PERFORMANCE EVALUATION OF REINFORCED FLEXIBLE PAVEMENTS ON DIFFERENT SUBGRADE

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ABSTRACT: ***Expansive soils, such as black cotton soils, are basically susceptible to detrimental volumetric changes, with change in moisture regime. In monsoon, they take up water and swell, and in summer, they tend to shrink on evaporation of water, thus posing the problem of alternate swelling and shrinkage. This behaviour of expansive soils is attributed to the presence of mineral montmorillonite, which has an expanding lattice.Commonly, gravel is considered to be suitable for road construction (MOST-1998). However in the latest MORT specifications, several types of gravel are found to be unsuitable for road construction in view of higher finer fraction and excessive plasticity properties. As thermal power plants are spatially distributed all over the country, utlisation of flyash from these plants for the road construction not only helps to consume bulk quantities of flyash solving its disposal problems to a certain extent but also satisfy the construction requirements. In the recent past, reinforced earth technique has been tried effectively in solving majority of geotechnical engineering problems (Hausmann, 1990). With the introduction of geosynthetics, the reinforced earth technique gained prominence due to its adaptability for varying field conditions. Few researchers have tried (Haas et al, 1988; AL. Qadi and. Shutter., 1999) to introduce geosynthetic reinforcement layer in the pavement system to improve its performance and the results are encouraging. In majority of the previous studies, the reinforcement layer was used either at the pavement - subgrade interface as a separator or immediately below the wearing course to control the rut and crack formation. Limited studies (Kinney et al, 1998) are also made by placing the reinforcement in one of the layers of flexible pavement system laid over conventional non-swelling subgrades. However, the results are not conclusive in respect of the type of the reinforcement layer for overcoming the problems related with expansive soil. By providing reinforcement in the gravel and flyash subbase, the load carrying capacity of the system has increased by 89%, 67%; 89%, 67%; 56%, 34%; 11%, 20% and11%, 20% for geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber respectively in saturated state of the sand subgrade. Similarly for expansive soil subgrade at saturation state, the load carrying capacity of the system for gravel and flyash subbase has increased by 84%, 55%; 84%, 55%; 67%, 37%; 25%, 10% and 25%, 10% for geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber respectively. To confirm the findings made during the laboratory investigations with reinforcement, field studies were also carried out.***

It is observed from the test track studies that the use of reinforcing material in the subbase course has resulted in insignificant reduction in heave values. The rebound deflections for sand subgrade with gravel and flyash subbase during wet season are decreased by 48%, 70%; 45%, 64%; 38%, 55%; 29%, 35% and 19%, 26% for geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber respectively. Similarly for expansive soil subgrade with gravel and flyash subbase, during wet season the rebound deflections are decreased by 60%, 36%; 44%, 32%; 36%, 24%; 23%, 21% and 15%, 6% for geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber when compared with untreated stretch respectively.

Key Words: Flexible Pavement, Subgrade, Bitumen, Performance Evaluation.

I. INTRODUCTION

Expansive clays are the most problematic soils due to their unique alternate swell-shrink behavior with fluctuations in moisture content. World over, many case studies (Holtz and Gibbs, 1956; Ganapathy, 1977; Evans and Mc Manus, 1999) of failed structures built on expansive soils have been reported. The situation in India is also no different from extensive coverage of expansive soils that occupy almost one-fifth of the geographical land area (Snethen et al, 1979; Chen 1988a). It is an established fact that suitable site conditions are not available everywhere. Variations in the subsoil specially the presence of treacherous soils pose a challenge to the civil engineers. To put the infrastructure in position, there is no other-go but to improve the sub soil for expected loads and make them suitable for the type of construction planned. Flyash is being used as a partial replacement of cement in concrete. The most significant advantage of increased strength is achieved by replacement of cement with flyash. Bottom ash and pond ash can be gainfully used for the construction of embankments or back filling and replacing granular layer in subbase course (Guruvittal and Murthy, 1998). Digioia and Nuzzo (1972) used flyash as a structural fill material such as embankments, fill behind retaining walls, as a reclamation fill etc. Phani Kumar and Radhey Sharma, 2004 reported that flyash can be used as an additive in improving the engineering characteristics of expansive soils and further observed that the plasticity, hydraulic conductivity and swelling properties of the blends decreased and the dry unit weight and strength increased with an increase in flyash content.

