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Improving the Strength Characteristics of Subsoil by Using Admixture

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ABSTRACT: *From the year 1999, the PMGSY under Govt. of Republic of India is sanctioned project on in each part of the country for better communication system and transportation facilities. Under such circumstances a big amount of road construction is needed, specially in rural areas. Considering the poor subsoil condition in some of the districts of state, is extremely poor. Now the major parts of the roads are made over the sub grade soil. Sub grade is used as the bottom most layer of the pavement like Rigid or Flexible. As the sub grade supports the road pavement, the quality and strength of the sub grade soil should be increased to maximize the sturdiness of the pavement with the increasing rate of the traffic. With varying strength i.e. low to high strength characteristics, the soil having low strength in terms of California Bearing Ratio (CBR) needs an improvement by sensible quality material or by adding some admixture as well, which should not be quiet expensive. In the present study some attempts has been made to enhance subsoil properties by adding different kinds of sustainable admixtures. In this paper we have mixed "Fly-Ash", "Laterite soil" and "Sand" in different proportion with the virgin soil. Mainly we are dealing with CBR and UCS values to find out the substantial improvement of the sub grade soil after adding the admixture.*
KEYWORDS*: UCS, CBR, Subgrade soil, Flexible Pavement, Rigid Pavement.*

I. INTRODUCTION

Any types of Pavement are overlain on the sub grade layer. It is distributed the applied moving load to the Virgin or compacted soil. A major portion of the road networks in India are reported to be composed of flexible pavement as per Highway Statistics. The approximate design life of flexible pavement is 10 years to 20 years as per classes of road. So the quality of the weak sub grade soil ought to be increased to maximize the sturdiness. Soil stabilization is the commonest application within the field of construction where the most objective is to reinforce the strength, stability of the natural soil as well on reduce the price by exploitation waste materials or regionally accessible materials. Over the time cement, lime and sand were the effective materials of soil modification. But these materials have speedily inflated in value due to the sharp increasing in value of energy. Thus the use of fly ash and laterite soil can significantly economical. Actually fly ash is the waste matter of thermal station which can cause environmental hazards. But this will be with success when used as useful materials for its two vital properties i.e. Maximum Dry Density (MDD) and Specific Gravity. In our developing Country, thermal power plants are speedily increased with the high demand of electricity. Thus flyash is the simply accessible materials. As the PMGSY project is running everywhere the country, laterite soil and sand are conjointly accessible in various districts of West Bengal.

In this study, an attempt has been created to decrease the number of use of standard expensive materials as a major improvement substance by work with fly ash and laterite soil with the mixture of sand. By making the variation(%) of these mixtures, many experiments has been conducted to emphasize the strength characteristics of the virgin soil and also an attempt is made create some innovative conclusion from the experiment result.

II. MATERIALS USED

A. Soil Used:

Soil sample is collected from a place of lord's ground at Shibpur at 2.5m depth. On visual inspection it was found to be light grey clay. Evaluated properties of the soil are shown in Table-1.0 below. Based on L.L. and P.I. the soil may be classified as MI & OI.

Table: 1.0 Properties of soil

SL.No.	Test Conducted	Results
1.	Specific Gravity	2.65
3.	Liquid Limit(%)	47.21
4.	Plastic Limit(%)	29.43
5.	Plasticity Index(%)	17.78
6.	Classification of Soil	MI & OI
7.	Maximum Dry Density(MDD) (gm/cc)	1.913
8.	Optimum Moisture Content(OMC) (%)	14.05
7.	Unconfined Compressive Strength(KN/m^2)	30.71
8.	California Bearing Ratio(CBR)	
	Unsoaked	8.514
	Soaked	5.75

B. Flyash:

This is the waste product of thermal power plant and easily available in India as well as West Bengal. In this experimental study, we have collected from Budgebudge.

Table: 1.1 Chemical Compositions of Flyash

Sl. No.	Constituents	Percentage(%)
1	Silica(SiO_2)	55
2	Aluminum(Al_2O_3)	20.3
3	Iron(Fe_2O_3)	6.3
4	Calcium(CaO)	12
5	Magnesium(MgO)	3.5
6	Alkali	1.0
7	Sulphur(SO_3)	1.5
8	Heavy Metals	trace

C. Laterite Soil: These are rock types of soil with rich iron content. On the visual inspection laterite soils are red in color. For this study we have collected the sample from the area of Paschim Medinipore.

