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Effect of Flyash Stabilisation on the Design of Flexible Pavement

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Abstract—*Recycling initiatives that have recently undertaken worldwide proposes sustainable use of non-renewable resources in highway construction and allow us to conserve our resources for future generations as well. One of the excellent inventiveness in this field is to use flyash as a binder. In this paper the effect of flyash on the flexible pavement design has been thoroughly studied. A road of length 1 km from Majhauli to Katra at Muzaffarpur district, Bihar had been selected for investigation. Disturbed and undisturbed sampling were done at every 250m of intervals. 5 samples were collected and brought to (Muzaffarpur Institute of Technology) M.I.T. laboratory, Muzaffarpur. Further, samples of flyash were collected from Muzaffarpur Thermal Power Station (MTPS) Kanti and brought to M.I.T. laboratory for analysis. Flyash was then mixed in different percentages in soil samples and tested for strength and characteristics properties as per Bureau of Indian Standards (BIS). The various test that has been performed were field water content, specific gravity, Atterberg's limits, compaction test, triaxial test and CBR test. Further the results were tabulated and used in calculating the pavement thickness using G.I. method, triaxial method. Results were analysed and a considerable amount of reduction in pavement thickness was found.*

Keywords: *Flyash, Pavements, Flexible pavements, non-renewable resources, binder.*

1. INTRODUCTION

The surface of the roadway should be stable and non-yielding, to allow heavy wheel load of road traffic to move with least possible rolling resistance. The road surface should also be even along the longitudinal profile to enable the fast vehicles to move safely and comfortably at the design speed. The earth road may not be able to fulfill any of the above requirements, especially during the varying conditions of traffic loads and the weather [1-3]. At high moisture contents, the soil becomes weaker and soft and starts yielding under heavy wheel loads, thus increasing the tractive resistance. The unevenness and undulations of the surface along the longitudinal profile of the road causes vertical oscillations in the fast moving automobiles increasing the fuel consumption and the wear of the vehicle components resulting in considerable increases in the vehicle operation cost. Apart, form this uneven pavements surface cause discomfort and fatigue to the passengers of fast moving vehicles and cyclists. Therefore, in order to provide a stable and even surface for the traffic, the roadway is provided with a suitably designed and constructed pavements structure. Thus a pavements consisting of a few layers of pavements materials is constructed over a prepared soil sub-grade to serve as a carriageway [2-4]. The pavement carries the wheel loads and transfers the loads stresses through a wider area on the soil sub-grade below. Thus the stresses transferred to the sub-grade soil through the pavement layers are considerably lower than the contact pressure or compressive stresses under the wheel load stress due to the pavement depends both on its thickness and the characteristics of the pavement layers. A pavement layer is considered more effective or superior, it is able to distribute the wheel load stress through a larger area per unit depth of the layer[5-6]. However, there will be small amount of temporary deformation even on a good pavement surface when heavy wheel loads are applied. One of the objectives of a well designed and constructed pavement is therefore to keep this elastic deformation of the pavement within the permissible limits, so that the pavement can sustain a large number of repeated load applications during the design life.

Based on the vertical alignment and the environment conditions of the site, the pavement may be constructed over an embankment, cut or almost at the ground level itself. It is always desirable to construct the pavement will above the maximum level of the ground water to keep the sub-grade relatively dry even during monsoon.

2. TRANSPORTATION IN RURAL DEVELOPMENT

With over 75 percent of the population of the country living in the villages, the development in urban centres alone do not indicate the overall development of the country. Only with the improvement in transportation facilities in rural areas, there could be faster development of the rural centres. The fertilizers and other inputs for agriculture and cottage industries could reach the rural population easily and similarly the products can be sold at the nearest marketing centres for more remunerative price resulting in faster economic growth and decreased wastage. With improved facilities for education, health care and other social needs in the villages, the urge for the migration to urban centres decreases, thus helping in balance development of the country as a whole.