Flyash has been used in India for filling low lying areas, for construction of road embankments and for construction of dykes around ash ponds as well as backfilling behind retaining structures. Apart from the use of flyash as a geo-engineering material, it is being used in concrete structures, brick industry, in the manufacturing of asbestos sheets and also as poultry feed. Various alternative technologies of utilising flyash for the manufacture of bricks, blocks, tiles etc., are available today, the progress in adapting them is not very satisfactory (Suryanarayana,2000; Kuan-Yeow Show et al., 2003). In order to avoid various associated problems of flyash disposal, the best remedy is to use flyash in bulk quantities. In spite of some inherent problems associated with flyash utilization, the encouraging engineering properties of the material prompted engineering community to utilize it in bulk quantities for construction purposes, which not only helps to dispose it off but also to preserve the top fertile soil from using it for several purposes.

In the recent past, reinforced earth technique has been tried effectively in solving majority of geotechnical engineering problems (Hausmann, 1990). With the introduction of geosynthetics, the reinforced earth technique gained its prominence due to its adaptability for different field conditions. Limited studies (Kinney et al, 1998) are also made by placing reinforcement in one of the layers of flexible pavement system laid over conventional non-swelling subgrades. However, the results are not conclusive in respect of the type of the reinforcement agent for overcoming the problems related with expansive soil.
Majority of studies on the expansive soils have been confined to laboratory (Srirama Rao, 1984). However, the efficacy of the proposed method will be proved only when it is tried in real life situation. Test tracks are the means by which one can perform this task in an effective manner. Several test track studies (Reddy et al, 1981; Rolt et al, 1987; Gichaga.1991; Seeds et al, 1999) have been focussed on pavement material characterisation, critical environmental conditions and problematic soil conditions. However not much work has been reported on evaluating the performance of reinforced test track constructed on expansive soil subgrade.
In the light of above discussions with respect to problems posed by expansive soils and flyash as well as the solutions tried to contain them for better pavement performance, there appears to be gaps either with the materials used or the technique adopted. Efforts are called for to bridge the gaps so as to enable to recommend a technique that addresses the issues. Further any technique proposed has to be validated with experimentation under field simulated conditions. Therefore, there is a need for further probing and coming out with the techniques in the present research with appropriate structural and economic analysis, and hence has been taken up with the following objectives.

OBJECTIVES OF THE PRESENT STUDY

The present study is carried out with the following objectives.
1. To identify the gambit of techniques to overcome the problems posed by expansive soils with a view to adopt suitable methodology through critical review of literature.
2. To examine the suitability and adaptability of alternative reinforcement materials like bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber in place of conventional geogrids that are relatively expensive as on date.

3. To construct a test track of flexible pavement with experiences gained in laboratory for evaluating the relative performance of alternative reinforcing materials.
4. To analyse the impact of the treatments on structural and economical aspects of highways.

II. MATERIALS AND THEIR PROPERTIES

In this section, properties of different types of materials used during the laboratory experimentation are presented.

Expansive Soil

The soil used as a subgrade in this study was a typical black cotton soil collected from `Lodi Lanka' near Amalapuram, East Godavari (Dt). This soil is classified according to IS classification as inorganic.

Table 1 Properties of Expansive Soil

S.N0	Property	Value
1	Specific Gravity	2.65
2	**Grain Size Distribution**	
	Sand (%)	4
	Silt (%)	34
	Clay (%)	62
3	**Compaction Properties**	
	Maximum Dry Density(kN /m^3)	15.69
	O.M.C. (%)	23
4	**Atterberg Limits**	
	Liquid Limit (%)	75
	Plastic Limit (%)	35
	Plasticity Index (%)	40
	Shrinkage Limit (%)	12
	IS Classification	CH
5	Differential Free Swell (%)	150
6	Soaked CBR (Compacted to MDD at (01VIC) (%t	2

Sand

Sand was used as another Subgrade material collected from a site at J.N.T.U.Engineering college campus, Kakinada. This soil is classified as well graded sandy soil. The properties of the soil are assessed as per I.S.Code provisions, which are presented in the table .2

Table .2 Properties of Sand Soil

. S.No	Property	Value
1	Specific Gravity	2.65
2	**Grain-Size Distribution**	
	Gravel (%)	1
	Sand (%)	96
	Silt and Clay *(%)*	3
	Coefficient of Uniformity (Cu)	6.15
	Coefficient of Curvature (Cc)	1.24
3	**Compaction Properties**	
	O.M.C. (%)	11
	Maximum Dry Density (kN/m^3)	16.68
4	Soaked CBR (Compacted to MDD at OMC)	6

Gravel

The gravel used as subbase material in this investigation, was collected from Dwarapudi, E.G.Dt. The properties obtained from the laboratory tests are furnished below in table 3.