Table: 1.2 Geotechnical Properties of laterite soil

Sl. No.	Property	Value
1	Specific gravity	2.7
2	Max. dry density (gm/cc)	1.52
3	Optimum moisture content (%)	18.5
4	Un soaked CBR	3.4
5	Soaked CBR	1.8
6	Liquid limit (%)	48
7	Plastic Limit (%)	25
8	Plasticity Index (%)	23

III. METHODOLOGY

In this paper we have mixed Flyash of 10%, 15%, 20% with the natural soil and conducting the following tests like (a) Atterberg Limit Test, (b) Standard Proctor Test, (c) UCS (d) CBR. And with this each combination we add 5%, 10%, 15%, 20% sand to evaluate the combined effect of flyash and sand to the natural soil. Table 1.3 and 1.4 shows the detailed mix proportion.

1.3 Mix proportion of soil, Flyash and sand:

Sl. No	Mix Proportion		
	Soil	**Flyash**	**Sand**
1	100%	--	--
2	90%	10%	--
3	85%	15%	--
4	80%	20%	--
5	85%	10%	5%
6	80%	10%	10%
7	75%	10%	15%
8	70%	10%	20%
9	80%	15%	5%
10	75%	15%	10%
11	70%	15%	15%
12	65%	15%	20%
13	75%	20%	5%
14	70%	20%	10%
15	65%	20%	15%
16	60%	20%	20%

1.4 Mix proportion of soil, Laterite soil and sand:

Sl. No.	Mix Proportion		
	Soil	**Laterite Soil**	**Sand**
1	95%	5%	--
2	90%	10%	--
3	85%	15%	--
4	90%	5%	5%
5	85%	5%	10%
6	80%	5%	15%
7	75%	5%	20%
8	85%	10%	5%
9	80%	10%	10%
10	75%	10%	15%
11	70%	10%	20%
12	80%	15%	5%
13	75%	15%	10%
14	70%	15%	15%
15	65%	15%	20%

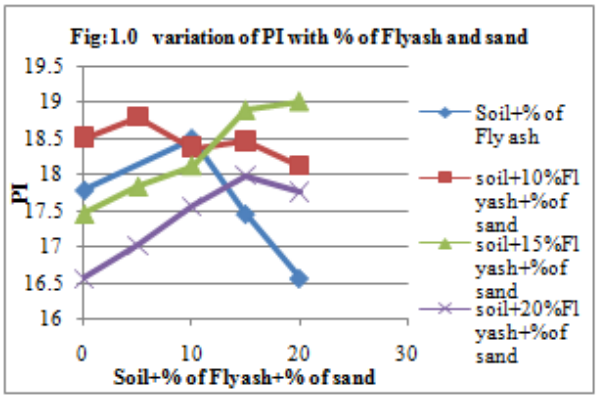
IV. RESULTS AND DISCUSSION

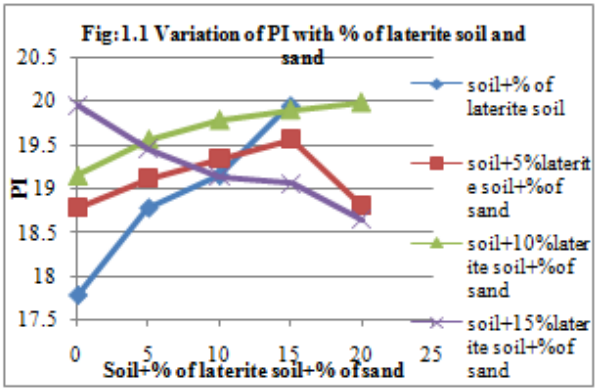
When the experiments are done by varying the combination, it shows a significant change on the geotechnical property. It represents in the following table 1.5.

