CHAPTER 1

INTRODUCTION

Highway pavements need good quality paving materials having adequate strength and durability characteristics. With petroleum prices rising sharply, bitumen is no longer a cheap material in India and therefore, bituminous macadam and other bituminous materials can not be considered as economical road bases at present. But highway activities have increased manifolds in recent times due to rapid industrialisation and urbanisation. As a result, quality paving materials have really become scarce and costly. Under the circumstances use of locally available indigeneous materials after suitable treatment or otherwise, is the only solution to meet the growing demand of road construction and replace the costly paving materials being used. The present study is one such attempt to evaluate the suitability of the soils available in the lateritic terrain of Kharagpur and the adjoining areas covering about 3000 sq. kms. between latitudes 22°50' N and 23°30' N and longitudes 87°00' E and 87°40' E (1)[1] for use as road bases after treatment with lime and coconut fiber.

"Laterites are products of intense sub-serial rock weathering, whose Fe and/or Al content is higher and Si

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[1] Numbers in parentheses refer to the list of references placed at the end of this dissertation.

content is lower than in merely kaolinised parent rocks. They consist predominantly of kaolinite, goethite, hematite, gibbsite and quartz. A laterite profile comprises all stages from parent rock to the surface (2)" and therefore, laterite soils cover a wide range of materials, from earthy to rocky. Essentially, they are products of tropical or sub-tropical weathering and commonly found as reddish pedogenic surface deposits. Popularly, they are known as 'red tropical soils'. The location and distribution of laterite materials have been associated with temperature and rainfall conditions characterising the earth's surface between latitudes 35°N and 35°S (3). Of this, nearly one-third of the total land surface of the earth is contained within the huge belt bounded by the tropics of cancer and capricorn. 'Red tropical soils' are the dominant feature of the landscape within this area (4). In India, the coastal part and its adjoining interior are areas of known laterite soil occurence and exhibits distinctive distribution of these soils. The present study area, being at Kharagpur, belongs to the east coast of the land.

Informations regarding engineering behaviour of laterite soils are still scanty. A great volume of work has been devoted to classification and preparation of an acceptable nomenclature of 'red tropical soils', which again are very confusing and of limited use (4). The reported studies on the geo-technical characteristics and field performance of laterite soils by some authors (5,6,7,8,9,10) have indicated that these soils are either inferior aggregates or problem materials, particularly in the context of pavement and earth dam construction. Now, it has been established, that all laterite soils are not problem soils. They may range in performance from excellent to poor for engineering purposes (11,12,13). The problem, as pointed out by Winterkorn and Chandrasekharan (14), 'is one of recognising the good, eliminating the poor and improving the intermediate ones'.

In case of temperate-zone soils, it is possible, through systematic research and geotechnical experience over the years, to classify the soils and predict their engineering behaviour on the basis of such index properties as particle size distribution and plasticity. But for laterite soils, no such straightforward relationships exist. Attempts to identify all laterite soils on the same basis has sometimes proved misleading and led to erroneous conclusions (7,8,9,15), although Clare (16, 17) and Remillon (18) have reported some success in the formulation of criteria for the identification of these soils for engineering purposes. Failure to develop universally acceptable procedures for all laterite soils has, therefore, intensified local efforts towards locating available laterite soils and evaluating their properties (19,20,21).

In view of above, the reddish-brown fine-grained laterite soils extending over a large area in and around Kharagpur have been chosen for the current laboratory investigation to evaluate the suitability of this regional soil for application in pavement layers, particularly as a lime-bound base material.

Suitability of a material for engineering purposes can be tested on the basis of strength and durability. The direct way to recognise whether a soil material for use in pavement layers is suitable or unsuitable or can be made suitable by treatment is possible by studying the various strength characteristics. In the present investigation, emphasis has been given on the strength aspect only. A good road base made up of bound material should have adequate flexural fatigue strength, particularly when the material is applied in the upper layers of the pavement. The laterite soils in and around Kharagpur have two distinct soil horizons, the laterite hard crust and the underlying mottled zone. The loamy soils, designated as A,B,C and D for the present study have been collected from the well developed mottled zone from various locations in the area. The air-dried soil without any treatment gives C.B.R. values under modified AASHTO compaction as low as 3.42 to 3.50, which further decrease on soaking. 5 per cent addition of hydrated lime, powdered and containing nearly 64 per cent calcium oxide increases the values 10 times or so and 4 days' soaking further improves the results. This, therefore, indicates that the soils are lime-reactive in nature and there is scope for detailed investigation of the material-strength based on compaction, curing and mix proportion.

It has been almost universally accepted that addition of lime in favourable climate in small amounts, 3 to 7 per cent by weight, to reactive soils produces a marked improvement in the engineering properties (22). This brings about a decrease in density, a reduction in plasticity, an improvement of workability and an increase in soil strength. The pozzolanic reactions that take place between lime and soil silica and/or alumina form various cementing agents, primarily silicates and aluminates of calcium. These reaction products are mainly responsible for development of strength. The degree to which lime will react with soil, however, depends on such variables as the quantity of lime, soil type, the compaction, the length of time, the lime-soil mixtures are cured and also the curing type, that is, accelerated or ordinary curing. The laterite materials as used here, having found to respond favourably to lime treatment on preliminary investigation giving increased C.B.R., have been subjected to unconfined compression to determine quantitatively the beneficial effects of the treatment by obtaining strength-density relationship, by working out optimum composition of the mix, and by comparing normal laboratory moist curing with accelerated oven curing.

Compaction is commonly used to improve the strength of the pavement layers, bound or unbound. The usual compaction variables are water content, dry density and compactive work. For compaction, dry of optimum, dry density is a function of both water content and compactive work, and for compaction