Table .3 Properties of Gravel

S.No	Property	Value
1	Specific Gravity	2.68
2	**Grain-Size Distribution**	
	Gravel (%)	59
	Sand (%)	31
	Silt 85 Clay (%)	10
3	**Compaction Properties**	
	Maximum Dry Density (kIslim^3)	18.05
	0 . M.C. (%)	13
' 4	**Atterberg Limits**	
	Liquid Limit (%)	28
	Plastic Limit (%)	20
	Plasticity Index (%)	8
5	Soaked CBR (Compacted to MDD at OMC) (%)	8.0

Flyash

Flyash used as another Subbase material, was collected from Vijayawada, thermal power station, Vijayawa.da. The properties of flyash are furnished in Tables .4

Table .4 Properties of Flyash

S.No	Property	Value
1	Specific Gravity	1.95
2	**Grain Size Distribution**	
	Sand (%)	25
	Silt (%)	70
	Clay (%)	5
3	**Compaction Properties**	
	Maximum Dry Density (kN/m^3)	13.24
	O.M.C. (%)	24
4	Liquid Limit. (%)	28
5	Soaked CBR. (Compacted to MDD at OMC) (%)	4

Table.5 Chemical Composition of Fly Ash

Name of the Chemical	Symbol	Range by % of weight
Silica	Si02	61 to 64.29
Alumina	Al204	21.60 to 27.04
Ferric Oxide	Fe203	3 . 0 9 t o
Titanium dioxide	TiO2	1.25 to 1.69
Manganese Oxide	MnO	Up to 0.05
Calcium Oxide	CaO	1.02 to 3.39
Magnesium Oxide	MgO	0.5 to 1.58
Phosphorous	P	0.02 to 0.14
Sulphur Trioxide	S03	Up to 0.07
Potassium Oxide	1(20	0.08 to 1.83
Sodium Oxide	Na20	0.26 to 0.48
Loss on ignition		0.20 to 0.85

Road Metal
Road metal of size 20 mm conforming to WBM-III, satisfying the MORT Specifications was used as base course material.

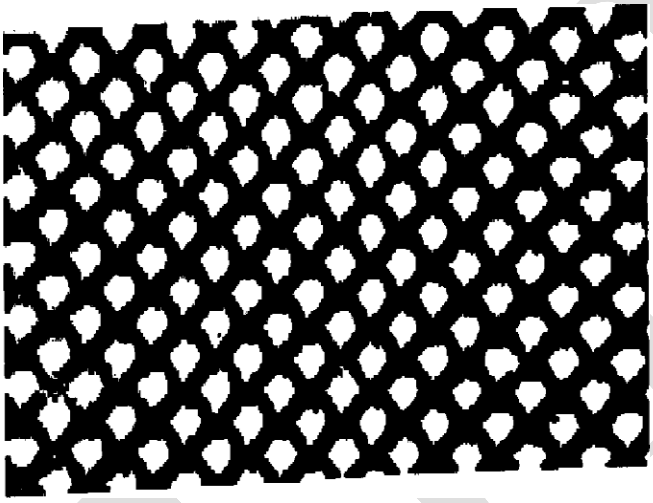

Fig.1 Netlon CE 121 Geogrid

Chicken Mesh
Chicken Mesh with peak tensile strength of 8.85 kN/m and aperture size of 2mm x 2mm coated with 80/100 grade bitumen was used as an alternative reinforcement material as shown in the Fig.2.