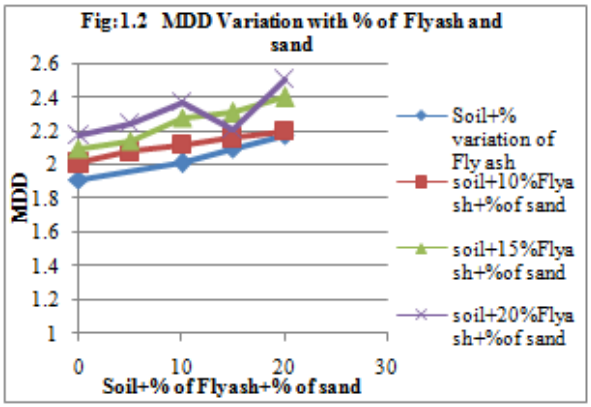
1.5 Details result

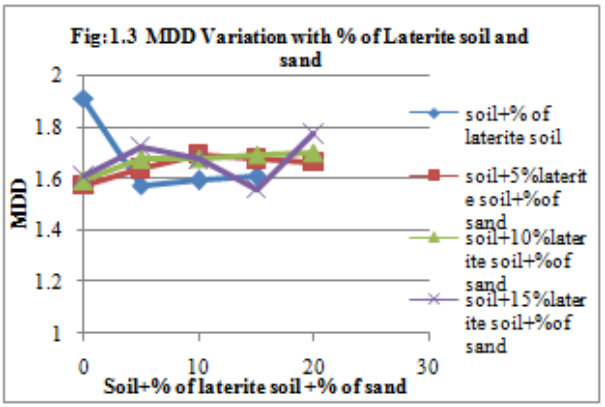
Sl. No.	Type of combination	PI	OMC	MDD	UCS	Soaked CBR	Unsoaked CBR
1	Lord's Soil	17.78	14.05	1.913	30.71	5.75	8.514
2	Soil+10% Flyash	18.5	17.89	2.01	38.34	6.8	10.89
3	Soil+15% Flyash	17.45	19.98	2.1	45.9	7.6	12.89
4	Soil+20% Flyash	16.56	21.2	2.18	65.56	8.73	14.43
5	(Soil+10% fly ash)with 5% sand	18.78	18.56	2.08	39.89	7.45	11.13
6	(Soil+10% fly ash)with 10% sand	18.37	18.97	2.12	40.78	8.87	13.98
7	(Soil+10%Flyash)with 15% sand	18.45	19.04	2.16	40.85	9.12	14.01
8	(Soil+10%Flyash)with 20% sand	18.12	19.01	2.2	41.34	9.45	14.89

9	(Soil+15%Flyash)with 5% sand	17.83	20.13	2.14	47.8	8.78	14.56
10	(Soil+15%Flyash)with 10% sand	18.12	21.89	2.28	52.78	9.98	15.676
11	(Soil+15% Flyash)with 15% sand	18.89	22.67	2.31	60.89	10.13	18.97
12	(Soil+15% Flyash) with 20% sand	19.01	23.86	2.4	65.98	11.45	20.6
13	(Soil+20%Flyash)with 5% sand	17.02	22.45	2.25	68.94	9.76	15.67
14	(Soil+20%Flyash)with 10% sand	17.56	23.78	2.37	66.65	10.76	17.87
15	(Soil+20%Flyash)with 15% sand	17.98	24.12	2.214	65.87	11.67	20.87
16	(Soil+20%Flyash)with 20% sand	17.76	23.98	2.51	64.98	12.98	21.87
17	Soil+ 5%Laterite soil	18.78	14.87	1.577	34.54	5.67	8.97
18	Soil+10%Laterite soil	19.15	15.12	1.595	35.87	6.32	9.18
19	soil+15%laterite soi	19.95	15.97	1.61	40.67	7.18	12.23
20	Soil+ 5%Laterite soil(with 5% sand)	19.12	16	1.64	36.53	6.1	11.555
21	Soil+ 5%Laterite soil(with10% sand)	19.34	16.6	1.694	39.87	5.8	11.283
22	Soil+ 5%Laterite soil(with15% sand)	19.56	16.74	1.678	40.56	5.72	11.134
23	Soil+ 5%laterite soil(with 20% sand)	20.8	16.98	1.668	42.98	5.698	11.079
24	Soil+10%Laterite soil(with 5% sand)	19.56	16.85	1.676	37.98	6.78	10.517
25	Soil+ 10%Laterite soil(with10% sand)	19.78	20	1.68	40.78	6.99	11.283
26	Soil+ 10%Laterite soil(with15% sand)	19.9	16.67	1.695	41.76	7.23	11.567
27	Soil+ 10%Laterite soil(with20% sand)	19.98	16.2	1.702	42.87	7.57	12.487
28	Soil+15%Laterite soil(with 5% sand)	19.45	16.2	1.727	42.8	7.78	12.335
29	Soil+15%Laterite soil(with 10% sand)	19.14	19.4	1.676	54.98	8.13	13.912
30	Soil+15%Laterite soil(with 15% sand)	19.06	17.56	1.56	56.7	8.98	15.673
31	Soil+15%Laterite soil(with 20% sand)	18.65	15.5	1.775	43.8	11.2	19.168









