International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 1135-1140 www.ijaem.net ISSN: 2395-5252

Study on Chemical Additive Equalization of Pavement Subgrade Soil

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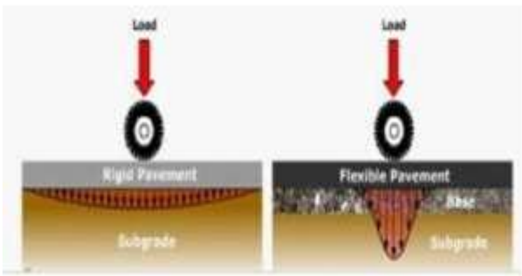
Submitted: 10-05-2022 Revised: 17-05-2022 Accepted: 20-05-2022

ABSTRACT
Sub grade soil is an essential component for design of both flexible and rigid pavement structures. The main cause of failure of pavement is the settlement of sub grade, high moisture susceptibility which leads to loss of strength of sub grade. Black cotton soil is a type of weak soil. The pavements constructed on this type of soil are normally subjected to deterioration. The disappointments of asphalt in from of hurl dejection splitting and unevenness are brought about by the occasional dampness variety in sub grade soil.

Soil adjustment proves to be an alternate to cutting out and replacement of soil as this saves time and money involved in it. The end goal of Soil adjustment is the improvement of nature of soil properties by physical or synthetic means. Thus achieving the enhanced bearing capacity to sustain vehicle load repetitions, imperviousness to weathering and soil penetrability. Pain soil and treated soil with additives were compared for strength properties. Cement kiln dust is a by-product obtained during the Portland cement manufacturing. CBR, triaxial compression test and permeability tests were conducted at various proportions of cement kiln added to plain soil. The results were analyzed for volumetric and performance properties.

I. INTRODUCTION

The characteristic of the road depends to a large extent on the subgrade soil strength parameter and shear parameter. Hence the subgrade strength evaluation was so important for a pavement design, its construction and in maintenance stages. The soil CBR value and its elastic modulus values are mandatory parameters for pavement design and construction. Soil stabilization aims at bonding together the soil particles or water proofing the soil or the combination of the two.Soil forms the basic component of road and the pavement industrysignifies its importance in pavement works. India is confronted with the colossal test of protecting and upgrading the transportation framework to meet the constantly expanding hassles because of heavier burdens delivering layers to the hidden soil. Roads running through expansive soil perform poor as they are subjected to stresses leading to various pavement distresses and causing increased maintenance cost. This study has taken an imperative step to accomplish monetary utilization of development in materials by endeavoring to keep the wastage of soil material through the change of its properties to meet the prerequisites of pavement configuration from its planned utilization. Chemical stabilization ofexpansivesoil results physico-synthetic change around and within clay particles. The earth obliges less water to fulfill the static imbalance and obstructswater to move into and out of the framework there byfulfilling particular road design and administration life of the asphalt. The Teraasil and Zycobond were found to be recognizable chemical admixtures for soil adjustment.



Rigid and Flexible Pavement Load Distribution

INDUSTRIAL WASTE STABILIZATION:

Many researches across the globe were carried on the laterites stabilizationFew studies findings were presented which aimed at stabilizing laterites to be used for highway construction. Researchers worked on stabilization of lateritic soil using bagasse ash. The improvements in geotechnical properties of laterite soil were studied with the baggase ash up to 12% bagasse ash by weight of dry soil. The particle size analysis, compaction, unconfined compressive strength (UCS), California Bearing Ratio (CBR) and durability tests were conducted on the test specimens. The British Standard Light (BSL) compaction standards were adopted. The laterite soil treated with the 2% bagasse ash resulted a peak 836 KN/m^2 UCS and 16% CBR on 7day test. These are found to be less than 1700 KN/m^2 UCS and 18% CBR which were recommended adequate for cement stabilization. The study concluded that the bagasse ash cannot be recommended as a mono-stabilizer but it canbe employed in admixture stabilization.

Researchers investigated the stabilization of lateritic soil using GKS soil stabilizer. The unconfined compressive strength and shear strength of the plain laterite soil and the treated soil were compared. Results showed the significant improvement in unconfined compressive strength and shear strength of laterite soil treated with GKS (polymer layer). The unconfined compressive strength increased with the duration of curing time, the variation mainly occurring in the first 7days. The result proved to be worthy in in using the stabilizer for practical project including pavement construction, backfilling, controlling erosion and stability of slopes.