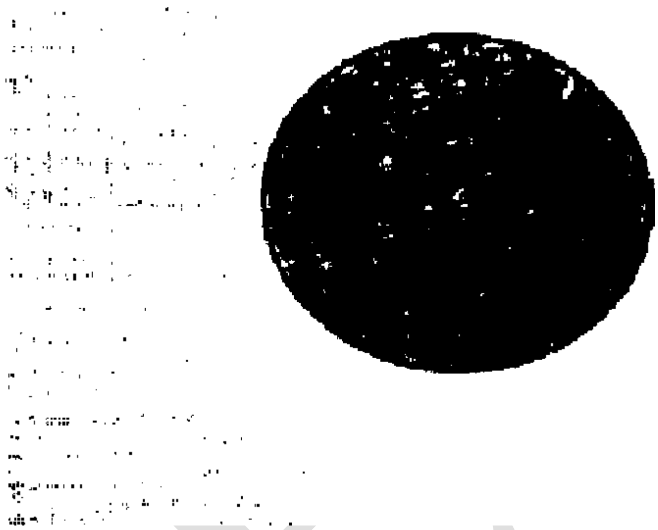

Fig.2 Bitumen Coated Chicken Mesh

Bamboo Mesh
Bamboo Mesh of thickness 1mm with peak tensile strength of 26.32 kN/m coated with 80/100 grade bitumen was used as an alternative material as shown in the Fig.3.

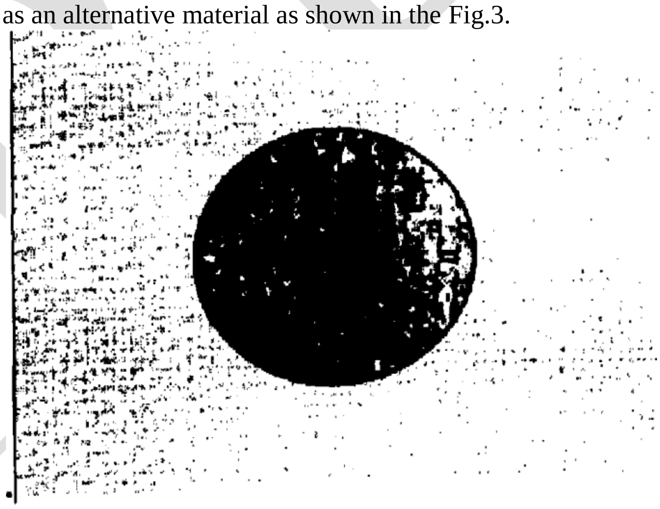

Fig.3 Bitumen Coated Bamboo Mesh

Waste Plastic Strips
Waste plastic strips having a size of 12 mm x 6 rnm and a thickness of 0.5 nun was used as an alternative reinforcement material in this study, as shown in Fig.4.

Fig.4 Waste Plastic Strips

Waste Tyre Rubber Chips

Waste Tyre Rubber chips passing through 4.75 mm sieve were used in this study, as an alternative reinforcement material as shown in Fig.5.

Fig.5 Waste Tyre Rubber Chips

III. FIELD STUDIES

GENERAL

Details regarding the laboratory experimentation carried-out with reinforcement have been discussed in the previous chapter. Procedures adopted for developing experimental set-up for the test track studies conducted for reinforcement materials are explained in this chapter. Further, the in-situ testing details are also discussed.

CONSTRUCTION DETAILS OF TEST TRACKS

Generid

Laboratory experimentation was followed by the test track studies in this research, for which, a single lane test track of 18 m long and 1.5 m wide with different reinforcements was used in the campus of JNTU Engineering College, Kakinada. Details of procedures followed in the construction of test tracks are given in the following section

Construction Details of Test Track on Sand Subgrade with Gravel Subbase

Six alternative model pavement stretches were laid on sand subgrade with gravel as subbase, shown in fig and the details of which are presented below.

Gravel sub-base (alternative -1)

Excavation of test pit

A stretch of size 3m long and 1.5m wide was excavated to an average depth of 0.8m. Out of which 0.5m was for laying sub-grade, 0.15m was for laying subbase and 0.15m for laying base.

Laying of subgrade material

In the prepared test pit, the sand was mixed with water at OMC and was laid in the excavated pit in 10 layers such that each layer of 5.0 cm compacted thickness amount to a total thickness of 50 cm. The compaction was done with the help of hand operated 2 ton roller for the entire test corresponding to OMC and MDD.

Subbase

On the prepared subgrade, gravel as subbase, mixed with water content at OMC, in two layers each of 7.5 cm compacted thickness to a total thickness of 15cm was laid. The compaction correspond to MDD is done by using hand operated roller.