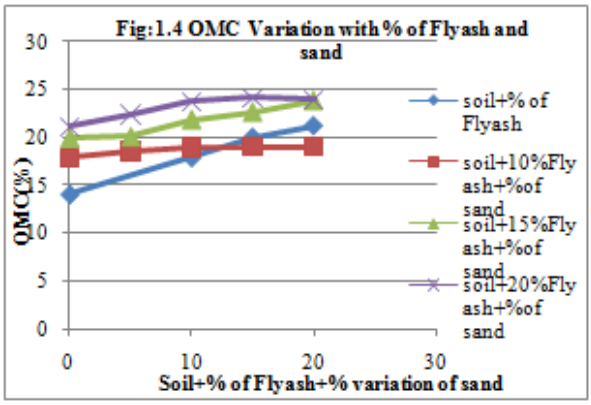


Fig:1.4 OMC Variation with % of Flyash and sand
OMC(%)
Soil+% of Flyash+% variation of sand
soil+% of Flyash
soil+10%Flyash+%of sand
soil+15%Flyash+%of sand
soil+20%Flyash+%of sand

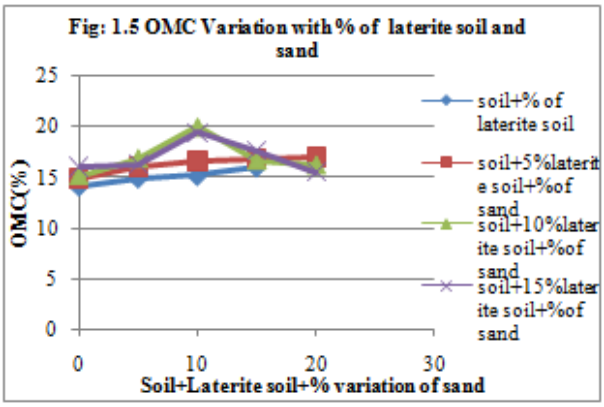


Fig: 1.5 OMC Variation with % of laterite soil and sand
OMC(%)
Soil+Laterite soil+% variation of sand
soil+% of laterite soil
soil+5%laterite soil+%of sand
soil+10%laterite soil+%of sand
soil+15%laterite soil+%of sand

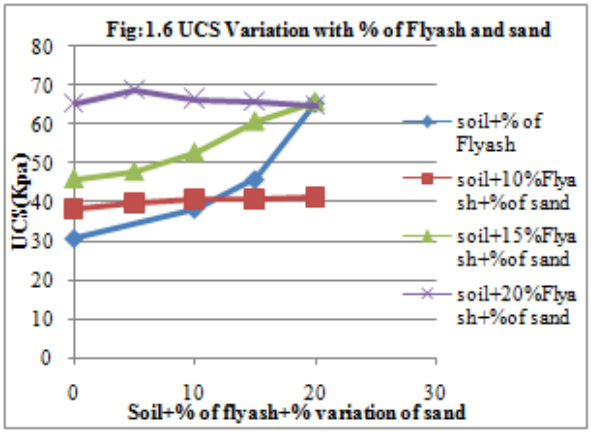


Fig:1.6 UCS Variation with % of Flyash and sand
UCS(Kpa)
Soil+% of flyash+% variation of sand
soil+% of Flyash
soil+10%Flyash+%of sand
soil+15%Flyash+%of sand
soil+20%Flyash+%of sand