II. LITERATURE REVIEW

The expansive soil undergo swell and shrink in the presence and absence of water. This is due to the presence of montmorillonite clay mineral. The cementitious additives and chemical additives can be used to improve the expansive soils. These additives include different waste material and manufactured materials such as fly ash, cement, lime and proprietary chemical stabilizers. Cement and lime are used for the weak subgrade treatment.For the weak subgrade material sin the pavement structure, the cement stabilization proved to be an effective solution to the fatigue failures caused by repeated high deflection of asphalt surfaces.Cement stabilization of expansive soils showed significant improvement in strength and reduced the deflection. The swelling behavior of expansive soil was curtailed treatment with lime or flu ash. The type of flu ash and its composition widely effects the properties of stabilized soil.

Amitkumar A. Patel (2015). The Warm mix technology in India is quite new with very few laboratory evaluation and field evaluation studies carried out since 2009. While the energy savings and the reduction in carbon emissions by using WMA are quite appealing, the performance of these mixes in India is not well known. The asphalt mix designs, type and quality of bituminous binders, equipment, climate conditions, highway engineering practices in India are very different from those in the western countries and thus warm mix asphalt technology needs investigations and extensive research before being completely adopted in India. Many researchers have studied the effect of warm mix additives on the performance characteristics of asphalt mixes and on the binder properties. The main focus is to reduce mixing and compacting temperature while achieving similar performance properties as that of hot mixasphalt.

Zhen Leng, A.M.ASCE, AngeliGamez, (2014).indicated that bituminous binders modified with inorganic additive do not show significant changes in binder properties when compared with the virgin binders. During the preparation of asphalt mixture, foaming materials like Asphamin® and water generally evaporate. So their effect on binder‟s rheological properties is negligible. Further they reported that when the organic wax based additive like Sasobit® is used with PG 64-22 the effect on flow, stiffness, and creep response is significant. But the wax based additives effects the properties of asphalt mixture and asphalt binder when mixed with binder to reduce its viscosity.

Hossian et al. (2012) reported a decrease in the viscosity of the base binder and thus reduction in mixing temperature with increase in the dosage (1 to 3%) of Sasobit®. Reduction in mixing temperature of 11°C with 3% Sasobit® was found to be at desired viscosity of 170 mPas. On the other hand, no positive effect was observed for any dose ofAspha-Min.

Addition of Sasobit® up to 3% increased the aliphatic content which indicate the increased complex component (G*) which increases the elastic modules of the binder while there was no significant change in the aliphatic content of the binder with the increase in content of Aspha-Min. Such results are in linewith the DSR test data where the G* value increases with the increase of Sasobit® content in thebinder.

Liao and Chen (2011) opined that current rutting parameter G*/sinδwas not reflected in rutting performance of asphalt pavement in some cases as it does not consider the recovery phase during oscillatory testing. ZSV of bituminous binders is an alternate performance indicator of rutting resistance. They studied rutting behavior of binder and it‟s mastic in term of zero shear viscosities for three different concentrations of limestone filler. ZSV was determined by two types of measurement techniques, through oscillatory and viscometry testing and it was found that CoxMerz rule was obeyed by the bitumen-filler mastics at low concentrations (15% and 35%) of limestone filler. At high filler concentration (65%) two different values of complex viscosity were obtained by two techniques for a given oscillation frequency and therefore Cox-Merz rule was not found suitable. They attributed this behavior of mastic at high limestone concentration to filler particle-particle interaction in masticsuspension.

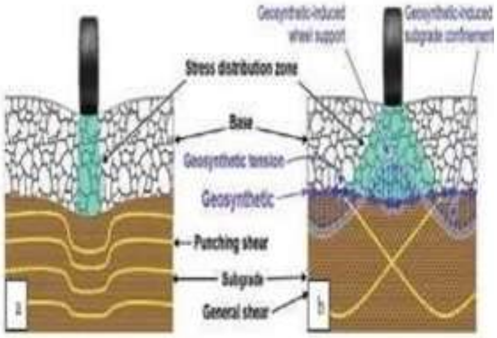
T.,andAmirkhanian, S. (2009). Warm Mix Asphalt (WMA) is a fast emerging new technology with potential of revolutionizing the production of asphalt mixt. WMA technology may permit the mixing, and compaction of asphalt at 30°C to 40°C lower temperatures compared to Hot Mix Asphalt (HMA). WMA is produced by incorporating additives into asphalt mixtures to let the production and placement of the mix at temperatures well below the temperatures of conventional hot mix asphalt (HMA). Warm Mix Asphalt (WMA) is the process of using additives to reduce the mixing temperatures of HMA by 10ºC to 35ºC. ZycothermAspha-min Sasobit Warm asphalt-mix foam Revix and Rediset-WMX For the present study Zycotherm additive has been used. Zycotherm is WMA additive developed by Zydex Industries, Gujarat, India. This is an odour-free, chemical warm mix additive which has been developed to provide significantly enhanced benefits over the existing. WMA technologies by offering lower compaction temperatures and at the same time improving the moisture resistance of pavements by serving as an antis trip