Base course

Two layers of WBM -II each of 7,5cm compacted thickness to a total thickness of 15cm using crushed stone of size 43 to 60mm, with gravel as binding material was laid on the prepared subbase

Geogrid Reinforced subbase (alternative-2)

This stretch was also constructed similar to alternative-1, except that gravel subbase was reinforced with Geogrid. On the prepared subgrade, gravel subbase material, mixed with water content at OMC, of 7.5 compacted thicknesses was laid. The reinforcement material geogrid was placed above the first compacted layer of the test pit. Another compacted layer of gravel subbase of thickness 7.5 cm was laid over the reinforcing material. On the prepared subbase two layers of WBM-II each of 7.5 cm compacted thickness to a total thickness of 15cm using crushed stone aggregate of size 43mm to 60mm with gravel as binding material was laid. The compaction was done with the help of hand operated roller for the entire test.

Bitumen coated chicken mesh reinforced subbase (alternative-3)

This stretch was also constructed similar to alternative-2, except in place of geogrid reinforcement, bitumen coated chicken mesh.

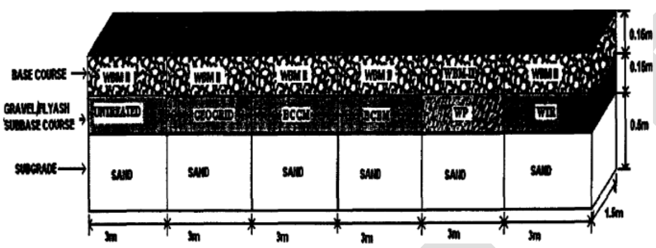

Fig.6 Test Tracks Laid on Sand Subgrade with Gravel/Flyash Subbase

Flyash subbase stretch (Alternative- 19)

Excavation of test pit

A test pit of 0.8m average depth was excavated with a size of 3m x1.5m. In this pit 0.5m depth was used for laying subgrade, 0.15m depth for laying subbase and 0.15m depth for laying base course.

Preparation of subgrade

In this model pavement stretch, the expansive soil brought from Gandilanka, was spread in the field, allowed for dry and then pulverised with the help of wooden rammers.

Laying of subgrade material

In the prepared stretch, the pulverised expansive soil mixed with water at OMC was laid in layers of 5cm compacted thickness, to a total thickness of 50cm. The compaction corresponding to MDD was done using hand-operated roller.

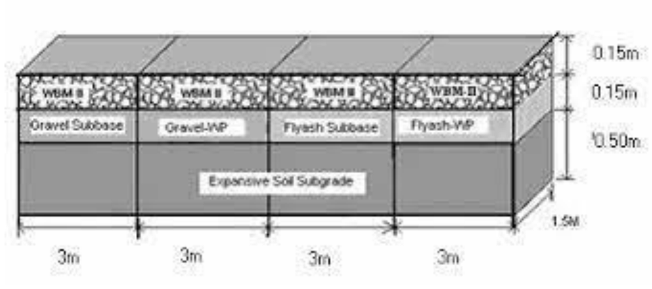

Fig 7 Test Tracke Laid Expensive Subgrade with Gravel/Flyash Subbase

Subbase

On the prepared subgrade, flyash mixed with water at OMC was laid in two layers each of 7.5 cm compacted thickness amounting to a total thickness of 15 cm. The compaction corresponding to MDD was done using 2 ton hand operated roller.

Baas course

On the prepared subbase, two layers of WBM-I1 each of 7.5cm compacted thickness, was laid to a total thickness of 15cm.

IV. RESULTS AND DISCUSSION

The results obtained in this research work were presented here.

GENERAL

Details of the Laboratory and Field *experimentation* carried out with different reinforcement materials viz, geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh, waste plastics and waste tyre rubber are used in gravel/ flyash subbases with sand / expansive soil subgrade have been discussed in the previous chapters. In this chapter a detailed discussion on the results obtained from various laboratory tests are presented. Further, the results of the test track constructed on the sand / expansive soil subgrade are also discussed.