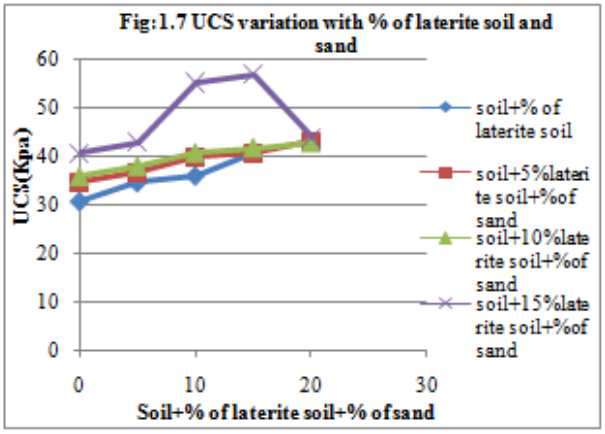


Fig:1.7 UCS variation with % of laterite soil and sand
UCS(Kpa)
Soil+% of laterite soil+% of sand
soil+% of laterite soil
soil+5%laterite soil+%of sand
soil+10%laterite soil+%of sand
soil+15%laterite soil+%of sand

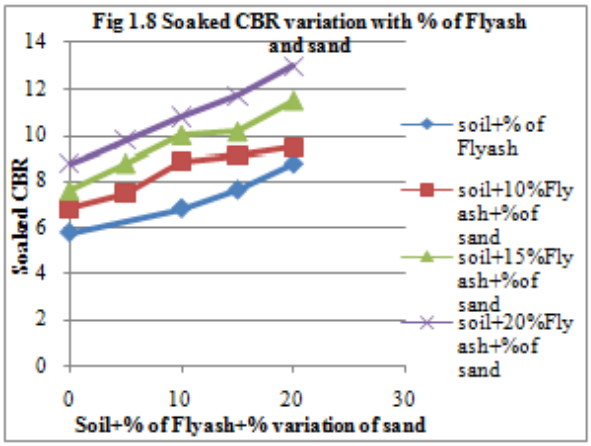


Fig 1.8 Soaked CBR variation with % of Flyash and sand
Soaked CBR
Soil+% of Flyash+% variation of sand
soil+% of Flyash
soil+10%Flyash+%of sand
soil+15%Flyash+%of sand
soil+20%Flyash+%of sand

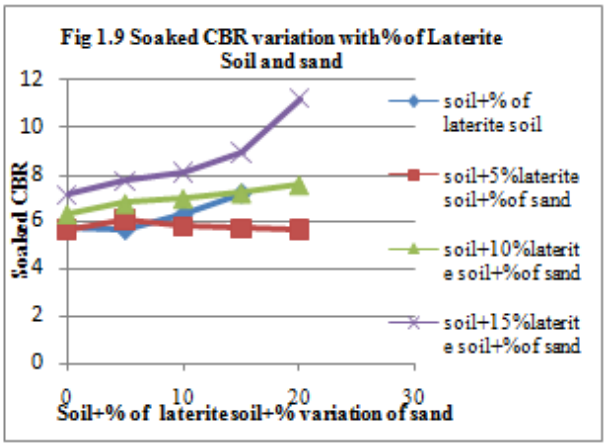


Fig 1.9 Soaked CBR variation with% of Laterite Soil and sand
Soaked CBR
Soil+% of laterite soil+% variation of sand
soil+% of laterite soil
soil+5%laterite soil+%of sand
soil+10%laterite soil+%of sand
soil+15%laterite soil+%of sand

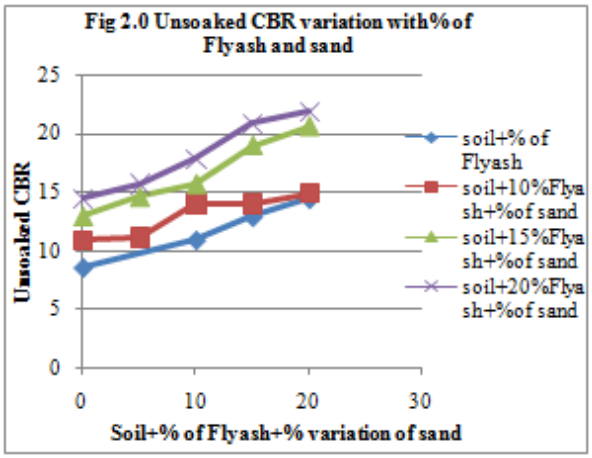


Fig 2.0 Unsoaked CBR variation with% of Flyash and sand
Unsoaked CBR
Soil+% of Flyash+% variation of sand
soil+% of Flyash
soil+10%Flyash+%of sand
soil+15%Flyash+%of sand
soil+20%Flyash+%of sand