III. METHODOLOGY

Soil has various meaning, depending upon the general professional field in which it is being considered in general soil mean the top layer of the earth surface in which plants can grow consisting of rocks and minerals particles mixed with decayed organic matter and having the capability of retaining water. And thus stabilizing soil gives better bearing capacity

Stabilization of road sub grades:

Sub grade stabilization is defined herein as the roadway application involving the use of geo synthetics to increase the bearing capacity of soft sub grade soils. The functions of reinforcement, stiffening, separation, and filtration are involved in this application. Among these multiple functions, the reinforcement function leads to an increased bearing capacity of soft foundation soils while the stiffening function contributes to decreased lateral displacement within the base. Accordingly, a key design property for the reinforcement function is the geo synthetic tensile strength. It should be noted, though, that the stiffening function, which requires quantification of the rigidity of the soil-geo synthetic composite, is also relevant to complement stabilization of the sub grade with that of the base. The geo synthetic is placed at the interface between the sub grade being stabilized and the overlying granular base. As previously indicated, it is then the case that a geo synthetic used for sub grade stabilization also provides stabilization to the overlying base material, as discussed in the previous section of this paper. This exemplifies use of a single geo synthetic for two applications: sub grade stabilization (to increase the sub grade bearing capacity) and base stabilization (to control lateral displacement of base material and consequently maintain a comparatively high base stiffness). However, sub grade stabilization involves the mobilization of comparatively large geo synthetic strains and the development of comparatively large rutting depths, which are consistent with those expected in unpavedroads.



Use of geo synthetics in stabilization of road sub grades: (a) roadway designed without geo synthetics,
(b) roadway designed with geo synthetics.

IV. RESULTS & DISCUSSIONS

Indirect Tensile Strength:

The level about powerlessness to dampness harm is confirmed toward get ready An situated for laboratory- compacted examples adjusting of the job-mix equation. It measures the Part rigidity by the provision of a polar compressive drive with respect to barrel shaped bituminous blend example put with its hub level. Tensile strength ratio is determined according to AASHTO 283, which is the ratio of wet tensile strength to dry tensile strength of Marshall Specimens. Graph shows the Indirect Tensile Strength and IndirectTensile

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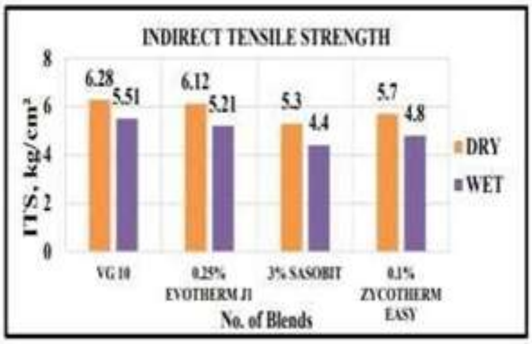
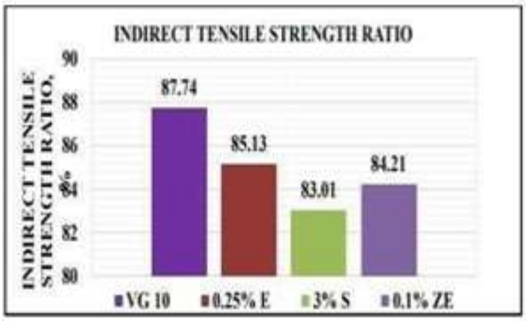
Strength Ratio for VG 10 with and without warm mix additives.



Indirect Tensile Strength for VG 10 with and without warm mix additives



Indirect Tensile Strength Ratio for VG 10 with and without warm mix additives

Static Creep Test:

It was directed to appraise the rutting capability of bituminous blends under unconfined conditions. This test is led by applying a static heap of 100 kPa to Marshall Specimens at a temperature of 40oC for a time of one hour and afterward measuring the lasting deformation of the sample subsequent to emptying. Table shows demonstrates the watched estimations of static creep test.