PRELIMINARY LABORATORY TEST RESULTS

General

In the laboratory, direct shear and CBR tests were conducted by using different percentages of waste plastics and waste tyre rubber chips mixed with gavel and flyash materials, with a view to find the optimum percentage of waste plastics and waste tyre rubber. Cyclic load tests were conducted for different model pavements reinforced with different bamboo mesh, waste plastics and waste tyre rubber laid on expansive soil/sand subgrade.

Direct Shear Test Results

The direct shear tests were conducted as per IS: 2720 (part XIII, 1986) in the laboratory for gravel/flyash materials with

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and without waste plastics and waste tyre rubber and the results are furnished in tables & figures below.

Table 6.Shear Strength Parameters for Gravel and Flyash Materials Reinforced with Different Percentages of Waste Plastic Strips .

% of Waste Plastics	Gravel		Flyash	
	C (kN m2)	a,	C (kN/m²)	0°
0.0	14.72	36	7.85	33
0.1	18.93	37	9.64	34
0.2	23.64	40	12.65	36
0.3	27.76	44	16.70	38
0.4	27.65	43	18.64	40
0.5	26.29	42	17.66	38

Based on the above results, it is observed that, for gravel reinforced with waste plastics, the angle of internal friction values are increased from 360 to 440 with 0.3 % of waste plastics and thereafter decreased with further additions. The cohesion values are increased from 14.72 to 27.76 kN/m2
plastics, the cohesion and angle of internal friction values are increased from 7.85 to 18.64 kN/ m2 and 330 to 400 respectively with 0.4 % of waste plastics and there after decreased.

Table 7 Shear Strength Parameters for Gravel and Flyash Materials Reinforced with Different Percentages of Waste Tyre Rubber.

% of Waste Tyre Rubber	Gravel		F 1	
	kN m2	0°	C li.N m²	0°
0.00	11.77	36	7.85	33
0.50	14.72	36	10.10	3 3
1.00	17.66	37	11.77	34
2.00	20.60	38	13.24	35
3.00	21.58	40	14.13	36
4.00	24.53	41	15.21	37
5.00	26.48	43	17.37	38
6.00	25.51	42	18.64	39
7.00	25.51	41	15.70	38

The cohesion and angle of internal friction values for gravel materials are increased from 11.77 to 26.48 kN/m2 and 360 to 430 respectively with 5.0 % of waste tyre rubber chips and thereafter decreased. The cohesion values are increased from 11.77 to 26.48 kN/m2 with 5.0 % waste tyre rubber chips and there after decreased. The cohesion and angle of internal friction values for flyash are increased from 7.85 to 18.64 kN/ m2 and 330 to 390 respectively with 6.0% of waste tyre rubber chips and thereafter decreases as observed.

California Bearing Ratio (CBR) Test Results

CBR tests were conducted for *gravel/flyash* materials reinforced. with different percentages of waste plastics/waste tyre rubber and the results are presented..

Table 8 Variation of Soaked CBR values for Gravel and Flyash Materials Reinforced with Different Percentages of Waste Plastics

% Waste Plastics	Gravel I	Piggish
	Soaked CBR (%)	
0.0	8.0	4.0
0.1	9.37	5.98
0.2	13.34	7.41
0.3	16.42	8.91
0.4	15.23	10.81
0.50	1 4 . 1 2	9.47

It is observed that for gravel / flyash reinforced with waste plastic strips, soaked CBR values are increased from 8.0 to 16.4 and 4.0 to 10.81 *for* 0.30 % and 0.40 % of *waste* plastics *respectively*. The soaked CBR values are also increased from 8.0 to 13.32 and 4.0 to 8.73 for 5.0 % and 6.0 % of waste tyre rubber respectively.

Table 9 Variation of Soaked CBR value* for Gravel and Flyash Materials Reinforced with Different Percentages of Waste Tyre Rubber

% Waste Tyre Rubber	Gravel	Flyash
	Soaked CBR (%)	
0.0	8.0	4.0
0.50	8.63	4.89
1.0	9.13	5.41
2.0	10.04	6.32
3.0	10.98	7.02
4.0	11.91	7.83
5.0	13.32	8.31
6.0	12.98	S.73
7.0	11.69	7.81

It is observed from the results that the gravel *material reinforced* with waste plastics and waste tyre rubber has shown better performance when compared to flyash reinforced material. It is also observed that waste plastics reinforced gravel/ flyash materials has shown maximum improvement compared to waste tyre rubber reinforced material.