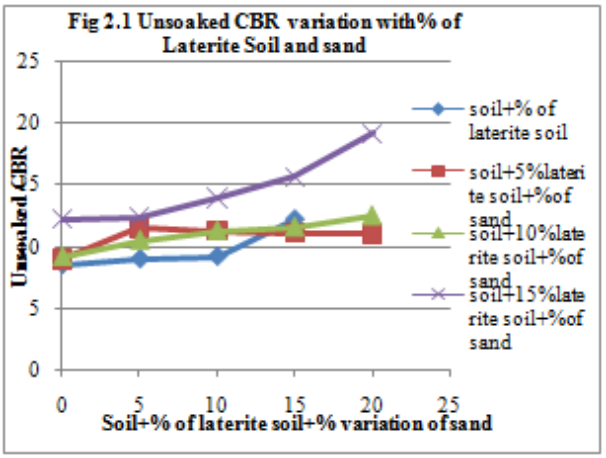


Fig 2.1 Unsoaked CBR variation with% of Laterite Soil and sand
Unsoaked CBR
Soil+% of laterite soil+% variation of sand
soil+% of laterite soil
soil+5%laterite soil+%of sand
soil+10%laterite soil+%of sand
soil+15%laterite soil+%of sand

Effects of alternative materials on Plasticity Index:

On increasing the flyash percentage along with sand with the natural soil at first Plasticity Index (PI) is increasing. After adding about 10% of Flyash with the natural soil and about 15% sand with the soil and Flyash mix, the plasticity index tends to decrease gradually or remains constant. When the Plasticity index is going to decrease the soil will be in low plastic state thereby strength characteristics is expected to decrease.

By adding the laterite soil with the natural soil as per table: 1.5 the PI is also increased. When sand is added in different proportion (5%, 10%, 15%, 20%) with the mixture of natural soil and laterite soil, then also PI is increasing, except the composition of natural soil with 15% laterite soil with the variation of sand.

Effects of alternative materials on the compaction characteristics of soil:

On increasing the flyash percentage (10%,15%,20%)in the natural soil and the addition of sand(5%,10%,15%,20%) in the natural soil and flyash mix, the Maximum Dry density tends to increase. So that the strength of the natural soil is also expected to improve.

The addition of laterite soil in the natural soil with the increasing percentage first leads the MDD to decrease. After addition of 5% laterite soil to the natural soil, it increases gradually or remains constant. With the increasing of sand percentage (5%,10%,15%,20%) with the natural soil and (5% and 10%) laterite soil mix, the MDD increases gradually or remains constant. But only in the composition of Natural soil,15% laterite soil and various percentage(5%,10%,15%,20%) of sand, thee MDD increases at first, then decreases, after adding 15% sand MDD again started to increase. Therefore the strength characteristic is also lead to increase.

In case of Soil with the increasing percentage of laterite soil, OMC increases gradually or remains almost constant. Same thing happens only with the composition of Soil, 5% laterite soil and increasing percentage (5%, 10%, 15%, and 20%) of sand. But for the other composition OMC first increases then decrease gradually. Hence about after 10% of addition of laterite soil and sand the strength behaviour may be improved.

Effects of alternative materials on the strength characteristics of soil:

In addition of Flyash in increasing percentage with the natural soil leads to increase the UCS value. And the increasing addition of sand with the natural soil and Flyash mix also maintain that. But only in the composition of Soil, 20% Flyash and Variation of sand, UCS value increases first and after about 10% addition of sand it remains almost constant or decreases very slowly. Therefore only this composition is not suitable for strength enhancement. Other composition is very much applicable for strength improvement.

In addition of Laterite soil in increasing percentage with the natural soil leads to increase the UCS value. And the increasing addition of sand with the natural soil and laterite soil mix also maintain that. But only in the composition of Soil, 15% laterite soil and Variation of sand, UCS value increases first and after about 15% addition of sand it decreases gradually. Therefore only this composition is not suitable for strength enhancement. Other composition is very much applicable for strength improvement. Incase of CBR same improvement observed.

V. CONCLUSION

From on these experimental results, it's revealed that fly ash is an effective admixture which could have been used to the strength characteristics of the weak sub-grade soil and also to enhance the other geo-technical properties as well. on the contrary, while sand is mixed with the combination of fly ash and the laterite soil, consequences a greater impact on the geotechnical properties of the virgin soil. Thus by this substitution process we can enhance the strength of subsoil which will help to reduce the thickness of the pavement.

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