Type of binder	Accumulated strain (microns)	Permanent strain (microns)	Recovery (%)
VG 10 @ 4.5% OBC	16648	14856	10.76
0.25% Evotherm	16201	14384	11.22
3% Sasobit	15548	13842	10.97
0.1% Zycotherm Easy	15984	14224	11.01

Static Creep Test for different mixtures

Dynamic Creep Test:

It test was performed on Marshall Specimens prepared using different binders and warm mix additives. This test was achieved on Universal Testing Machine at a temperature of 40°C. The test was conducted as per NCHRP 9 – 19 (report 465).Table shows dynamic creep testresult.

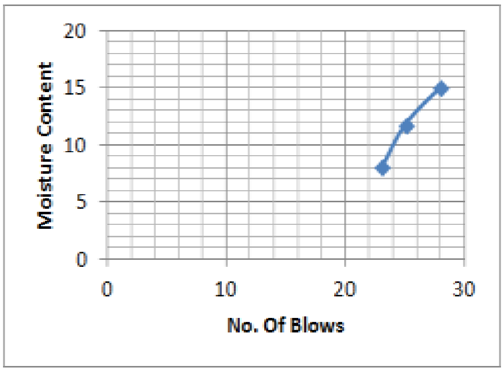
Mix ID	Total permanent strain, %
VG 10 @ 4.5% OBC	0.654
0.2% Evotherm	0.482
3% Sasobit	0.358
0.1% Zycotherm Easy	0.442

Chemical Method Engineering Properties

In chemical method 0.041% of Terrasil is used as an additive to the red & black cotton soil by weightof soil. All the test such as liquid limit, plastic limit, specific gravity, modified proctor & C.B.R test were performed on respective soils.

N0	I	II	III
No. Of blows	25	28	23
Container no	1	2	3
Mass of container + wet soil(g)	26	28	30
Mass of container + dry soil(g)	25	26.5	29
Mass of water (g)	1	1.5	1
Mass of container (g)(W_1)	16.5	16.5	16.5
Mass of oven dry soil (g)(W_2)	8.5	10	12.5
Water content (%)	11.76	15	8

LL Red soil With 0.041% Terrasil



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Flow curve for Red Soil with 0.041% Terrasil.

NO	I	II	III
CONTAINER NO	1	2	3
Wt of container	16.5	16.5	16.5
Wt of cont+ wet of soil	33.5	32.5	31.2
Wt of cont. + dry soil	30	29.5	28
Wt of water	3.5	3	3.2
Wt of dry soil	13.5	13	11.5
Water content	25.9	23.07	27.8

LL Red soil With 0.041%Terrasil.

Penetration	Unit std. Load (kgf/cm2)	Total std. Load (kgf)
2.5mm	70	1370
5mm	105	2055
7.5mm	134	2630
10mm	162	3180
12.5mm	183	3600

Standard Load used in C.B.RTest.

- Chemical stabilization had more CBR value than conventional method of soil stabilization.
- Chemical stabilization required lesser thickness of sub grade in comparison with conventionalstabilization.
- By adding terresil plasticity index reduced and dry densityincreases.
- Chemical stabilization was more economical than conventionalstabilization

V. CONCLUSION:

The characteristic of the road depends to a large extent on the strength and shear parameter of sub grade material. The evaluation of sub grade is an important for the road pavement during design, construction and service stages. The use of CBR and elastic modulus values are mandatory parameters for pavement design and construction. The behavior of soil varies largely with introduction of stabilizer. It is observed that increment in dosages resulted in decrement of consistency limits. So it is clear that the chemical makes the soil stiff. It is noted that CBR value increases with increase in dosage of stabilizer and an optimum value is obtained. Cement kiln dust being a waste product is economical and the CBR value also showed a considerable increase. The water proofing property of soil had a significant effect of adding Terrasil compared to cement kiln dust. The elastic modulus value for soil with additives showed a considerable increase compared to unstabilized soil Significant strength improvements were observed for soil treated with cement-fly ash admixture. Most of the strength gains over the soaking period, suggesting that stabilization reactions and strength gains were ongoing. Cement- treated soil may be experiencing the formation of additional inter-particle bonds over time, while most of the fly ash stiffness gains were achieved very early in the curing process with little additional gainsover time.

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