From the results of direct shear and california bearing ratio tests, the optimum percentage of waste plastics and waste tyre rubber chips for gravel and flyash materials, based on direct shear tests and CBR tests are presented in table 9.

Table: 9 Optimum Percentages of Waste Plastics and Waste Tyre Rubber

&NO	Subbase Soil	Reinforcing Material	Optimum Percentage of Reinforcing Material	
			Direct Shear Test	CSR Test
1.	Gravel	Waste Plastics Chips	0.3	0.3
2.	Gravel	Waste Tyre Rubber Chips	5.0	5.0
3.	Flyash	Waste Plastics Chips	0.4	0.4
4.	Flyash	Waste Tyre Rubber Chips	6.0	6.0

The reason is that, density of gravel is more as compared to flyash and the fibre reinforcement increases the ultimate shear strength and also limits reduction in the post- peak shearing resistance of the soil. The angular shape and excellent friction characteristics allow the tyre shreds to lock together with soil and increase the density as well as strength of the material.

V. CONCLUSIONS

Expansive clays me the most problematic soils due to their unique alternate swell-shrink behaviour with fluctuations in moisture content. Continued efforts have been made all over the world to devise ways and means to solve the problems due to the expansive soils, Placements of adequate surcharge load, prewetting, moisture control, chemical stabilisation and reinforcement technique are some of the tried and tested remedial measures to overcome the problems posed by these soils. However, these and many other techniques are successful only to a partial extent and hence the attempts to device better techniques are still on. In addition, majority of these works have been confined to laboratory under on remoulded samples (Srirama Rao. 1984) and hence fail to simulate many of the field conditions (Chen, 1988)- Even now, it is still a puzzling problem among researchers in identifying the factors that control the behaviour of expansive soils and the magnitude of in-situ heave and pressures generated by such soils when they absorb water.

In the recent past, reinforced earth technique has been tried effectively in solving majority of geotechnical engineering problems (Hausmann, 1990). With the introduction of geosynthetics, the reinforced earth technique gained prominence due to its adaptability for different field conditions. Few researchers have tried (Haas et al, 1988; AL. Qadi and Bhutta, 1999) to introduce geosynthetic reinforcement layer in the pavement system to improve its performance and the results are encouraging. In majority of the previous studies, the reinforcement layer is used either at the pavement - subgrade interface as a separator or below the wearing course to control the rut formation. Limited studies (anney et al, 1998) are also made by placing reinforcement in one d the layers of flexible pavement system laid over conventional non - subgrades. However, the results are not conclusive with spm refa-ence to roads, in respective of the type of the reinforcement agent for overcoming the problems related to expansive soil. Hence, it is proposed in this resemh to investigate the influence of introducing a reinforcement layer in the subbase course of the flexible pavement on overall performance of the pavement in terms of improvement of strength as well as control of crack propagation. Experimentation is proposed to be carried-out in the laboratory and field to investigate the possibility of using cheaper alternative reinforcement materials like bitumen coated chicken mesh, bamboo mesh, waste plastics and waste lyre rubber in place of conventional geosynthetics. showed lesser bound deflections. However, the variation in the performance is marginal for the geogrid and bitumen coated chicken mesh reinforcement materials. Relatively poor perfomana of bitumen coated bamboo mesh could be attributed to its smooth surface to mobilize adequate friction. Waste plastics and waste tyre rubber are more elastic which can lead to higher normal deformations.

No significant control of heave is observed when reinforcement is placed in flexible pavement subbase laid on expansive soil subwade. Funhcr it can be seen that heaving of the expansive soil considerably decreases the load carrying capacity of the pavement system.

- The load carrying capacity has increased for gravel reinforced subbase when compared to flyash reinforced subbase on both sand and expansive soil subgrades during dry and wet seasons.

- At all deformation levels, flexible pavement system laid on sand subgrade has yielded higher load-carrying capacity when compared with the flexible pavement system laid on expansive soil subgrade in both dry and wet seasons.

- The improvement of the pavement performance is cognizable for the two reinforcement materials tried viz., geogrid and bitumen coated chicken mesh. Both geogrid and bitumen coated chicken mesh provide excellent interlocking of soil particles, thereby msdting in better performance compared with bitumen coated bamboo mesh, waste plastics and waste tyre rubber.

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