and of 38 mm diameter and 76 mm height with each of 5 layers of soil and subjected to specific numbers of blows of 4.5kg rammer falling from a height of 0.46m. the compacted soils were tested in CBR machine to determine the strength. Samples were soaked for 48 hours and then tested again.

II. RESULTS AND DISCUSSIONS

Table 1 Consistency limits

Sample code	LL %	PL %	PI %
PA2	41.26	24.88	16.38
PA3	39.00	22.74	16.26
PA4	38.13	22.09	16.04
PA7	39.22	23.09	16.13
PA8	38.00	21.77	16.23
PB1	37.00	18.43	18.57
PB2	36.09	16.21	19.88
PB8	49.00	28.46	20.54
PB9	46.09	24.19	21.90
PB10	40.10	22.35	17.75

LL: liquid limit, PL: plastic limit, PI: plasticity index

Table 1 shows that the values of plasticity index in samples at locations PA & PB are generally lower than 25, the maximum recommended for sub- grade tropical soils (Medina 1963 in Simon et al. 1973 and cited in Adeyemi and Oyeyemi 2000). However, the values of PI at location PA are lower those at location PB indicating better samples at location PA.

Table 2 Grain size distribution.

Sample code	% Gravel	% Sand	Amount of fines %
PA2	12	40	48
PA3	5	51	44
PA4	4	55	41
PA7	5	43	52
PA8	4	52	44
PB1	17	38	45
PB2	18	33	49
PB8	15	25	60
PB9	12	40	48
PB10	12	46	42

Table 2 summarises the grain size distribution parameters. The proportion of amount of fines fraction at location PA are generally lower than those in samples at location PB This also indicates that the samples from

location PA have better geotechnical characteristics; however, the samples from both locations would be classified as well graded.

Mechanical Stabilization

Mechanical stabilization involves the changing of the soil gradation of two or more types of natural soils mixed to obtain a composite material that is superior to their original components are employed in this research.

Table 3: Properties of the soil samples from 2 sample locations.(Plasticity Index and Amount of Fines) .

Sample code	PI%	Amount of fines %	
PA2	16.38	48	
PA3	16.26	44	
PA4	16.04	41	Stabilizers
PA7	16.13	52	
PA8	16.23	44	
PB1	18.57	45	
PB2	19.88	49	
PB8	20.54	60	Stabilized
PB9	21.9	48	samples
PB10	17.75	42	

PI =Plasticity Index

Table 3 shows the properties of the soil sample used in the selection of the better soil sample. The stabilizers have higher better geotechnical properties (PA) than the stabilized samples (PB).

Stabilization method

Haven evaluated the geotechnical properties of the soil in terms soil classification, samples at location PA ranked best than the other sample location. Also, in terms of consistency limits, Plasticity Index of soil sample PA was considered better, hence soil samples at location PA were used in stabilizing soil samples at location PB which is considered to be having poorer geotechnical properties.

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Order of stabilization:

PA2 was used to stabilize PB1
PA3 was used to stabilize PB9
PA4 was used to stabilize PB8
PA7 was used to stabilize PB10
PA8 was used to stabilize PB2

Unsoaked and soaked California Bearing Ratio: California Bearing Ratio is used by highway geotechnical engineers to recommend thickness of sub-base. The CBR is often extended to soaked compacted samples. Soaking of compacted samples prior to CBR test would help in determining the amount of water the sample would absorb and how much strength reduction it would suffer if there is ingress of water to sub-base on highway. Chukwuemeka (2012) cited in Adeyemi (2013) noticed that even when the amount of absorbed water is low, lateritic soils often suffer great loss in strength in terms of CBR.

Table 4: Percentage increase in moisture content of soaked samples

CODE	% Stabilizer	Optimum Moisture Content (OMC)- Moisture Content of Unsoaked Samples(%)	Moisture Content of Soaked Samples (%)	% increase in Moisture Content
PB1	0	22.50	26.40	17.33
	10	21.60	25.73	19.12
	20	21.20	25.66	21.10
	30	20.40	23.98	17.54
PB2	0	20.10	26.12	29.95
	10	19.60	24.72	26.12
	20	19.20	25.06	30.52
	30	20.00	23.98	19.90
PB8	0	21.00	25.72	22.47
	10	20.40	24.79	21.52
	20	20.00	24.34	21.70
	30	18.80	23.36	24.26
PB9	0	23.20	27.02	16.47
	10	23.00	27.30	18.70
	20	22.40	26.74	19.38
	30	21.60	25.80	22.86
PB10	0	21.80	26.12	19.82
	10	21.20	26.08	23.02
	20	21.00	25.94	23.52
	30	20.00	24.68	23.40

Table 4 shows the percentages of increase in moisture content (from 17.33% to 29. 95%) whereas, in table 5, the corresponding percentages of reduction in the CBR are between 30.5 to 77.98). See Table 5. This shows that, influence of water on CBR is very significant and it must be taken into consideration when designing a flexible road pavement.

TABLE 5 Influence of soaking on CBR of stabilized lateritic soils

Sample code	% stabilizer PA 2	Unsoaked CBR(%)	Soaked CBR(%)	% reduction in CBR
PB1	0	16.38	7.70	53.00
	10	20.14	7.26	63.30
	20	21.74	9.16	57.73
	30	26.73	13.67	48.89
PB2	0	11.57	5.59	49.00
	10	15.33	6.91	54.40
	20	18.34	7.81	57.40
	30	23.11	7.06	69.40
PB 8	0	27.96	11.27	59.70
	10	31.86	22.13	30.50
	20	33.22	19.03	42.72
	30	57.71	22.20	61.53
PB9	0	17.89	9.09	49.80
	10	32.85	16.77	56.9
	20	34.89	17.90	48.64
	30	34.69	18.35	47.07
PB10	0	32.17	9.70	71.40
	10	36.70	10.72	70.79
	20	45.39	10.00	77.98
	30	50.95	17.90	64.85

III. CONCLUSIONS AND RECOMMENDATIONS

There are significant reductions in the strength in terms of CBR when the samples were soaked. Percentages reduction in strengths varied from 31% and 78% while the moisture content increased from between 17.35 % to 29.95%.

It is therefore necessary to keep water away from highway by providing adequate drainage system.

The study has shown that even when the amount of water absorbed is low, the studied lateritic soils can suffer great loss in strength in terms of CBR. It is therefore necessary to carry out geotechnical investigation on the sub-grade and sub- base soils before construction of highway flexible pavement to ascertain the likely influence of ingress of water at the site.

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