3. COMPARATIVE STUDY OF ROAD STATISTICS

The road statistics give an idea of the stage of road development of a country. The road statistics may be presented on the basis of area of the country or the population. The road network of this country has to be considerably increased during the development plans. The poor state of road development in India in the past may be due to the following reasons:

(i) There was no planned development of roads in the country up to the initiation of Nagpur Road Plan in the year 1943. Only during the five year plans since 1951, the development works were speeded up.

(ii) The investment even today on the road development programme is much lower than the revenue from the road transport.

(iii) Poor economic conditions of the vast majority of the population in villages prohibit the owning of private vehicles and discourage the use of transport.

A natural earth track is incapable of supporting modern wheel loads. A constructed pavement is required on the top of the soil in order to distribute the wheel road efficiently and to provide the necessary wearing surface. A pavement is, therefore, defined as a relatively stable crust constructed over the natural soil for the purpose of supporting and distributing the wheel loads and providing and adequate wearing surface. Depending upon the mode of supporting and distributing loads, pavements are classified as flexible, rigid and semi flexible.

4. STRUCTURE OF FLEXIBLE PAVEMENT

The essential difference between rigid and flexible pavements is the manner in which they distribute the load over the sub-grade. The design of a flexible pavement is based on the principle that a surface load is dissipated by carrying it deep into the ground through successive layer of granular materials. Hence the strength of a flexible layer is a result of building up thick layers and thereby distributing the load over the sub-grade rather than by the bending actions. The thickness design of the flexible pavement is influenced primarily by the strength of the sub-grade. The cross section of Flexible Asphalt-Based Pavements Rigid Portland-Cement Concrete Pavement is shown below in Fig 1.

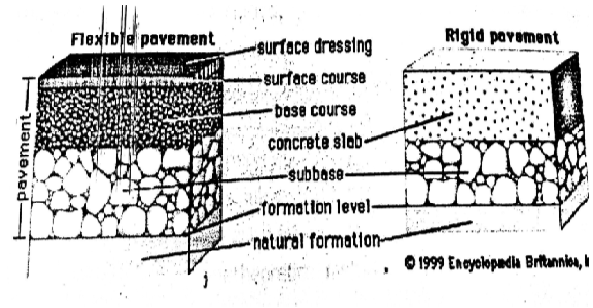

Fig. 1: Cross section of Flexible Asphalt-Based Pavements Rigid Portland-cement Concrete Pavement

5. CHRONOLOGY OF INVESTIGATION

The chronology of this experimental investigations is as follows:

a) The routine properties and strength characteristics (Triaxial and CBR etc.) of the soil of Muzaffarpur was determined.

b) Analysis of the fly ash available as a byproduct of the thermal power station at Kanti, Muzaffarpur.

c) The effect of soil properties after mixing fly ash with soil in different percentage was studied.

d) Effect of mixing fly ash (in different percentages) on the pavement design in terms of thickness was determined.

e) The percentage saving in material of pavement in the case of stablised soil with fly ash was compared to that of natural soil was investigated.

Soils samples will be collected from selected site of road length 1 km running from Majhauti to Katra Road, Muzaffarpur. Detailed investigations and laboratory tests (routine tests, CBR value etc.) will be carried out for collected natural soil samples as per Bureau of Indian.

Standard (BIS) Pavement design were carried out on the basis of investigated soil properties and criteria laid down in Indian Road Congress (IRC). Further, flyash were be procured from the Muzaffarpur Thermal Power Station, Kanti to ascertain its properties in laboratory and were mixed in different percentage with soil samples. All the test result with different methods are being shown in the Table no.1.

Table No. 1: Comparison of Pavement Thickness obtained by different methods with mixing of flyash in different percentages with Natural soil

Sl no	Soil composition and percentages savings	CBR method		GI method	Triaxial method
		Unsoaked (cm)	Soaked (cm)	(cm)	(cm)
1	Natural soil	40.5	47.2	30.6	29.18

2	Soil with 10% flyash	33.6	35.4	30	26.63
3	Soil with 20% flyash	31.6	33.6	30.1	24.63
4	Percentage saving in pavement thickness w.r.t natural soil for 10 % mixing of flyash	17.03	25	1.96	8.74
5	Percentage saving in pavement thickness w.r.t natural soil for 20 % mixing of flyash	21.96	28.81	1.63	15.59
6	Percentage saving in pavement thickness w.r.t natural soil mixed with 10% flyash for 20% mixing of flyash	4.93	3.81	0.33	6.85

The graphs of thickness of pavement vs soil and flyash proportion by CBRI method is shown below in Fig.1

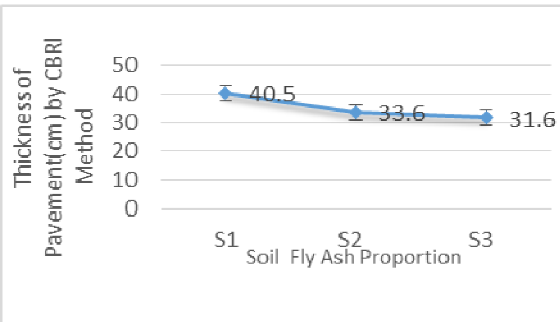

Fig. 1: Graph of thickness of pavement vs soil and flyash proportion by CBRI method

The graphs of thickness of pavement vs soil and flyash proportion by GI method is shown below in Fig.2

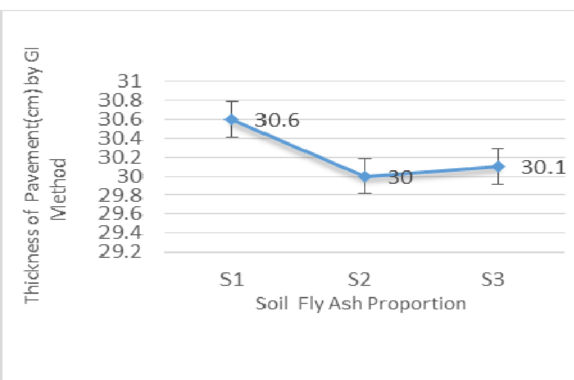

Fig. 2: Graph of thickness of pavement vs soil and flyash proportion by GI method

The graphs of thickness of pavement vs soil and flyash proportion by GI method is shown below in Fig.3

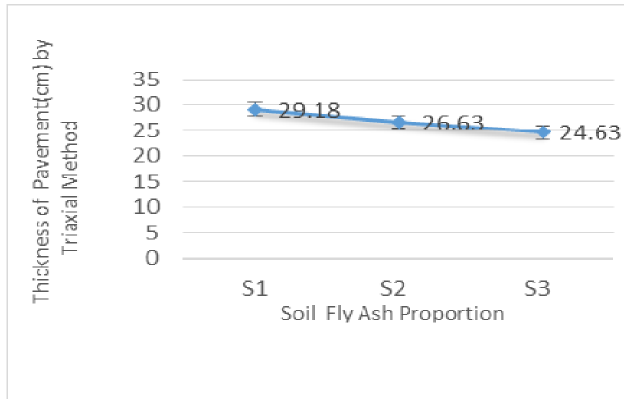

Fig. 3: Graph of thickness of pavement vs soil and flyash proportion by Triaxial method

6. CONCLUSION

Among all the samples, that were taken, it was observed that, when the soil was replaced by flyash by 20% by its weight, least pavement thickness was required. Based on the above test results it can be concluded that the natural soils should be stabilised by flyash on the commercial basis. The stabilisation of natural soil with flyash will certainly yield in terms of economy as well as minimizing environmental pollution. Since the reasonable percentage of reduction is found in pavement thickness after mixing of flyash in soil, hence the giant problem of flyash disposal can be mitigated.

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